
TOROS ÜNİVERSİTESİ
2009
1st International Traditional Foods and Sustainable Food Systems Symposium
TFSF
1st International
Traditional Foods and
Sustainable Food Systems
Symposium
August 10, 2022
Mersin - Türkiye
zoom

TOROS UNIVERSITY

FACULTY OF FINE ARTS, DESIGN AND ARCHITECTURE

DEPARTMENT OF GASTRONOMY AND CULINARY ARTS

1st INTERNATIONAL TRADITIONAL FOODS AND SUSTAINABLE FOOD SYSTEMS SYMPOSIUM

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E-ISBN: 978-605-9613-14-9

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COĞRAFİ İŞARETE SAHİP ZİLE KÖMESİNİN ENERJİ VE BESİN ÖGELERİ İÇERİĞİNİN İNCELENMESİ

Kübra ESİN[1]

ÖZET

Zile Kömesi, içerisinde ipe dizili ceviz içeren, narince üzümü şırası, buğday nişastası ve un ile hazırlanmış hasuda ile kaplanmış tatlı bir gıda ürünüdür. 2017 yılında coğrafi işaret alan Zile Kömesinin iki temel bileşeni olan Tokat cevizi ile narince üzümünün kendine has özellikleri, Zile kömesini diğer yörelerde yapılan benzer ürünlerden farklı kılmakta ve kendine özgü tat ve aromasını sağlamaktadır. Zile kömesinin üretiminde şeker, tatlandırıcı, aroma verici veya aroma verme özelliği bulunan bileşenler de dahil olmak üzere herhangi bir gıda katkı maddesi kullanılmamaktadır. Temelinde üzüm şırası, ceviz ve nişasta ile hazırlanan ve rafine şeker içermeyen bu yöresel tatlı, lezzetinin yanında besleyiciliği ile de dikkat çekmektedir. Ancak literatürde Zile kömesinin enerji ve besin ögesi değerlerini analiz eden herhangi bir çalışmaya rastlanmamıştır. Bu nedenle, bu çalışma Zile kömesinin enerji ve besin ögesi değerlerini analiz etmeyi amaçlamıştır. Zile kömesinin içeriği, Türk Patent ve Marka Kurumu resmi internet sayfasından alınmış olup verilen miktarlar üzerinden 100 gramının içeriği hesaplanmıştır. Zile kömesinin enerji ve besin ögeleri Beslenme Bilgi Sistemi (BeBiS) 9 bilgisayar programında analiz edilmiştir. Zile kömesinin 100 gramı 352,1 kalori olup 2,3 g lif içermektedir. Makro besin ögesi dağılımına göre %57'si karbonhidrat, % 38'i yağ ve %5'i proteindir. Zile kömesi zengin bir vitamin ve mineral içeriğine sahip olup E vitamini, niasin, biotin, bakır, manganez, linoleik asit ve alfa-linolenik asit içeriği yüksektir. Sonuç olarak rafine şeker içermeyen ve zengin besin ögesi içeriğine sahip Zile kömesi sağlıklı bir yöresel tatlıdır. Bu ve benzeri çalışmaların yapılması, yöresel yemeklerin sadece lezzet boyutunun değil besin ögesi ve sağlık ile olan ilişkisinin anlaşılması açısından da faydalı olacaktır.

Anahtar Kelimeler: *Zile kömesi, coğrafi işaret, yöresel yemek, enerji, besin ögesi.*

INVESTIGATION OF THE ENERGY AND NUTRIENT CONTENT OF THE GEOGRAPHICALLY MARKED ZİLE CHURCHKHELA (KÖME)

ABSTRACT

Zile Churchkhela (Köme) is a sweet food containing walnuts threaded on a string and coated with hasuda prepared with unfermented narince grape juice, wheat starch and flour. The unique qualities of Tokat walnut and narince grape, the two primary components of Zile Churchkhela, which received a geographical indication in 2017, make it distinct from similar products produced in other regions and provide its unusual taste and aroma. No food additives are used in the production of Zile Churchkhela, including sugar, sweetener, flavouring or components that give flavour. This local dessert, prepared primarily with unfermented grape juice, walnut and starch and not containing refined sugar, attracts attention with its nutritiousness besides deliciousness. Yet, there is not any study in the literature examining the energy and nutrient values of Zile Churchkhela. Hence, the current study aimed to analyse the energy and nutrient values of Zile Churchkhela. The content of the Zile Churchkhela was taken from the official website of the Turkish Patent and Trademark Office, and the content of its 100 grams was

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calculated based on the given amounts. Zile Churchkhela's energy and nutrients were analysed in the Nutrition Information System (BeBiS in Turkish) 9 computer program. 100 grams of Zile Churchkhela contains 352.1 calories and 1.2 g of fibre. According to the macronutrient distribution, 57% is carbohydrates, 37% is fat, and 4% is protein. Zile Churchkhela is rich in vitamins and minerals and has high vitamin E, niacin, biotin, copper, manganese, linoleic acid and alpha-linolenic acid content. In conclusion, Zile Churchkhela is a nourishing local dessert with a rich nutrient content that does not contain refined sugar. Conducting similar studies will be worthwhile in understanding the taste factor of local dishes as well as their relationship with nutrients and health.

Keywords: *Zile Churchkhela (Köme), geographical indication, local food, energy, nutrient.*

1. GİRİŞ

Günümüzde, küreselleşmenin etkisi ile birlikte fast-food ve hazır işlenmiş yiyecekler ülkelerin beslenme alışkanlıklarında önemli yer tutmaya başlamıştır. Fakat son yıllarda bu yiyeceklerin insan sağlığında yarattığı olumsuzluklar ön plana çıktığından, tüketiciler yöresel besinleri tüketmeye tekrar eğilim göstermeye başlamışlardır. Bunun sonucu olarak, yöresel ürünlerin taklitlerinden korunması ve yerel üreticinin ekonomik olarak gelir sağlaması için Avrupa ülkeleri başta olmak üzere dünyada coğrafi işaret uygulamalarına başvurulmuş ve yasalar çıkartılmıştır (Hazarhun ve Tepeci, 2018).

Coğrafi işaretler yöresel bir ürünün, bir ülke, yöre ya da bölge ile arasında bağlantıyı ifade etmek için kullanılmaktadır (Yılmaz ve ark., 2021). Türk Patent Enstitüsü (2022a), coğrafi işaret kavramını, "belirgin bir niteliği, ünü veya diğer özellikleri itibariyle kökenin bulunduğu bir yöre, alan, bölge veya ülke ile özdeşleşmiş bir ürünü gösteren işaretlerdir" şeklinde tanımlamıştır. Coğrafi işaretin temel amacı, bir bölgeye has olan yöresel ürünleri koruyarak ve devamlılığını sağlayarak belgelendirmektir. Coğrafi işaretin bir başka amacı ise, bir yörede üretim yapan üreticiyi korumak ve tüketicilere de kaliteli ürünler sunulmasını sağlamaktır (Yılmaz ve ark., 2021).

Gastronomi anlamında oldukça fazla yöresel varlığa sahip Tokat Mutfağı, bulunduğu coğrafya gereği Karadeniz ve İç Anadolu mutfaklarının bir karışımı niteliğindedir. Yöresel lezzetler anlamında çok çeşitli bir mutfağa sahip olan Tokat'ın bu zenginliğinin arkasında yatan temel neden tarımsal üretiminin bolluğu ve tarihsel süreçte oluşan kültürel yapısıdır. Tokat'ta iklime uygun her türlü tarım ürünü yetiştirilmektedir. Bu ürünlere; sebzeler (domates, patlıcan, biber, salatalık vb.), meyveler (kiraz, vişne, şeftali, elma, üzüm, kuşburnu vb.), tahıllar (buğday, arpa, mısır), baklagiller (fasulye, nohut, mercimek), otlar ve köklü bitkiler (madımak, şeker pancarı, patates, soğan) örnek verilebilir. Söz konusu ürünler aynı zamanda Tokat mutfağının gastronomik lezzetlerinin hammaddesi niteliğindedir (Tokat İl Kültür ve Turizm Müdürlüğü, 2022). Tokat mutfağına ait, 2022 yılı itibariyle, 11 adet gastronomik değer coğrafi işaretle tescillenmiştir. (Türk Patent ve Marka Kurumu, 2022b). Tokat ilinin coğrafi işaretli gıda ürünleri Erbaa narince bağ yaprağı, Niksar cevizi, Tokat ekmeği, Tokat bez sucuğu, Tokat narince salamura asma yaprağı, Tokat yağlısı, Tokat çöreği, Turhal yoğurtmacı, Zile pekmezi, Tokat kebabı ve Zile kömesidir.

Zile kömesi 2017 yılında coğrafi işaret almıştır. Zile kömesi içerisinde iplere dizilmiş halde sırayla konulan ceviz bulunan, Erbaa narince üzümü şırası, un ve buğday nişastası ile hazırlanmış, hasuda bulanmış tatlı bir lezzettir. Hasuda; buğday nişastası, üzüm şırası ve buğday ununun birlikte pişirilmesiyle hazırlanan muhallebi kıvamında yöresel bir tatlıdır. Zile kömesinde cevizlerin kaplandığı hasuda, üzüm şırası, nişasta ve nişastaya kıyasla daha az miktarda un ile hazırlanmaktadır. Kömenin yapımında kullanılan üzüm şırası ince kabuklu, hoş aromalı Narince üzümünden elde edilir. Narince üzümünün zengin aromatik bileşiklere sahip olmasından dolayı Zile kömesi üretiminde tercih edilmektedir (Işın ve Yalçın, 2020).

Zile kömesi; içeriğinde kullanılan cevizler Tokat ilinin kendi sınırları içerisinde yetiştirilmektedir. Bölgedeki sulama suyunun kalitesinin yüksek olması, toprakların fazla kirletilmemiş olması, ilkbahar mevsiminden hasat dönemi olan sonbahara kadar geçen dönem içinde iklim koşullarının uygun olması cevizlerin kaliteli olmasını sağlamakta ve cevizlerin ekonomik değerini arttırmaktadır. Üretilen bu cevizler, ince kabuklu, yağlı, büyük taneli ve beyaz görünümlüdür. Tokat il genelinde yetiştirilen cevizler Zile kömesinin lezzetini daha da arttırmaktadır (Akkuş, 2019).

Zile kömesinin üretiminde şeker, tatlandırıcı, aroma verici veya aroma verme özelliği bulunan bileşenler de dahil olmak üzere herhangi bir gıda katkı maddesi kullanılmamaktadır. Temelinde üzüm şırası, ceviz ve nişasta ile hazırlanan ve rafine şeker içermeyen bu yöresel tatlı, lezzetinin yanında besleyiciliği ile de dikkat çekmektedir. Ancak literatürde Zile kömesinin enerji ve besin ögesi değerlerini analiz eden herhangi bir çalışmaya rastlanmamıştır. Bu nedenle, bu çalışma Zile kömesinin enerji ve besin ögesi değerlerini analiz etmeyi amaçlamıştır.

2. YÖNTEM

Zile kömesinin içeriği, Türk Patent ve Marka Kurumu Coğrafi İşaret resmi internet sayfasından (Türk Patent ve Marka Kurumu, 2022b) alınmış olup verilen miktarlar üzerinden 100 gramının içeriği hesaplanmıştır. Zile kömesinin 100 gramı 200 gram üzüm şırası, 20 gram ceviz içi, 15 gram buğday nişastası ve 2,5 gram buğday unu içermektedir. Zile kömesinin 100 gramının enerji ve besin ögeleri Beslenme Bilgi Sistemi (BeBiS) 9 bilgisayar programında analiz edilmiştir. Analiz edilen miktarlar Türkiye Beslenme Rehberi (T.C. Sağlık Bakanlığı, 2016) önerileri ile karşılaştırılmıştır.

3. BULGULAR ve TARTIŞMA

Zile kömesinin 100 gramı 352,1 kalori içermekte olup makro besin ögesi dağılımı %5 protein, %38 yağ ve %57 karbonhidrattır (Tablo 1). İçeriğinin temelini oluşturan üzüm şırası, buğday nişastası ve buğday unu sebebiyle karbonhidrat ağırlıklı bir besindir (Baysal, 2020). Zile kömesinin 100 gramı 2,3 gram lif içermektedir. Bileşiminde hayvansal kaynaklı bir besin içermediği için kolesterol bulunmamaktadır. Zile kömesinin 100 gramı 4,2 gram omega-3 yağ asitleri ve 17,2 gram omega-6 yağ asitleri içermektedir.

Tablo 1. Zile kömesinin 100 gramının enerji ve makro besin ögeleri analizi

Enerji ve Makro Besin Ögeleri	**Analiz Edilen Miktar**
Enerji	352,1 kal
Protein	3,9 g (5%)
Yağ	14,6 g (38%)
Karbonhidrat	49,1 g (57%)

Zile kömesinin 100 gramının bazı vitamin içeriği ve önerileri karşılama yüzdesi Tablo 2'de verilmiştir**.** Zile kömesinin 100 gramının içerdiği vitaminlerden bazılarının 19-50 yaş kadın ve erkeklerde önerileri karşılama oranı sırasıyla B1 vitamini için %24 ve %22, B3 vitamini için %43, biotin için % 23, E vitamini için %116 ve %98'dir.

Tablo 2. Zile kömesinin 100 gramının bazı vitamin içeriği ve önerileri karşılama yüzdesi

Vitamin	**Miktar**	**19-50 yaş kadın önerileri karşılama oranı**	**19-50 yaş erkek önerileri karşılama oranı**
A Vit.	1,6 µg	%0	%0
B1 Vit/Tiamin	0,3 mg	%24	%22
B2 Vit/Ribofl.	0,1 mg	%11	%9
Niasin eşd.	2,8 mg	%43	%43
B5 Vit/Pant.as	0,2 mg	%4	%4
Biotin	9,2 µg	%23	%23
E Vit. (eşd.)	12,8 mg	%116	%98
C Vit.	6,8 mg	%7	%6
K Vit.	1,2 µg	%1	%1

Zile kömesinin 100 gramının içerdiği minerallerden bazılarının 19-50 yaş kadın ve erkeklerde önerileri karşılama oranı sırasıyla fosfor için %34, magnezyum için %31 ve %27, demir için %18 ve %26, manganez için %22, bakır için %29 ve %22'dir. Zile kömesinin 100 gramının bazı mineral içeriği ve önerileri karşılama yüzdesi Tablo 3'de verilmiştir.

Tablo 3. Zile kömesinin 100 gramının bazı mineral analizi ve önerileri karşılama yüzdesi

Mineral	**Miktar**	**19-50 yaş kadın önerileri karşılama oranı**	**19-50 yaş erkek önerileri karşılama oranı**
Sodyum	12,6 mg	%1	%1
Potasyum	782,8 mg	%17	%17
Kalsiyum	87,1 mg	%9	%9
Fosfor	185,1 mg	%34	%34
Magnezyum	93,9 mg	%31	%27
Demir	2,9 mg	%18	%26
Manganez	0,7 mg	%22	%22
Çinko	1,3 mg	%13	%12
Bakır	0,4 mg	%29	%22

Narince üzüm çeşidi, Tokat ilinin tarımsal ürünleri arasında önemli bir yere sahip olup şaraplık, şıralık ve sofralık olarak meyvesinden, salamuralık olarak yaprağından bölgeye önemli derecede katkı sağlamaktadır. Üzümün bileşiminde temel olarak şekerler, organik asitler, antosiyanlar, tanenler, aroma maddeleri, pektik maddeler, azotlu maddeler, mineraller ve vitaminler bulunmaktadır. Üzüm gerek meyve olarak gerekse sahip olduğu yüksek miktardaki fenolik bileşikler ve antosiyaninlerden dolayı doğal bir antioksidan kaynağı olarak kabul edilmektedir (Cangi ve ark., 2011). Zile kömesinde narince üzümü karbonhidrat, lif, çeşitli vitamin ve mineral açısından ürünün besin değerini ve çeşitliliğini artırmaktadır.

Ceviz omega-3 yağ asitleri, E vitamini ve posa içermesinin yanı sıra sağlığa olumlu etkileri olan bitkisel steroller ve özellikle polifenoller açısından zengindir (Sánchez-González ve ark., 2017). Tokat mutfağında ceviz önemli bir yere sahip olup yemekler, börekler, pastalar ve tatlılarda sıklıkla kullanılmaktadır. Niksar cevizi Tokat yöresine ait coğrafi işarete sahip bir ürün olup kendine has özellikleri ile tüketim ve gıda endüstrisinde aranan özelliklere sahiptir (Türk Patent ve Marka Kurumu, 2022b). Ceviz yağ, omega yağ asitleri, çeşitli vitamin ve mineral açısından Zile kömesinin besin değerini zenginleştirmektedir.

4. SONUÇ

Zile kömesi zengin bir vitamin ve mineral içeriğine sahip olup B1 vitamini, E vitamini, niasin, biotin, fosfor, magnezyum, bakır, manganez, omega 3 ve omega 6 yağ asit içeriği yüksektir. Zile kömesi, rafine şeker içermeyen ve zengin besin ögesi içeriğine sahip Zile kömesi sağlıklı bir yöresel tatlıdır. Bu ve benzeri çalışmaların yapılması, yöresel yemeklerin sadece lezzet boyutunun değil besin ögesi ve sağlık ile olan ilişkisinin anlaşılması ve de toplumun bilinçlendirilmesi açısından faydalı olacaktır.

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MONOSODIUM GLUTAMATE: AS A FIFTH TASTE "UMAMİ" IS IT SAFE OR HARMFUL?

Çağdaş Salih MERIC[1], Nezihe OTAY LULE[2], Hacı Ömer YILMAZ[3]

ABSTRACT

Monosodium glutamate, abbreviated MSG or code E621, is the sodium salt of amino acid glutamate. Also, it is a flavor enhancer frequently used in prepared foods. MSG strengthens the flavor properties of the food and makes it want to eat more often and faster by increasing saliva secretion. MSG was first discovered in 1865, and its commercial production began in 1909. It is widely used in ready-to-eat foods in many countries including Turkey, especially in Chinese and Japanese cuisines. MSG is included in all types of chips, some fats, broths, instant soups, sauces, processed meat, fish and chicken products, mayonnaise, spice mixes, colored yogurts, baby foods, and many other consumer products with different names (glutamic acid, glutamine, etc.). There are opposing views in studies on the safety of MSG, which is especially used in ready-made foods for its flavor-enhancing feature. It is known to cause chest pain, headache, facial flushing, shortness of breath, edema, and sweating when used as a flavoring called Chinese Restaurant Syndrome. In addition to the data reporting its harmful effects on the nervous system, retina, and kidneys, it is suggested that excessive use causes disorders in learning and memory mechanisms, and causes neurodegenerative diseases such as obesity, infertility, growth disorder, Alzheimer's, Parkinson's and epilepsy in advanced ages. Today, studies evaluating the possible effects of MSG on human health are still ongoing. Although there are different opinions on this subject, there is not enough scientific evidence to prohibit the use of MSG. However, for many people, the fact that it is discussed that MSG may have harmful effects and that it is not fully proven to be harmless is enough to cause reservations about its use.

Keywords: *Chinese salt, Chinese restaurant syndrome, diet, monosodium glutamate, nutrition, umami taste.*

1. INTRODUCTION

Food additives have been widely used for over a century in modern industrial countries for flavoring, coloring and increasing the shelf life of products. There are products such as fruits, vegetables, meat, fish, instant soups, ready meals, cooking sauces, confectionery, beverages, chilled and frozen ready foods from different countries in the markets. In the process from the harvest to the packaging of all these products, it is necessary to offer the consumer a suitable, sufficient shelf life and taste. Especially, recently, food additives have been a critical place in the food industry since, many markets take into consider the features of ready-made foods such as fat, energy amounts, fat levels and salt contents, additives and nutritional values (Saltmarsh and Lynn, 2013).

Today, many chemicals are used in food ingredients to increase the various properties of foods. Most of these substances are natural components of food and are classified as carbohydrates, proteins, vitamins, minerals and fats. In addition to these natural components, there are some substances that are intentionally added to the food during food processing or that enter through contamination unintentionally (Arslan, 2011).

There are different definitions of food additives in many sources. The common definition of food additives according to the International Food Codex Commission (Codex Alimentarius

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Commission - CAC), which was formed by the joint efforts of the World Health Organization (WHO) and the Food and Agriculture Organization (FAO); "Food additive is not used as a food alone and is not a typical component of food, whether it has nutritional value or not, it is added for technological (including organoleptic) purposes in food at the stages of production, processing, application, preparation, processing, packaging, packaging, transportation, preservation and storage. or substances that become a component of these foods or their by-products or change their characteristics" (Altuğ, 2006). In a simple definition; food additives are elements naturally present in the composition of foods or that are obtained purely from foods by various methods or that are added to foods for various purposes after being chemically made (Pașca et al., 2018).

Food additives can be grouped under four main headings: additives that extend shelf life by preserving quality (preservatives), additives that improve structure, preparation and cooking properties, additives that improve flavor and color, and additives that protect and improve nutritional value. Flavor enhancers constitute the predominant and most important groups among additives in the food industry. In its use, the amounts to be added are determined according to the qualities that the final product should have, and the texture (solid-liquid, viscosity status, water, and oil content), color, acidity, alcohol and carbon dioxide amounts of the product are considered. Flavor enhancement practices are as old as cooking, and the identification of substances used for this purpose began in the 20th century. For the first time in 1866, a German chemist named Ritthausen obtained glutamic acid in the laboratory, then another chemist converted this acid into sodium salt and obtained Monosodium Glutamate (MSG) (Carocho et al., 2014; Kaitano, 2014).

1.1. Monosodium Glutamate (MSG)

MSG is the most well-known and widely used flavor enhancing additive in food production in the world, and it is the sodium salt of non-essential L-Glutamic acid (Andarwulan et al., 2012; Basu et al., 2006). It is present in many foodstuffs and in the form of amino acids, which are the building blocks of proteins in the human body, or in free form (Rolls, 2009). MSG is compatible with meat, fish, chicken, many vegetables, sauces, soups and seasoning mixes. As a flavoring, MSG have the ability, when used in the right amount, to balance and unify the overall taste of certain dishes by improving other flavor-activated components (Loliger, 2000). MSG is a flavor enhancer that is added to many foods but also occurs naturally. Additionally, MSG strengthens the natural flavor of the food, reveals hidden flavor characteristics, increases weak flavor characteristics, improves food-specific quality characteristics such as mouth fullness and consistency, without adding a special flavor (Bellisle, 1998; Prescott, 2004). Known as a food additive with the code E 621, the chemical name of monosodium glutamate is monosodium L-glutamate monohydrate ($C_5H_8NNaO_4.H_2O$) and has a molecular weight of 187.13. The IUPAC name of MSG is Sodium 2-Aminopentandioate. It is practically odorless. It is freely soluble in water, sparingly soluble in ethanol, and practically insoluble in ether (Kalapanda, 2010).

MSG's E number is E 621. MSG glutamate gives the same umami flavor as other foods. Chemically, both have the same structure. Industrial food manufacturers market and use MSG as a flavor enhancer as it balances, blends and combines the overall perception of other flavors. The trade names for monosodium glutamate include AJINOMOTO, Vetsin and Ac'cent (Uslu and Tosun, 2013).

Only the free form of glutamate in the L-configuration exhibits flavor enhancing properties and is therefore widely used as a flavor enhancer in the food industry [30]. Today, its consumption exceeds 2.5 million tons per year and continues to increase by a few percentages per year. This widespread and increasing use of MSG demonstrates that MSG plays both physiological and nutritional roles in metabolism in addition to its role as an oral sensory sweetener (Torii, 2012).

MSG produces a flavor that cannot be provided by other foods. It elicits a taste described as umami, translated as "appetite" in Japanese (Husarova and Ostatnikova, 2013).

1.2. History of Monosodium Glutamate and the fifth basic taste “umami”

In 1908, Japanese researchers conducted a study in 1907 in brown seaweed (Laminariaceae) to determine the substances that cause a unique flavor in soups. In these studies, it has been investigated that there may be one or more flavor substances in seaweed that are not known as bitter, sour, salty, or sweet and do not fall into one of these categories. This fifth basic taste is called “umami.” He thought that the results of the study could have commercial applications as a spice that contributes to the improvement of human nutrition. In 1908, he reported that the umami flavor component was L-glutamate found in seaweed. MSG was isolated from seaweed and thus monosodium glutamate was commercially produced in 1909. Saburousuke Suzuki, a well-known scientist in the chemical and pharmaceutical industries, has partnered with Ikeda to manufacture and commercialize this new spice. It started to be produced commercially in 1909 (Kaitano, 2014). Because of these studies, it was observed that the umami stimulus remained outside the taste prism and was an independent taste, while soups made from animal substances containing naturally MSG was found to be close to the umami outside the four basic taste prisms (Elmacı, 2009).

Recently, in addition to the standard basic flavors (sweet, sour, salty, and bitter), umami has been classified as the fifth basic flavors. The typical umami flavor is monosodium L-glutamate, which is used in many cultures to flavor many foods. Food additives that provide umami flavor are categorized as a flavor enhancer, the glutamate salt of MSG, monoammonium glutamate, monopotassium glutamate, and ribonucleotide compounds, namely, IMP and GMP (Ninomiya, 2001).

Umami has a characteristic flavor imparted by glutamate and 5'-ribonucleotides such as inosinate and guanylate. Glutamate and nucleotides are found in many foods and play an important role in the taste, palatability and acceptability of foods. This distinctive taste was first discovered in 1908 by Ikeda, who coined the term "umami" to describe it. Ikeda determined that there is a stimulus different from the four basic tastes in the components that make up the flavor in foods such as fish and meat, and that this stimulus is created by glutamic acid, and named this new taste umami. Although Ikeda coined the term "umami" in 1908, it took 75 years for it to become internationally recognized as a staple flavor. Although the recognition and classification of umami as the main flavor is a relatively recent development, foods and ingredients rich in umami have been used throughout history. The use of fermented fish sauces has been documented in ancient Greece and Rome (Husarova and Ostatnikova, 2013). Considered the 5th basic form, umami flavor has been mainly associated with the identification of G protein-coupled mGluR4 and heterometric T1R1+T1R3 receptors for glutamate. Umami has a critical place in food seasoning and is widely used in food production (Zhang et al., 2017). MSG enhances umami, which is responsible for "delicious" flavors. MSG is known as a flavor enhancer because glutamate alone does not evoke a flavor but enhances the flavors present (Freeman, 2006). MSG can be combined with salt, which increases flavor and reduces the need for salt (Ault, 2004).

In studies on MSG, it has been determined that only the "L" form of the amino acid in question has flavor-enhancing activity, while the "D" form has no activity. MSG can be added to foods either purely or as a secret ingredient in yeast extracts, or as a hydrolyzed protein with high glutamate content (Hegenbart, 1998).

1.3. Commercial Production of Monosodium Glutamate

MSG is generally used along with salt and is usually prepared in a way that 10%-20% of the added rate is salt. Crude glutamic acid, which is in crystalline form, first hangs in suspension

in water, then dissolves, becomes neutralized and becomes a monosodium salt by adding sodium hydroxide to the content. The solution is decolorized using activated carbon and, if necessary, concentrated and prepared under vacuum at 60º before cooling (Ault, 2004).

1.4. Use of Monosodium Glutamate in Food

MSG is one of the most abundant amino acids in nature and is found in many proteins, peptides, and tissues. Glutamate is produced in the body. It binds with other amino acids to form a structural protein (Filer and Stegink, 1994). When glutamate binds to the protein molecule, it is tasteless and does not give the food an umami flavor. However, protein hydrolysis that occurs during fermentation, aging, maturation, and heat cooking, releases glutamate (Yoshida, 1998). Glutamate is an essential ingredient for cheese, seafood, broth, and many other foods (Ninomiya, 1998). MSG consumption continues to increase from past to present (Sharma and Deshmukh, 2015).

1.5. Legal Regulations Regarding Monosodium Glutamate

The availability of all food additives and the ingredient list of the foods in which the food additives are used must be constantly monitored. It should be re-evaluated, when necessary, considering changing conditions of use and new light. Generally, in order for food additives not to harm nature and human health, they should be used considering the daily intake and maximum usage amounts given using international procedures such as JECFA and local procedures such as Turkish Food Codex (Mehreen et al., 2012). In European countries, MSG content in ready-to-eat products should not exceed 10 g/kg (TSE, 2018; Türk Gıda Kodeksi, 2013).

Although glutamate occurs naturally in many foods, it is often added as a supplement to enhance a flavor. Foods containing large amounts of free glutamate, such as tomatoes, mushrooms and cheese, are traditionally used to produce savory dishes (Giacometti, 1979). When glutamate is added to foods, naturally occurring free glutamate provides a flavoring function similar to (Konosu, 1987). Therefore, it is used to enhance the natural flavors of meat, soups, poultry, seafood, snacks and casseroles (Fuke and Shimizu, 1993).

1.6. Health Effects of Monosodium Glutamate

The effects of MSG on human health and its safe use have been a controversial issue since the early 1980s. L-GLU, which is a monosodium salt, has an important place in the food industry, giving the typical "umami" flavor, which is known as the fifth basic taste, very similar to the flavor of meat. In 2007, the worldwide production of MSG was estimated to be around 2.5 million tons. With this increasing use, there is no consensus on the health effects of this substance, which is widely used in the food industry, although the FDA defines MSG as safe. There is information in the literature that MSG is effective in various diseases and can show toxic effects. Such-conflicting information also casts doubt on the safe use of MSG (Uslu and Tosun, 2013). Adding MSG to foods in high amounts can lead to health problems (Lau and Mok, 1995). Mehreen et al. established acceptable daily intake of MSG. However, he determined the palatable dose to be 60 mg/kg (Mehreen, 2012).

Colucci and Grovum (1993) have found that MSG trigger obesity by increasing insulin secretion, decreasing ketogenesis and suppressing the release of growth hormones in adolescence. In an experiment on MSG-increasing appetite, sheep were given herbs containing varying amounts of MSG. The relationship between the amount of MSG and grass eating was examined. It has been observed that MSG given by mixing at a rate of 5 – 40 g/kg increased the appetite by 146% in sheep. It has been observed that the use of poor-quality foods described in this study can be increased by the addition of MSG.

Consumption of MSG above the permissible limit has been associated with neurotoxin effects resulting in pathological conditions such as brain cell damage, retinal degeneration, endocrine disorder and addiction. In addition to these problems, studies associated with health problems such as stroke, epilepsy and brain trauma have been reported (Eweka et al., 2010).

MSG elicits a unique taste sensation called umami, and there have been a growing body of studies recently that its use as a common flavor enhancer in various cuisines brings with it some health problems. It revealed receptors for L-glutamate (Glu) and transduction molecules in the intestinal mucosa and oral cavity. The gastric afferent vagal nerve responds to luminal stimulation by Glu, particularly in the stomach, and regulates autonomic reflexes. Intragastric infusion of MSG also activates several brain areas (insular cortex, limbic system, and hypothalamus) and may induce aroma preference learning in rats. These results suggest that signaling by Glu nerve and visceral pathways plays an important role in digestion, absorption, metabolism and other physiological functions by activation the brain (Beauchamp, 2009; Niaz et al., 2018; Noel et al., 2018).

Glutamate itself has very low toxicity in most cases, but the oral lethal dose LD50 of glutamate for rats and mice is 15,000–18,000 mg/kg body weight (Walker and Lupien, 2000). Additionally, glutamate is an effective excitatory neurotransmitter in the human brain. If glutamate receptor inactivation is not balanced by glutamate reuptake at the synaptic cleft, glutamate may accumulate and become neurotoxic, affecting memory, learning, and regulation processes (Maragakis and Rothstein, 2001). Transient MSG syndrome (Chinese restaurant syndrome) characterized by exposure to 0.5-2.4 g MSG, flushing, headache, numbness in the mouth, and other symptoms, as reported by the American Federation of Societies for Experimental Biology (FASEB) 1995 may result in. Therefore, controversial opinions on the safety of MSG consumption have been reported (FAO/WHO, 1974).

MSG is a free amino acid salt with a single sodium atom bound to the amino acid glutamate and is a food supplement that is frequently used as a flavor enhancer in processed foods. There have been some studies showing that certain amounts of MSG have possible toxic effects. For this reason, MSG as a food ingredient has also been the subject of health studies. Subjects with diabetes and obesity have been observed in relation to MSG consumption in both human and animal studies. MSG enhances the palatability of food and thus positively affects appetite and increase body weight (Shannon et al., 2017). Because of recent epidemic and animal studies, various metabolic diseases such as body mass index, obesity and insulin resistance, which have increased recently, have been associated with the use of MSG (Lateef et al., 2012).

However, there are some studies showing possible toxic effects of certain amounts of MSG and suggesting that it may be associated with myocardial and hepatic diseases (Ault, 2004). There are many studies on the effects of MSG on human health. Some evidence from these studies suggests that MSG trigger asthma and migraine (Freeman, 2006). Also, based on anecdotal reports, some individuals may have MSG intolerance causing the 'MSG symptom complex', which is thought to be representative of acute, transient and self-limiting reactions to MSG ingestion (Kim et al., 2015).

In another study, in which the effects of MSG on human health were observed, it was concluded that MSG can exacerbate many neurological disorders such as Alzheimer and Parkinson's disease when used above the optimum amount. The most commonly reported symptoms are headache, numbness/tingling, flushing, muscle tension, and fatigue (Bawaskar et al., 2017).

Hashem et al., (2012) in their study in 2012, conducted research on the dangerous effects of MSG on the brain. They concluded that MSG has a neurotoxic effect leading to degenerative changes in neurons and astrocytes in the cerebellar cortex of albino rats.

Umukoro et al., (2015) in their study conducted in 2015, found that low-dose MSG administered orally to mice did not cause significant impairment in the Y maze test; however, they reported depressive symptoms in the swimming test after a 500 mg/kg dose, as well as an

increase in malondialdehyde (MDA) levels in brain tissue and a decrease in glutathione (GSH) levels.
Prastiwi et al., (2015) in their study, determined that a high dose (3.5 mg/g body weight) MSG administration to rats caused a significant decrease in motor coordination.

1.7. Chinese Restaurant Syndrome

In 1968, a recipe for the syndrome was found that started 15 to 30 min after eating in a Chinese restaurant and lasted for about 2 h, with no lasting effects. These symptoms have been described as numbness, general malaise, and palpitations that progress to both arms and back (Schaumburg et al., 1969). They stated that the cause of these symptoms could be many factors, such as salt in food, MSG or alcohol. During this period, the complex symptom of 'Chinese Restaurant Syndrome (CRS)' were emphasized. Since then, a great deal of literature has focused on MSG as a factor for CRS. An ever-increasing number of various symptoms have subsequently been added to the symptoms of CRS. In 1995, an attempt was made to review the reports on MSG in the FDA commission of the Federation of American Societies for Experimental Biology (FASEB). We conclude that MSG is representative of transient and self-limiting acute reactions with oral ingestion. The diseases thought to be caused by MSG are given below (Bawaskar et al., 2017).

✓ Burning sensation between neck, chest and arm,
✓ Facial pressure/tension,
✓ Chest pain,
✓ Headache,
✓ Nausea,
✓ Palpitations,
✓ Numbness toward the back, arms and neck,
✓ Tingling, fever, weakness in the face, temples, upper back, neck and arms,
✓ Bronchospasm (observed only in people who have asthma),
✓ Drowsiness,
✓ Fatigue.

The optimal palatability concentration for MSG is between 0.2% and 0.8%, and the largest palatable dose for humans is approximately 60 mg/kg body weight. MSG has been controversial in use since 1980, and questions have remained about its safety ever since. It has been identified as the determining factor of CRS (Yang et al., 2017).
When some people consume foods containing MSG, symptoms such as headache, nausea, facial pressure, tightness, chest pain and warmth may occur (Oyiengo, 2014). It has also been suggested that excitatory amino acids (glutamic and aspartic acid) play a central role in the pathophysiology of Parkinson's disease.
It is important to determine the amount of MSG in food and to check its compliance with the RPL, due to the risks it may pose to health when limit values are not followed in MSG consumption and when it is consumed unconsciously. In our country and in the world, MSG amount determination is made in foods by using various methods. The titration method, enzymatic methods, paper chromatography, fluorometric methods and gas and liquid chromatography methods are some methods used for analysis. Due to the high sensitivity of HPLC, it is among the most common methods used for MSG quantification (Soyseven et al., 2021; Wijayasekara and Wansapala, 2017).
Dosage is critical in the use of food additives. The regular chemical analysis of food additives is of high importance. Therefore, restrictions on food additives have been made according to the Turkish Food Codex (TFC) and European Union Directives (EC).

2. CONCLUSION

There are no restrictions on the use of MSG in our country. Additionally, the American Food and Drug Organization (FDA) stated that MSG is safe for most people when taken in certain amounts, but some allergic reactions can be seen in people who are sensitive to MSG, especially in asthma patients. However, it has been emphasized in experimental models that long-term use of MSG is a trigger for the emergence of neurodegenerative diseases, metabolic diseases such as obesity and diabetes.

Several clinical studies revealed that there was only a minimal correlation between chronic human exposure and MSG consumption. Because these studies used excessive dosages that did not correlate with the quantities people usually eat from food products, they provided limited useful information. It is recommended that clinical and epidemiological research is necessary, but when the findings of preclinical research are considered, it may pose serious hazards. Therefore, certain data may be compared with blood, tissue, or histological samples when MSG dose is received with food records for clinical investigations, and this condition can be understood better. As a result, the fact that it is being discussed that MSG may have harmful effects and that it is not fully proven to be harmless is enough to cause reservations in its use.

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DOĞAL GIDA KATKI MADDESİ OLARAK BETANİN: KARDİYOVASKÜLER HASTALIKLARIN PATOGENİZİNDE KORUYUCU ETKİLERİ

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ÖZET

Kardiyovasküler hastalıklar (KVH), periferik arter hastalığı, koroner kalp hastalığı ve serebrovasküler hastalığı içeren hastalık grubu olarak tanımlanmaktadır. Bu hastalıklarda, vasküler endotel hasarı sonucu oluşan oksitlenmiş lipidler, trombositler, immün ve inflamatuar hücreler, düz kas hücreleri ve trombositlerden oluşan agregatlar beyne ve kalp kasına giden kan akışını bloke eder. İnflamasyon durumlarının etkin rol oynadığı bu durumlarda, klinik deneyler ve epidemiyolojik kanıtlar, antioksidanlarla zenginleştirilmiş sebzelerin alımının oksidatif stres ve kardiyovasküler hastalık üzerindeki koruyucu etkisini göstermiştir. Reaktif oksijen türlerini (ROS) ve reaktif nitrojen türlerini (RNS) süpürücü yetenekleri nedeniyle, biyoaktif fitokimyasalların çoğu organizmada bir redoks durumunun korunmasında rol oynayabilirken, diğerleri hücre içi ile ilgili proteinleri kodlayan genlerin ekspresyonunu modüle edebilir. Bununla birlikte oksidatif hasara karşı savunma sağlar, enzimlerdeki aktif bölgeler için rekabet eder veya çeşitli hücre altı yapılarda antagonistler olarak reseptör bölgelerine bağlanır. Betalainlerin başlıca fitokimyasalı, pancara kırmızı-mor rengini veren suda çözünür nitrojenli heterosiklik bir molekül olan betanindir (betanidin 5-O-b-D-glucoside). Ayrıca betanin, lipid membranı ve LDL peroksidasyonunu baskılayabilen, inflamatuar sitokin salınımını azaltmak için ROS sentezini ve gen ekspresyonunu düzenleyebilen ve antioksidan enzim aktivitelerini arttırabilen biyoaktif bir madde olarak tanımlanır. Bu nedenle, betanin, KVH bozukluklarına katkıda bulunan oksidatif stres ve inflamatuar süreçlerin patofizyolojik sonuçlarını yavaşlatmak/engellemek için destekleyici bir tedavi olarak kullanılma potansiyeline sahiptir. Bu çalışmanın amacı, betanin'in KVH'ın patogenezine olası etkisi ile ilişkili literatürdeki çalışmaların sonuçlarını gözden geçirmektir.

Keywords: *Betanin, kardiyovasküler hastalıklar, koruyucu etki, pancar.*

BETANIN, AS A NATURAL FOOD ADDITIVES: PROTECTIVE EFFECTS ON CARDIOVASCULAR DISEASE PATHOGENESIS

ABSTRACT

Cardiovascular diseases (CVD) are a group of conditions that include peripheral arterial disease, coronary heart disease, and cerebrovascular disease. These conditions block the blood flow to the brain and cardiac muscle as a result of aggregates form of oxidized lipids, platelets, immune and inflammatory cells, smooth muscle cells, and platelets that occurs as the result of vascular endothelial injury. Clinical trials and epidemiological evidence have demonstrated the protective effect of the intake of vegetables enriched in antioxidants on oxidative stress and CVD. Because of their ability to scavenge reactive oxygen species (ROS) and reactive nitrogen species (RNS), many of these bioactive phytochemicals may be involved in maintaining a redox

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state in the organism, while others may modulate the expression of genes encoding proteins involved in intracellular defense against oxidative damage, compete for active sites in enzymes, or bind to receptor sites as antagonists in various subcellular structures. The major phytochemical representative of betalains is betanin (betanidin 5-O-b-D-glucoside), a water-soluble nitrogenated heterocyclic molecule that gives beetroot its red-violet hue. Furthermore, betanin is defined as a bioactive substance capable of suppressing lipid membrane and LDL peroxidation, regulating ROS synthesis and gene expression to decrease inflammatory cytokine release, and increasing antioxidant enzyme activities. Thus, betanin has the potential to be used as a supportive treatment to alleviate the pathophysiological consequences of oxidative stress and inflammatory processes that contribute to CVD disorders. The purpose of this study to review the results of studies in the literature on the possible effect of betanin on the pathogenesis of cardiovascular diseases.

Keywords: *Betanin, cardiovascular disease, protective effect, beetroot.*

1. GİRİŞ

Kardiyovasküler hastalıklar (KVH), dünya genelinde ölümlerin başlıca nedeni olarak belirtilmektedir. Bu hastalık grubunun altında; periferik arter, koroner arter ve serabrovasküler hastalıklarda yer almaktadır. Belirtilen hastalıkların patogenezi incelendiğinde; vasküler endotel hasarı sonucunda oluşan okside lipitler, trombositler, immün ve inflamatuvar hücrelerin agregasyonu sonucunda beyin ve kalbe giden kan akamının engellenebilme durumu söz konusu olabilmektedir (Manoharan ve ark., 2022).

Hipertansiyon, hiperlipidemi, diyabet ve obezite gibi kronik hastalıklar şiddetlendiğinde vasküler hastalığın başlangıcından önce geldikleri için KVH için risk faktörleri olarak kabul edilen patolojik durumlardır. Ayrıca, KVH'ın gelişmesi/oluşum durumuna yönelik risk faktörleri, vücudun antioksidan savunma sisteminin detoksifikasyon kapasitesini azaltabilir ve aşırı reaktif oksijen (ROS) ve nitrojen (RNS) türlerinin oluşumunu tetikleyebilmektedir (Matuz-Mares ve ark., 2021). Bu reaktif türlerin aracılık ettiği doğrudan oksidasyon ve redoks homeostazı, nikotinamid adenin dinükleotit fosfat (NADPH) oksidazlar, süperoksit dismutaz, katalaz ve glutatyon preoksidaz ile ilişkili genlerin ekspresyonunun ve aktivitesinin aşağı regülasyonu yoluyla oksidatif stresin oluşturulmasında etkileri bulunmaktadır (Zarkovic, 2020). Bu patofizyolojik durum oksidatif stres olarak adlandırılır ve lipidler, proteinler, DNA molekülleri ve hücre zarlarında hasara neden olurken aynı zamanda nitrik oksit (NO) düzeyini azaltır ve KVH başta olmak üzere birçok kronik dejeneratif hastalığın patogenezinde gelişen süreçleri tetiklemektedir (García-Sánchez ve ark., 2020).

Klinik ve epidemiyolojik çalışmalar sonucunda elde edilen kanıtlar, antioksidan içeriği zengin sebzelerin alımının oksidatif stres ve kardiyovasküler hastalık üzerindeki koruyucu etkisini göstermiştir (Aune, 2019). Bu biyoaktif fitokimyasalların çoğu, ROS ve RNS süpürücü yetenekleri nedeniyle organizmada bir redoks durumunun korunmasında rol oynayabilirken, ayrıca oksidatif hasara karşı hücre içi savunmada yer alan proteinleri kodlayan genlerin ekspresyonunu modüle edebilmekte, enzimlerdeki aktif bölgeler için rekabete girmekte veya çeşitli hücre yapılarında antagonist olarak reseptör bölgelerine bağlanmaktadır (Taheri, 2021).

Pancar (Beta vulgaris L.), Chenopodiaceae familyasına aittir ve betalainler, nitrat (NO_3^-) ve fenolik bileşikler dahil olmak üzere önemli biyoaktif bileşiklerin kaynağı olarak kabul edilmektedir. Betalainler arasında, betanin (betanidin 5-O-b-D-glucoside), pancara kırmızı-mor rengini veren suda çözünür azotlu bir heterosiklik bileşik olan ana fitokimyasaldır (Fu ve ark., 2020). Ayrıca betanin, lipid membranlarını ve düşük yoğunluklu lipoprotein (LDL) peroksidasyonlarını inhibe edebilen, inflamatuar sitokin salınımını azaltmak ve antioksidan enzim aktivitelerini artırmak için ROS üretimini ve gen ekspresyonunu modüle edebilen biyoaktif bir bileşik olarak tanımlanmaktadır (Milton-Laskibar ve ark., 2021). Betanin

tarafından gözlemlenen biyolojik etkilerin temelinde iki redoksa duyarlı yol nükleer faktör kappa B (NFkB) (inflamatuar yolağı) ve nükleer faktör eritroid-2 ile ilişkili faktör-antioksidan yanıt elemanı (Nrf2-ARE) (antioksidan yolağı)'dir. Bu nedenle betanin, KVH yol açan oksidatif stres ve inflamatuar olayların neden olduğu patofizyolojik etkileri iyileştirmek için kullanılan destekleyici bir tedavi olarak potansiyel göstermektedir (Abedimanesh ve ark., 2021; Qiu ve ark., 2021).

Yukarıda belirtilen bilgiler ışığında bu derlemede, betanin yapısı, serbest radikal süpürücü aktivitesi, oksidatif stres ve proinflamatuar yapılar üzerindeki etkileri ve bu durumların KVH patogenizinde olası ilişkilerinin değerlendirilmesi amaçlanmaktadır.

2. BETANİN

2.1. Biyosentezi ve Biyoerişilebilirliği

Betalainler (veya kromoalkaloidler), bazı mantar türlerinde, çiçeklerde, meyvelerde bulunabilen, Caryophyllales takımına ait 10 familyaya ait olan bitkilerdende elde edilebilen doğal suda çözünür pigmentlerdir (Strack ve ark., 2003). Betalainler, shikimate yolunda bir amino asit olan tirozinden sentezlenir. İlk olarak tirozin, L-DOPA oluşturmak üzere hidroksillenir ve betalamik aside dönüştürülür. Alternatif olarak, L-DOPA oksitlenir ve siklo-DOPA'ya siklize edilir ve betalamik asit ile kendiliğinden yoğunlaşarak kırmızı pigmentler, betasiyaninler oluşturur ve hepsinde ortak yapı olarak betanidin bulunur (Timoneda ve ark., 2019). Betalamik asit ayrıca sarı pigmentler, betaksantinler oluşturan amino asitler veya amino türevleri ile yoğunlaşabilir. Mor pitaya (Hylocereus polyrhizus) ve esas olarak kırmızı pancarda (Beta vulgaris) bulunan prebetanin, izobetanin, neobetanin ve betanin (betanidin 5-O-b-D-glukozit) gibi çeşitli betasiyaninlerin oluşumuna yol açan C-5 veya C-6 pozisyonlarında bulunan hidroksillerde glikosilasyon ve asilasyon meydana gelir (Rodriguez-Amaya, 2019).

Pancardan elde edilen betanin birçok endüstriyel uygulamaya sahiptir. Yenilebilir bitkilerde doğal olarak bulunduğundan, insanlar için toksik olmadığı kabul edilir ve Gıda ve İlaç Dairesi (FDA) ve Avrupa Birliği tarafından E162 kodu altında gıdalarda kullanımı onaylanmıştır (EFSA 2015).

Betanin, kırmızı pancarda 3.0 ila 7.6 mg/g kuru madde arasında değişen betalainlerin yaklaşık %75-95'ine karşılık gelir. pH 2.0'ın altında veya pH 9.0'ın üzerinde değişken bozunma ile 3'ten 7'ye kadar geniş bir pH aralığında stabilitesini korumaktadır. Betanin, pH 7.0'da donma ve soğutma sıcaklıklarında depolama sırasında ve soğutulmuş et örneklerine eklendiğinde yüksek stabilite göstermektedir. Betanin biyolojik olarak aktif kalmakta ve ürünlerin raf ömrü boyunca lipid peroksidasyonunu inhibe edebilmektedir. Gastrointestinal sistemde, oral yoldan verilen betaninin yaklaşık %50'si mide asidine direnmekte ve 37 ºC'de bağırsak sindiriminden sonra stabil kalmaktadır. Esas olarak bir gıda katkı maddesi olarak kullanılan betanin, yüksek biyoerişilebilirlik göstermekted, yüksek pH ve sıcaklık durumlarının vücutta gözlemlenmesi olağan olmadığından biyoaktif bir fitokimyasal bileşik olarak kabul edilebilir (da Silva ve ark., 2019).

2.2. Betanin, aterogenez ve kardiyovasküler hastalıklar

Sigara, alkol, stres, hareketsiz bir yaşam tarzı ve yaşlanmadan kaynaklanan toksinlerle ilişkili doymuş ve trans yağlar ve basit şekerler açısından zengin diyetler gibi uygun olmayan yaşam tarzı ve yeme alışkanlıkları, obezite, diabetes mellitus, dislipidemi (hiperkolesterolemi) (hipertrigliseridemi ve karışık hiperlipidemi) ve arteriyel hipertansiyon gibi komorbiditelerin gelişmesine yol açar (WHO 2003). Kanıtlar, yukarıda belirtilen fizyopatolojik koşulların, anormal ROS ve RNS oluşumunun neden olduğu pro-oksidan-antioksidan denge bozukluklarını ve/veya oksidatif stres oluşturan antioksidan savunmalarının bozulmasını desteklediğini göstermiştir.

Süperoksit anyonu (O_2-), hidrojen peroksit (H_2O_2), hidroksil radikali (HO) ve peroksinitrit ($O=N–O–O^-$), en az bir eşleşmemiş elektron içerdiği (yüksek reaktivite) için insan sağlığına potansiyel zararlı etkileri olan ana oksidatif moleküllerdir. Yüksek miktarda reaktif tür, DNA, lipidler ve proteinler gibi makromoleküllerde oksidatif hasara ve ayrıca vaskülatürde redoks bağımlı sinyal yolaklarının kesintiye uğramasına neden olarak endotel disfonksiyonuna ve aterojeneze neden olur (Cabezas ve ark., 2019). Serbest radikallerdeki artış, LDL partiküllerindeki yağ asitlerinin peroksidasyonuna, negatif yüklerinde, yoğunluklarında ve lizolesittin, kolesterol oksit, hidroksit ve hidroperoksit içeriğinde artışa, sitotoksisiteye ve çoklu doymamış yağ asitlerinin azalmasına ve bunun sonucunda apolipoprotein B-100'ün parçalanmasına yol açar (Mahmoud ve ark., 2019). Fizikokimyasal olarak LDL özelliklerindeki bu değişiklikler, dolaşımdaki monosit ve T-hücreleri için kemotaktik aktiviteyi destekler, inflamatuar hücrelerin endotelyuma yapışmasına, proinflamatuar interlökinlerin, sitokinlerin ve ROS'un salınmasına, LDL oksidasyonunun sürdürülmesine yol açar. LDL ve alttaki endotel molekülleri üzerindeki kalıcı ROS etkisi, tromboksan ve anjiyotensin II gibi vazokonstriktör maddelerde, adezyon moleküllerinde ve büyüme faktörlerinde, düz kas hücrelerinin çoğalmasıyla birlikte homeostaz ve vasküler tonu olumsuz yönde etkilemektedir (Radovanović ve ark., 2021).

Betanin antioksidan ve antiinflamatuar aktiviteleri, aterogenez ve kardiyovasküler hastalık mekanizmalarını zayıflatabilir. Pozitif yüklü betanin bölgeleri, negatif yüklü lipid kısımlarına ($–CO2^-$) afinite vererek, lipid membranlar ve LDL ile etkileşimi ve bunların korunmasını destekler. Ek olarak, bu pigment, yağ asitlerinin polar başına veya apo B-100'ün polar kalıntılarına bağlanarak LDL peroksidasyonunu inhibe ederek LDL'yi oksidasyondan korur. Ek olarak, betanin, önce oksitleyici moleküllerle reaksiyona girerek elektron verme yeteneği sayesinde lipid peroksidasyonunun başlamasınada etki etme yeteneğine sahiptir. Betanin, insan plazmasından izole edilmiş LDL'lere bağlanır ve bakır kaynaklı lipoprotein peroksidasyonunu ve LDL'deki β-karoten yıkımını önlemektedir (Akbar ve ark, 2018). Ek olarak, betanin, ferrus (Fe^{2+}) indirgenen ve OH radikal oluşumunu engelleyen ferrik iyonlar (Fe^{3+}) gibi oksidan moleküllerle etkileşime girebilmektedir. Bu radikal, lipid peroksidasyonunun ana başlatıcısıdır, hidrojen atomlarının lipid membranlardan uzaklaştırılmasına etki ederek, geçirgenliklerini değiştirerek, besin maddelerinin ve toksik maddelerin hücreye giriş ve çıkışı için seçicilik kaybına neden olarak hasara ve hücre ölümüne yol açmaktadır (Kajarabille ve Latunde-Dada, 2019).

Betanin'in lipid peroksidasyonu üzerindeki etkileri, preklinik çalışmalarda çeşitli organ ve dokularda toksik metabolitlerin üretiminin azalmasıyla yorumlanmıştır. İskemi ve reperfüzyon hasarı, KVH tedavileri sırasında yaygın komplikasyonlardır. Reperfüzyon sırasında aerobik metabolizmanın reaktivasyonu nedeniyle, nötrofiller ve mitokondriyal metabolizma tarafından ROS'ta varlığı yükselmektedir. Membran ve nükleik asitler zarar görmekte ve hücre ölümü gerçekleşebilmektedir (Cadenas, 2018). Malondialdehit (MDA), linoleik asit gibi çoklu doymamış yağ asitlerinin peroksidasyonundan oluşmakta ve oksidatif hasarı değerlendirmek için klinik bir biyobelirteç olarak ifade edilmektedir. Betanin, dokularda azalmış MDA üretimi ile ilişkilendirilen, iskemi-reperfüzyon hasarının neden olduğu hayvanların akciğerinde ve kalbinde oksidatif hasarı önleyebilmektedir. Betaninin MDA üzerindeki aynı olumlu etkisi, iskemi ve reperfüzyon yaralanmasını takiben abdominal aorttada gözlemlenmiştir (Tural ve ark. 2020). Birlikte ele alındığında, bu bulgular betaninin oksidatif hasara karşı vasküler bütünlük üzerindeki koruyucu etkiler konusundaki olumlu hipotezleri daha da güçlendirmektedir.

Betanin, serbest radikal süpürme yeteneğine ek olarak, hücresel antioksidan sistem savunmalarının indüklenmesi yoluyla hücre ve vasküler intima üzerindeki koruyucu rolü bulunmaktadır (Ramirez-Velasquez ve ark., 2019). KVH için risk faktörleri, süperoksit dismutaz, katalaz ve glutatyon peroksidaz gibi endojen antioksidan enzimlerin aktivitesinin azalmasıyla ilişkilidir ve hücresel redoks homeostazını korumada başarısız olmaktadır. Klinik

deneyler, betaninin çeşitli oksidatif stres indüklenen bozukluklarda endojen antioksidan sistemleri modüle etme yeteneği belirlenmiştir. Redoks dengesizlikleri bu bozuklukların fizyopatolojisine özgü olduğundan, betaninin kardiyovasküler anormallikler sırasında antioksidan enzimlerin salınımını indükleyebileceğini göstertermektedir (Rahimi ve ark., 2019).

ROS'u uzaklaştırma ve antioksidan enzimleri modüle etme yeteneğine ek olarak, betaninin anti-inflamatuar yanıtlarda önemli bir rol oynadığı savunulmaktadır. Betaninin inflamatuar enzimler siklooksijenaz 2 (COX-2) ve siklooksijenaz 1 (COX-1) in vitro olarak sırasıyla %97 ve %33.5 oranında inhibe ettiği gösterilmiştir. Betanin ayrıca inflamatuar sitokinler olan TNF-a ve IL-B'nin üretimini azaltmakta ve IL-10 düzeylerini artırmaktadır (Martinez ve ark., 2015). TNF-a ve IL-B, kalp yetmezliği, miyokard enfarktüsü ve kardiyomiyopatiler gibi çoklu inflamatuar kardiyak patolojilerde kritik bir önemi olduğundan, kardiyovasküler olaylara karşı tedaviler için hedef olarak kabul edilmektedir (Sreejit ve ark., 2021).

Betaninin inflamatuar yanıtı hafiflettiğine yönelik çeşitli araştırma sonuçları olmasına rağmen, farmakolojik etkilerinin değerlendirildiği moleküler mekanizmalar düzeyindeki rolünün belirlenmesi için daha fazla klinik araştırmaya ihtiyaç duyulmaktadır. Betanin bahsedilen olumlu etkilerin, proinflamatuar kemokinleri ve sitokinleri kodlayan birkaç genin ortak bir modülatörü olan nükleer faktörü kappa beta (NF-kB) aracılığıyla aracılık ettiği varsayılmaktadır. Ek olarak, betaninin insülin direncinde ve tip 2 diyabette spesifik bir rol oynadığı ve her ikisinin de koroner kalp hastalığı, periferik arter hastalığı ve serebrovasküler hastalık dahil olmak üzere aterosklerotik hastalıkların gelişimi için önemli bir risk oluşturduğu gösterilmiştir (Aronson ve Edelman, 2014). 60 gün boyunca 25 ve 100 mg/kg uygulanan betanin, yüksek fruktoz alımı ile indüklenen deneysel diyabet oluşturulan hayvanlarda hiperglisemi, hiperinsülinemi, insulin direnci ve glikasyon ürünlerini pozitif yönde etkilediği belirlenmiştir (Han ve ark. 2015). Yine ratlara uygulanan 20 mg/kg konsantrasyonunda betaninin, deneysel tip 2 diyabetin etkilerini hafiflettiği gösterilmiştir. Betanin bu etkilerini glukokinaz, glukoz-6-fosfataz, piruvat kinaz, glukoz-6-fosfat dehidrojenaz ve fruktoz-1,6-bisfosfataz gibi karaciğer glukoz metabolizması ile ilgili enzimleri düzenleyerek gösterdiği sonucuna ulaşılmıştır (Dhananjayan ve ark., 2017).

Betaninin kardiyovasküler sisteme sağlığa yararlı faydaları, zararlı moleküllerin reaktivitesini stabilize eden, endotel doku hasarından koruyan, aynı zamanda endojen antioksidan savunmaları güçlendirirken proinflamatuar mediatörlerin mRNA'sını aşağı regüle eden anti-radikal süpürücü etkisinden kaynaklanmaktadır. Bu özellikler, endotelyal hücrede ROS aracılı hasarı ve inflamasyonu azaltmaya katkıda bulunmaktadır. Betanin, dolaylı etkilerinin altında yatan mekanizmalar olarak gösterilen iki sinyal yolağı Nrf2-ARE ve NF-kB sinyal yolaklarıdır (Qiu ve ark., 2021). Özetle, betanin oksidatif stresi modüle edebilmekte ve çoklu yollarla inflamasyonu azaltabilmekte ve KVH'nin ilerlemesi için ana mekanizmalar üzerinde etkili olabilmektedir.

3. SONUÇ

Betanin, herhangi bir zararlı etki olmaksızın, oksidatif stres ve inflamasyon ile KVH'de yer alan ana mekanizmaları düzenlemek için destekleyici bir terapötik alternatif olarak değerlendirilebilir. Betanin, oksidatif homeostazın yeniden sağlanmasına ve vasküler inflamasyonun azalmasına katkıda bulunabilir. Ana yapının korunması ile farklı fizyolojik konsantrasyonlarda plazmaya ulaşan betanin biyoyararlılığı, kan akışının fizikokimyasal özelliklerine göre stabilitesini koruması nedeni ile yüksek olduğu düşünülmektedir. Betaninin kardiyoprotektif rolünün tespitine yönelik kesin mekanizmalar henüz tam olarak aydınlatılmamış olsa da, antioksidan/sitoprotektif Nrf2-ARE yolunun indüklenmesi ve inflamatuar NF-kB yolunun baskılanmasının yanı sıra doğrudan ROS/RNS türleri üzerinde hareket etme yeteneği ile birlikte, KVH sağlığı geliştirici ve koruyucu etkileri son derece dikkat

çekici noktalar olarak değerlendirilmektedir. Ek olarak, betanin yüksek biyoerişilebilirlik ve biyoyararlılık özelliğine sahip olması, gıdalarda kullanım için resmi kurumlardan onay alması ve hayvanlarda herhangi bir zararlı etki göstermemesi gibi olumlu özelliklere sahip olmasının yanı sıra, insanlarda istenen terapötik sonuçları elde etmek için etkili doz ve takviye protokolünü belirlemek için daha fazla klinik araştırmalara ihtiyaç bulunmaktadır.

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BAUHINIA AS A BIOACTIVE SOURCE AND HEALTH POTENTIAL

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ABSTRACT

Bauhinia variegata also known as Kachnar is a medicinal tree, native to tropical and temperate regions of India. Kachnar is well practiced in Indian indigenous health sciences; Ayurveda. Various parts of plants i.e. flowers, buds, stems, roots, barks, seeds, and leaves have been used since ancient times for the treatment of diseases. Kachnar bark is used in disorders such as lymphadenopathy, goiter, tumor disorders, while flowers have pittaghna cures dysfunctional uterine bleeding, curing cough, and antitubercular properties. Kachnar leaves are beneficial in managing diabetes by reducing blood glucose levels and improving the lipid profile due to the presence of antioxidants. It have fat 12%, protein 2.53%, fiber 11.2% and carbohydrate as 3.45%.

Purpose: The present study is to evaluate the bioactive constituents and health potentials of Kachnar in the previous studies done. The plants contribute a variety of bioactive compounds such as tannins, phenolic compounds, phytosterols, flavonoids, lysine, oleic acid, glycosides, linoleic acid, saponins, etc. Besides this, the plant and its parts are used for many conventional activities, such as mosquito control, dying industry, and agricultural operations.

Methodology: Different review and research papers are collected for the present study evaluation to know about bioactive and health status of the crop. Findings done on Kachnar crop was identified and the present study highlights the nutritional, bioactive and health benefits of crop among consumers.

Findings: Kachnar has bundle of bioactive compounds which highlight the health status of crop. Kachnar helps in wound healing by inducing the formation of new skin cells due to its anti-inflammatory and antioxidant properties. In Ayurveda, applying Kachnar powder mixed with honey helps manage skin problems such as acne, and pimples due to its Sita (cold) and Kashaya (astringent) properties. Kachnar improves the digestive fire which corrects the metabolism and also helps to balance tridosha due to its appetizer and Tridosha balancing property.

Keywords: *Bauhinia, kachnar, bioactive constituents, saponins, tannins, health benefits.*

1. INTRODUCTION

Mother nature has provided us generously with everything as we require in for good health. Majority of us use plants because these are good source of nutrients and many other constituents that are good source of nutrition and help fight against various diseases and pharmacological importance. Not only medicinal properties these plants have ornamental usage and have Ayurvedic importance in Indian culture (Sawhney et al., 2011; Arain et al., 2010). Regular consumption of plant parts dried or raw (buds, stem, flower, bark, seeds etc.) in diet to claims us to have beneficial effects on human health and helps in protecting the body from chronic diseases like cancer, arthritis, ulcer and diabetes. Still wide ranges of plants are unexplored for the human consumption and are known in only particular area. These plants can be used for various medicinal properties. Among such trees Kachnar i.e., Bauhinia Variegata is one, which is native to tropical and temperate regions of India, and belongs to the family Leguminosae includes more than 200 species (Rojas-Sandoval and Acevedo-Rodríguez, 2015). These all are

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found in different parts of the country. Kachnar is well practiced in Indian indigenous health sciences; Ayurveda. It is small to medium sized deciduous tree with simple leaves alternate stalked cleft at the apex into two rounded lobes resembling a camel's foot. It is grown in the Himalayas up to 1900m of altitude. Kachnar tree possesses various biological and therapeutic properties (anti-inflammatory, anticarcinogenic, antihyperlipidemic, anti-ulcer, anti- cancer, anti-diabetic, antimicrobial activity (Sawhney et al., 2011). The flower of Bauhinia variegata contains carbohydrates and significant amount of protein and fat content and also have high energy value and are used in dried and raw form. Flower is used for chutney, pickle, curry and for juice (Ready to serve beverages, squash, appetizers, wine, vinegar). Whereas dried flowers are used for pharmaceutical industry, instant food products mix (chutney, pakora mix) flavouring agents. Buds of Bauhinia variegata are used on commercial level because of its unique antioxidant properties and contains significant amount of moisture and ash content that's why is used for curry preparation. Bauhinia variegata seeds are rich in amino acids and proteins and is used as pulses by various tribal regions of Central and North-eastern India (Kumar et al., 2020). Leaves of plant can be used as fodder for animals. Beside its traditional uses, health benefits, pharmaceutical properties the crop is still underutilized. The demand of the current era is to explore and make people aware about such plants for their value addition. Therefore, current review is based on explore the plants on the term of its composition, methodology, utilization (traditional and therapeutic) and future perspective. The Bauhinia variegata is a deciduous tree, native to the Southeast Asian countries of India, Sri Lanka and China, among others. It is generally medium in size, growing up to a height of 10 to 12 meters, with thick barks and lengthy stems (Kumar et al., 2020; Rojas-Sandoval and Acevedo-Rodríguez, 2015). These branches hold leaves that stretch up to 10 to 20 centimetres in size, being rather broad, having two rounded lobes each at the base and tip. Kachnar flowers are initially present as stuffed buds and upon blooming, appear in striking shades of vivid pink and dazzling white, bearing five petals. These flowers, upon developing, bud into fruits that are basically seedpods, housing numerous seeds (Sawhney et al., 2011). The present review described the origin, nutritional benefits and health status of *Bauhinia variegate*.

2. ORIGIN AND DISTRIBUTION

Origin of Bauhinia variegata is reported in East Indies and was first naturalized in Jamaica, and then spread to many other countries like Texas and Luisiminia. B. variegata is native to the tropical and temperate regions of Indian subcontinent (Nepal, India, Pakistan and Bhutan), South-eastern Asia (e.g., Vietnam, Myanmar, Thailand and Laos), and China. The plant is well described in ancient times of Indian science of Ayurveda and its stem bark and flowers are used as medicines in various ayurvedic formulations (Kansal et al., 2020). The bark of Bauhinia variegata is used for treatment of various diseases like galaganda (goiter), gandamala (Lymphadenopathy), ashthila (Benign prostatic hyperplasia, BPH), kappa pitta disorders, and arbuda (tumor). Whereas flower of Bauhinia variegate are used for treatment of rakta pradaraghna (curses dysfunctional uterine bleeding), pittaghna (pacify pitta dosha), kaasghna (cures cough and cold), kshyaghna (antitubercular). However various parts of Bauhinia variegata plays different role in curing disease. The dried bulbs of plant are used for carcinogenic properties. However, it is also practiced in treatment of various carcinomas. Kachnar (B. variegata) is eminent and most health beneficial tree in Himachal Pradesh, India (Bodakhe et al., 2010). Table 1. defined the common names of *Bauhinia variegate* crop.

Table 1. Common names of Bauhinia variegate crop Source

Latin name	Bauhinia variegata
English name	Butterfly ash, Camel's foot tree
Hindi name	Kachnar
Bengali name	Kachnar
Kannada name	Basavanpada

3. GENERAL INFORMATION

Kachnar is closely related to peacock flower and Kachnar tree is considered as a beautiful tree in the world when it blooms. Orchid tree, camel's foot tree, mountain ebony, butterfly ash, poor man's orchid, the ebony tree are all common names of Kachnar. It is an ornamental tree with beautiful and scented flowers. This tree is used to attract hummingbirds in parks and gardens. Leaves, flower buds of Kachnar tree are eaten as vegetable (Verma et al., 2012). Table 2. described the classification of *Bauhinia variegate* crop.

Table 2. Scientific classification of *Bauhinia variegate* crop

Kingdom	Plantae
Class	Dicotyledon
Family	Caesalpiniaceae
Genus	*Bauhinia*
Species	*Ariegatal*

3.1. Habitat

Kachnar is native to India and China. It is distributed throughout India at ascending altitude of 1300mt in Himalayan tract extending eastward to Assam, eastern, central and south India. It is also found in Burma, Nepal, Pakistan, and Sri Lanka. The Bauhinia variegata is a deciduous tree, native to the Southeast Asian countries of India, Sri Lanka and China, among others. It is generally medium in size, growing up to a height of 10 to 12 meters, with thick barks and lengthy stems (Rojas-Sandoval and Acevedo-Rodríguez, 2015). These branches hold leaves that stretch up to 10 to 20 centimetres in size, being rather broad, having two rounded lobes each at the base and tip. Kachnar flowers are initially present as stuffed buds and upon blooming, appear in striking shades of vivid pink and dazzling white, bearing five petals. These flowers, upon developing, bud into fruits that are basically seedpods, housing numerous seeds. All parts of the kachnar tree, namely the roots, bark, stems, leaves, flowers and seeds are packed with beneficial nutrients and medicinal compounds that confer astounding merits for overall wellbeing (Verma et al., 2012).

4. NUTRITIONAL VALUE OF KACHNAR

Kachnar Nutrition Values: Kachnar is rich in vital essential nutrients of vitamin C, B vitamins, key minerals of calcium, phosphorous, magnesium, iron, zinc, besides requisite macronutrients of reducing-sugar carbohydrates, dietary fibres, proteins and healthy unsaturated fats (Naeem and Ugur, 2019). In many regions of India, curries and pickles are prepared, by cooking, frying kachnar buds, seasoned with onions and spices, as a customary food, which is then eaten as vegetables or side dishes as part of the regular diet. Besides containing ample amounts of several pivotal vitamins, minerals, proteins, carbs, fats, kachnar also showcases an impressive profile of bioactive phytonutrients with anti-inflammatory, antimicrobial, antihyperglycemic, anti-arthritic and cytotoxic i.e., cancer-reducing properties (Sharma et al., 2021). These potent components are very useful in the prevention, management and treatment of a host of disorders, including hypothyroidism, irregular periods and amenorrhea, high blood sugar levels in diabetes, mouth ulcers and digestive complications (Naeem and Ugur, 2019).

Table 3. Nutritional characterization of different parts of *Bauhinia variegate* crop

Constituents	**Dried leaves**	**Flowers**	**Seeds**	**Buds**	**References**
Protein	15.19	3.24-5	41.9	3.7	Ramadan et al., 2006
Carbohydrate	66.82	16.01	28.4	6.4	Sharma et al., 2021; Verma et al., 2012
Fats	4.15	0.15-2.5	0.1	2.44	Sharma et al., 2021
Fibres	4.26	8.66	6.9	6.8	Verma et al., 2012
Moisture	8.83	77.80	6.7	84.51	Verma et al., 2012
Ash	4.9	2.81	4.8	4.33	Naeem and Ugur, 2019; Ramadan et al., 2006

5. HEALTH BENEFITS OF *BAUHINIA VARIEGATE*

In Ayurveda, Kachnar is designated as “Rakta Kanchan” in Sanskrit and it known by many other ancient names including “Kanchanara”, “Gandari”, “Yugapatraka”. The time-tested scriptures of Charaka Samhita, Sushruta Samhita classify this miraculous plant as “Vamanopaga” meaning utilised in emesis or expulsion of toxins from the body, besides “Kashayavarga” implying it holds an inherent astringent flavour (Parekh et al., 2006) Being rather bitter in nature, kachnar comprises a kashaya rasa i.e., astringent taste. This highly useful herb is famed for its laghu guna, since it is easy to assimilate in the system and also has a rather dry quality i.e., rooksha guna. Having an intrinsic sheeta veerya i.e., cooling attribute, kachnar also displays a prabhava or special curative feature, in the form of “Gandamala Nashana”, meaning it effectively rectifies all thyroid problems (Mishra et al., 2013) Kachnar is also beneficial in balancing elevated kapha and pitta doshas, soothing aggravated symptoms and instilling tridoshic harmony of vata, pitta and kapha in the human body. As per Ayurveda, consuming Kachnar powder along with honey or lukewarm water helps manage the thyroid due to its Tridosha balancing and Deepan (appetizer) properties. Kachnar helps in wound-healing by inducing the formation of new skin cells due to its anti-inflammatory and antioxidant properties (Singh et al., 2016; Mishra et al., 2013). In Ayurveda, applying Kachnar powder mixed with honey helps manage skin problems such as acne, pimples due to its Sita (cold) and Kashaya (astringent) properties. One of the most popular therapeutic concoctions prepared with kachnar, blended with resin from Mukul plants and various spices, is Kanchanar Guggulu, famed for mending instances of thyroid problems, PCOS, joint aches, hormonal imbalance and impurities in the blood. Possessing abundant quantities of vitamin C, vital trace minerals, besides potent antioxidants, kachnar is a panacea for curing a spectrum of health anomalies, ranging from haemorrhoids, indigestion, cough, to slowing progression of cancer and controlling blood sugar in diabetes (Singh et al., 2019; Rajani and Ashok, 2009).

5.1. Rectifies Thyroid Problems

Hypothyroidism occurs when the thyroid gland does not synthesize adequate quantities of thyroid hormones, which play a crucial role in conserving metabolism and immunity in the body. Since an imbalance in the three doshas of vata, pitta, kapha, besides overweight, obesity conditions and hampered digestion processes prompt thyroid problems, taking kachnar

decoctions and powders assists in treating hypothyroidism. Kachnar formulations significantly ease the assimilation of foodstuffs in the body, as well as regulate the three doshas, improve metabolism and promote weight loss (Vadivel and Biesalski, 2011).

5.2. Lowers Blood Sugar

Kachnar is blessed with profuse anti-diabetic and antihyperglycemic plant compounds. These control insulin mechanisms in the body, as well as bring down rising blood glucose levels. In this manner, kachnar assists in mitigating diabetes symptoms and keeping blood sugar levels in check.

5.3. Effectively Treats Haemorrhoids

Kachnar is imbued with agni-activating matter i.e., compounds that stimulate the digestive juices. Since rampant indigestion and constipation trigger inflammation in the veins in the rectum, resulting in itching, pain, bleeding during the elimination of wastes as urine, stools, kachnar relieves pain, swelling in the rectum and ceases the occurrence of piles or haemorrhoids (Verma et al., 2012).

5.4. Regulates Menstrual Cycles

Erratic occurrences of monthly periods or the total lack of menstruation i.e. amenorrhea, which happen due to imbalance in pitta dosha and an overheated body, can be alleviated by taking kachnar decoctions. This is because kachnar is packed with sheeta or cooling traits, besides an inherent ability to control pitta dosha, thereby assuring timely, normal menstrual cycles.

5.5. Treat Hypothyroidism

Hypothyroidism is a condition in which the thyroid gland does not produce a sufficient number of thyroid hormones. According to Ayurveda, the initial causes of Hypothyroidism are diet and lifestyle factors that imbalance the digestive fire and metabolism and disrupt the balance of the Tridoshas (Vata/Pitta/Kapha). Kachnar improves the digestive fire which corrects the metabolism and also helps to balance Tridosha due to its Deepan (appetizer) and Tridosha balancing property.

5.6. Treatment to Piles

Piles, known as Arsh in Ayurveda, is caused by an unhealthy diet and a sedentary lifestyle. This leads to the impairment of all the three doshas, mainly Vata. An aggravated Vata leads to low digestive fire, leading to constipation. If ignored or left untreated, this causes swelling in the veins in the rectum area leading to formation of Piles mass. Kachnar helps to improve the digestive fire because of its Deepan (appetizer) property, thereby preventing constipation and also helps to reduce swelling of the Piles mass.

5.7. Treatment to Menorrhagia

Menorrhagia or heavy menstrual bleeding is known as Raktapradar (or excessive secretion of menstrual blood) in Ayurveda and is caused due to an aggravated Pitta dosha. Kachnar balances an aggravated Pitta and controls heavy menstrual bleeding or Menorrhagia as it has Sita (cold) and Kashaya (astringent) properties.

5.8. Cure of Diarrhoea

Diarrhoea, known as Atisar in Ayurveda occurs due to improper food, impure water, toxins, mental stress and Agnimandya (weak digestive fire). All these factors are responsible for aggravating Vata. Aggravated Vata brings fluid to the intestines from various tissues of the body and mixes with the stool. This leads to loosen, watery motions or Diarrhoea. Kachnar

helps to control Diarrhoea by improving the digestive fire due to its Deepan (appetizer) properties. It also makes the stool thick and controls water loss due to its Grahi (absorbent) and Kashaya (astringent) properties.

Table 4. Health benefits of *Bauhinia variegate* crop

Shapes	Pods long narrow and pointed at the ends, hard, flat, glabrous, 13-25cm long, 15-18mm wide.
Taste	Sour, astringent, sweet
Health benefits	Treatment of Haemorrhoids, Regulating of Blood Flow during Menstruation, Purification of Blood, Treatment of Digestive System Problems, Healing Internal Wounds, Treatment for Cough, Anti-cancerous properties, Antidote for snake bites, Cures diuresis, treats oral disorders, Useful for rectal prolapse, Cure diarrhoea due to indigestion, Ease burning sensation, Controls blood sugar, Menorrhagia haemolysis, Treat hypothyroidism, Anti-tumor activity.

Source: Naeem and Ugur, 2019; Sunkar et al., 2018; Verma et al., 2012

6. AESTHETIC VALUE OF *BAUHINIA VARIEGATE*

To reduce air pollution and make urban areas more attractive; the concerned authorities should take essential measures from environmentalists. Health of environment will be improved and urban areas also become pollution free through planting of native species of trees including Kachnar. Due to its versatility, helping to reduce allergy problems in the future, provide animal fodder, adding beauty to the highways. It is a multipurpose tree that is planted along highways for the atmosphere and soil pollution safety in Pakistan (Sunkar et al., 2018). Most of the people in Pakistan are familiar with Kachnar tree especially those who live in sub-mountainous areas including Islamabad. It adds to the beauty of the cities because of its attractive colors. The type of Kachnar tree found in Islamabad are light violet flowers. Apart from these some complete white flowers look like orchid flowers which bloom in February to March. The flower buds are regarded as a delicacy, despite its aesthetic value. Due to its limited availability in spring, they are expensive. In Pakistan there is need to plant more of these indigenous species like kachnar trees to combat environmental pollution and to improve urban areas due to industrialization and urbanization as Kachnar is a multi-purpose plant tree (Verma et al., 2012).

7. PRODUCTS MADE FROM *BAUHINIA VARIEGATE*

Kanchanar Guggulu is an effective Ayurvedic remedy for treating hypothyroidism, hormonal imbalance, PCOS and joint pains. The word Guggul originated from the Sanskrit word Guggulu means ‘protection from the disease’. It also promotes the functioning of the lymphatic system and in getting rid of toxins (Ramadan et al., 2006).

Key Ingredients: Kanchanar Guggulu comprises Kanchanar (bauhinia variegate) bark, ginger, black pepper, long pepper, Haritaki, bibhitaki, amlaki (the combination of triphala), Varuna (crataeva nurvala bark), cardamom, cinnamon, and Guggulu resin in equal amounts. Kanchanar bark is brewed into a decoction and gets mixed with guggulu and other items to make it into a tablet (Naeem and Ugur, 2019).

8. CONCLUSION

Kachnar is truly a magical wonder from Mother Nature, that supplies tremendous quantities of essential nutrients, carbs, proteins, fats, vitamins, minerals, besides powerful antioxidants and advantageous plant-based biochemical. Kachnar is indeed a versatile herb. It can be consumed as food in measured amounts by incorporating it into the routine diet, as staple Indian dishes of

curry, achaar. Besides, it delivers magnificent curative traits as a medicinal aid for thyroid complications, indigestion, irregular menstrual cycles and healing a host of health woes, to ensure optimal wellbeing.

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GASTRONOMİK BİR DEĞER OLARAK COĞRAFİ İŞARETLİ TOKAT BEZ SUCUĞUNUN KARAKTERİSTİK ÖZELLİKLERİ VE ÜRETİM YÖNTEMİ

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ÖZET

Gastronomi turizmi bir yerin çekiciliğini belirleyen en önemli faktörlerden bir tanesidir. Bu bakımdan yerel gastronomik ürünlerin korunması, pazarlanması ve sürdürülebilirliğinin sağlanarak ticari boyut kazandırılması, destinasyon tanıtımı açısından büyük önem arz etmektedir. Ülkemizde geleneksel ve yöresel birçok değerin bulunması ve bu değerlerin kendine özgü nitelikleri olması, gelişen dünya ticareti içerisinde bu değerlerin sahiplenme olgusunu gündeme getirmiştir. Bu sebeple yöresel ve geleneksel değerlere ait bilgilerin belirli bir düzen içerisinde toplanması ve koruma altına alınması önem arz etmektedir. İşte bu noktada Coğrafi işaret, tüketiciler için ürünün kaynağını, karakteristik özelliklerini ve ürünün söz konusu karakteristik özellikleri ile coğrafi alan arasındaki bağlantıyı gösteren ve garanti eden kalite işaretidir. Zengin bir mutfağa sahip olan Tokat ilinin coğrafi işarete sahip gastronomik bir ürünü olan Tokat bez sucuğu yıllardır üretimi ve tüketimi yapılan bir mamüldür. Çok çabuk bozulan bir ürün olan etin değerlendirilerek katma değer katılması hem endüstriyel boyutta ithalat ve ihracat yapan fabrikaların ekonomik faaliyetlerinin gelişmesini desteklemekte hem de yöreye yapılacak olan gastronomi turizmleri sayesinde kırsal ve bölgesel kalkınmaya katkı sağlamaktadır. Tokat Bez Sucuk; kıyma makinesinden çekilen etin ve yağın tuz, sarımsak ve baharatlarla karıştırıldıktan sonra bez kılıflara doldurulması, askıya asılarak olgunlaştırılması ve merdanelemeyle yassılaştırılması suretiyle üretilen fermente sucuktur. Tokat bez sucuğu'nun ayırt edici özellikleri doğal fermantasyon yönteminin uygulanması, Mermerşahi denilen bezlere dolum yapılması, merdanelerle havasının alınıp yassı şekil verilmesi ve ısıl işlem uygulanmamasıdır. Bu sucuğun en önemli özelliklerinden birisi de damakta bıraktığı tadı olmakla birlikte Tokat'taki evlerde hemen herkes tarafından kışlık yiyecek olarak hazırlanmasıdır. Bez Sucuk, Tokat dışında da pazarlanıp bilinirliliği artan, Tokat'a gelen misafirlerin hediye olarak alıp götürdükleri bir üründür. Bu çalışma, gastromik bir ürün olan coğrafi işaretli Tokat bez sucuğunun Coğrafi İşaret Sicil Belgesi'nde bulunan ürün tanımı, ayırt edici özellikleri ve üretim metodu, tescillenen özelliklerinin ne olduğu ve diğer sucuklardan ne gibi ayırt edici özellikleri bulunduğunu, bilimsel bir çerçevede değerlendirmek amacıyla hazırlanmıştır.

Anahtar Kelimeler: *Gastronomi, fermantasyon, et, coğrafi işaret.*

GEOGRAPHICALLY INDICATED TOKAT BEZ SUCUK AS A GASTRONOMİC VALUE, ITS CHARACTERISTIC FEATURES AND PRODUCTION METHOD

ABSTRACT

Gastronomy tourism is one of the most important factors that determine the attractiveness of a place. In this regard, ensuring the protection, marketing and sustainability of local gastronomic products and gaining them to a commercial dimension is of great importance in terms of

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destination promotion. The fact that there are many traditional and local values in our country and that these values have their own characteristics has brought the phenomenon of appropriation of these values to the agenda in the developing world trade. For this reason, it is important to collect and protect information about local and traditional values in a certain order. At this point, geographical indication is a quality mark that shows and guarantees the source of the product, its characteristics and the connection between the said characteristic features of the product and the geographical area for consumers. Tokat cloth sausage, which is a gastronomic product with a geographical indication of Tokat province which has a rich cuisine, is a product that has been produced and consumed for years.The addition of added value by evaluating meat, which is a very perishable product, both supports the development of the economic activities of the factories that import and export on an industrial scale and contributes to rural and regional development thanks to the gastronomic tourism to be made in to the region. Tokat Cloth Sausage; It is a fermented sausage produced by mixing the meat and fat extracted from a meat grinder with salt, garlic and spices, then filling them in cloth covers, maturing by hanging them on a hanger and flattening them by rolling. The distinctive features of Tokat Cloth Sausage are the application of a natural fermentation method, filling of cloths called Marmershahi, taking air with rollers and giving it a flat shape and not applying heat treatment. One of the most important features of this sausage is its taste, which it leaves on the palate, but it is prepared as a winter food by almost everyone in Tokat houses. Cloth Sausage is a product that is also marketed outside of Tokat and has increased its awareness, which is taken away as a gift by the guests who come to Tokat. This study was prepared in order to evaluate the product description, distinctive features and production method of Tokat cloth sausage, one of the Tokat geographical indication products, in the Geographical Indication Registry Document, what its registered characteristics are and what distinctive features it has from other sausages in a scientific framework.

Keywords: *Gastronomy, fermentation, meat, geographical indication.*

1. GİRİŞ

Faydalı bir besin maddesi olan et, taze olarak tüketilebildiği gibi çeşitli teknolojik işlemler uygulanması suretiyle farklı lezzet ve aromalar kazandırılarak dayanıklı et ürünleri halinde de tüketilebilmektedir (Akbakla, 2019). Herhangi bir muhafaza yöntemi uygulanmadığında, patojen mikroorganizmalar dâhil olmak üzere çok farklı mikroorganizma grubunun gelişme ve çoğalması için uygun bir ortam olan etin raf ömrü, mikroorganizmaların gelişmesine bağlı olarak kısalmaktadır. İnsanoğlu etin hem raf ömrünü uzatmak hem de değişik özelliklerde yeni ürün elde etmek amacıyla farklı teknolojileri uzun yıllardan itibaren kullanmaktadır. Soğutma ve dondurma, kurutma, ışınlama, ısıl işlem uygulamaları, etin kimyasal maddelerle muamele edilmesi ve fermantasyon et ürünlerine uygulanan başlıca muhafaza yöntemlerindendir (Köse, 2010).

Fermantasyon çok eski zamanlardan günümüze kadar uygulanmakta olan bir gıda üretim ve koruma yöntemidir. Fermantasyon yöntemiyle hem gıdaların bozulmadan korunması sağlanmakta hem de vitaminlerin ve esansiyel aminoasitlerin senteziyle gıdaların besin değeri artmaktadır. Fermantasyon ile besinlerin sindirilebilirliği artırılırken, çiğ besinlerde bulunan istenmeyen maddelerin detoksifikasyon ve yıkımı da gerçekleştirilmektedir (Karaçil veTek, 2013).

Mikroorganizmaların gelişimi ve metabolik aktiviteleri sonucunda olgunlaşan fermente et ürünleri için, ülkemizde en bilinen örnek sucuktur. Sucuk tarihimizde ilk defa Kaşgarlı Mahmud tarafından 11.yy.'da kaleme alınan Divanü Lügati't-Türk'te bahsi geçmiş daha sonra ise 17.yy.'da Evliya Çelebi' nin ünlü eseri olan Seyahatname'de yer almış geleneksel bir Türk gıdasıdır. Türklere özgü olan bu ürün sucuk işleme teknolojisi açısından Avrupa ve

Amerika'daki kuru salam ve sosislere benzemektedir (Bakanoğulları, 2015). Türk Mutfağında sucuk, sucuk barbeküsü veya yağda sucuk kızartması olarak ve fasulye yemeklerinin yapımında kullanılır. Sucuk aynı zamanda tost ve yumurta ile ayrılmaz ikili olarak bilinirliği en fazla olan ürünlerdendir. Sucuğun Türk mutfağına özgü olması, gastronomik bir unsur olarak tüm dünyada daha fazla varlığını gerektirmektedir (Badem, 2021).

Türkiye'nin Karadeniz Bölgesinin orta kısmında yer alan Tokat ilinin kuzeyinde Samsun ve Ordu, güney ve doğusunda Yozgat ve Sivas, batısında ise Amasya illeri bulunmaktadır. Yüzölçümü 10.072 km^2 olup rakımı ortalama 623 metredir. Tokat; Yeşilırmak havzasının bereketli toprakları üzerinde kurulmuş olmasının verdiği kazanımla 6000 yıllık tarihi boyunca önemli bir kültür ve ticaret merkezi olmuş, 14 Devleti ve birçok Beyliği içerisinde barındırmış, önemli bir Anadolu şehridir.

Tokat, tarihsel geçmişiyle birlikte oldukça zengin bir mutfak ve beslenme kültürüne sahiptir. Evliya Çelebi Seyahatnamesi'nde Tokat'ın doğal ve coğrafi şartlarının da bu duruma oldukça uygun olduğunu ifade etmektedir (Sağır, 2012). Tokat ilinde 15 adet coğrafi işaretli ürün mevcut bulunmakta olup, bunlardan 11 adedi gıda maddesidir. Tokat ilinin coğrafi işaretli gıda ürünleri Erbaa Narince Bağ Yaprağı, Tokat Ekmeği, Niksar Cevizi, Tokat Kebabı, Tokat Narince Salamura Asma Yaprağı, Tokat Yağlısı, Tokat Çöreği, Turhal Yoğurtmacı, Zile Kömesi, Zile Pekmezi ve Tokat Bez Sucuğudur.

Tokat bez sucuğu; Tokat yöresine özgü bir besin ve lezzet kaynağıdır. Geçmişi 1900'lü yılların başına dayanan Tokat Bez Sucuğu çobanlar tarafından çok kullanılması sebebiyle zamanında Tokat Çoban Sucuğu markası ile ticarileştirilir ancak **bu** ifade zamanla unutulur ve Tokat Bez Sucuğu (elbiseli sucuk) olarak günümüzde sofralarımızı süslemeye devam eder (Orakçı, 2021). Bu sucuğun en önemli özelliklerinden birisi damakta bıraktığı tadı olmakla birlikte Tokat'taki evlerde hemen herkes tarafından kışlık yiyecek olarak hazırlanmasıdır. Bez Sucuk, Tokat dışında da pazarlanıp bilinirliliği artan, Tokat'a gelen misafirlerin hediye olarak alıp götürdükleri bir üründür (Sağır, 2012).

Tokat bez sucuğu 990 mahreç işareti numarası ile 03.01.2022 tarihinde 6769 sayılı Sınai Mülkiyet Kanunu kapsamında Türk Patent ve Marka Kurumu tarafından tescil edilmiştir (Şekil 1). Bu çalışma, gastromik bir ürün olan coğrafi işaretli Tokat bez sucuğunun Coğrafi İşaret Sicil Belgesi'nde bulunan ürün tanımı, ayırt edici özellikleri ve üretim metodu, tescillenen özelliklerinin ne olduğu ve diğer sucuklardan ne gibi ayırt edici özellikleri bulunduğunu, bilimsel bir çerçevede değerlendirmek amacıyla hazırlanmıştır.

Şekil 1. Tokat bez sucuk tescilli logosu

2. KAVRAMSAL ÇERÇEVE

2.1. Gastronomi ve Gastronomi Turizmi

Gastronomi kelimesi, Yunanca: mide anlamına gelen "gastros" ve kural anlamına gelen "nomos" kelimelerinin birleşmesi ile oluşmuştur. Gastronomi biliminin amaçları arasında; insanların yeterli ve dengeli bir şekilde beslenmesi ile sağlığının korunması, hayattan ve yemek yemekten zevk almasının sağlanması, yiyecek ve içeceklerin hijyenik bir ortamda hazırlanması,

damak ve göz zevkini amaçlayarak sofraya ve yenilmeye hazır hale getirilmesi yer almaktadır (Gök ve ark., 2017)

Gastronomi turizmi ise bir yöreye özgü yemeklerin ve içeceklerin tadına bakmak ve unutulmaz gastronomi deneyimi yaşamak için yapılan geziler olarak tanımlamaktadır. Gastronomi turizmi; gastronomi festivalleri, gıda fuarları, restoranları, çiftçi pazarları, yemek gösterileri, gıda turları ve yemek ile ilgili yapılan ziyaretler gibi birçok etkinliği kapsamaktadır. Gastronomi turizmi, turistlerin bir yeri tekrar ziyaret etmek istemelerinde, gezilecek yerleri belirlemede ve beğendikleri yerin reklamını yapma konusunda oldukça önemli bir yere sahiptir. Gastronomi turizmi aynı zamanda bir yerin çekiciliğini belirleyen en önemli faktörlerden bir tanesidir (Durmaz ve ark., 2022). Bu bakımdan yerel gastronomik ürünlerin korunması, pazarlanması ve sürdürülebilirliğinin sağlanarak ticari boyut kazandırılması, destinasyon tanıtımı açısından büyük önem arz etmektedir (Güllü ve Karagöz, 2019).

2.2. Coğrafi İşaret Tanımı ve Önemi

Ülkemizde geleneksel ve yöresel birçok değerin bulunması ve bu değerlerin kendine özgü niteliklerinin olması, gelişen dünya ticareti içerisinde bu değerlerin sahiplenme olgusunu gündeme getirmiştir. Bu sebeple yöresel ve geleneksel değerlere ait bilgilerin belirli bir düzen içerisinde toplanması ve koruma altına alınması önem arz etmektedir. Bu açıdan bakıldığında, birçok ürünün coğrafi adı ile tanındığı bilinen bir gerçektir. Bu bilgilerin coğrafi işaretler verilerek koruma altına alınması, hem yurt içi hem de yurt dışı piyasalarda ürünlerin menşeine ve üretim sürecine ait doğru bilgilerle değerlendirilmesi, ülke ekonomisine makro ve mikro anlamda ciddi katkılar sağlayabilmenin yolunu açmıştır (Orhan, 2010).

Coğrafi işaret, tüketiciler için ürünün kaynağını, karakteristik özelliklerini ve ürünün söz konusu karakteristik özellikleri ile coğrafi alan arasındaki bağlantıyı gösteren ve garanti eden kalite işaretidir. Coğrafi işaret tescili ile kalitesi, gelenekselliği, yöreden elde edilen hammaddesi ile yerel niteliklere bağlı olarak belli bir üne kavuşmuş ürünlerin korunması sağlanır. 6769 sayılı Sınai Mülkiyet Kanununun 34 üncü maddesine göre; "Coğrafi işaret: Belirgin bir niteliği, ünü veya diğer özellikleri bakımından kökenin bulunduğu yöre, alan, bölge veya ülke ile özdeşleşmiş ürünü gösteren işarettir. Coğrafi işaretler, menşe adı ya da mahreç işareti olarak tescil edilir. Gıda, tarım, maden, el sanatları, sanayi ürünleri coğrafi işaret tesciline konu olabilir " (Türk Patent, 2022).

Coğrafi işaret Belirli bir mekâna bağlı olan ve ürün coğrafi köken ilişkisini tanımlayan tek sınaî mülkiyet hakkı türüdür. Bu terim ile amaçlanan; bir ürünün, bir yöreyle, coğrafyayla özdeşleşmiş olması, birtakım özelliklerinin ya da tüm özelliklerinin bu yöreden kaynaklanması ve bu çerçevede tüketici gözünde belli bir bilinirliğe ve kaliteye sahip olmasıdır (Çekal ve Aslan, 2017).

Coğrafi İşaretlerin en önemli ekonomik işlevi, ürünün bilinirliliğini korumasıdır. Coğrafi İşaretle ürün piyasa kimliğine sahip olmakta ve ürün benzerlerinden farklılaşarak yüksek bir fiyattan satılabilmektedir. Coğrafi İşaretler hem yöresel ürünleri hem de onları oluşturan özellikleri tanımlamakta, kırsalın özellikli ürünlerinin markalaşmasını sağlamakta, üreticinin gelirlerinin artmasına, kırsal turizmin gelişmesine ve kırsal nüfusun çeşitli iş alanlarında çalışabilmesine imkân sağlamaktadır (Doğanlı, 2020).

Bu bağlamda zengin bir mutfağa sahip olan Tokat ilinin coğrafi işarete sahip gastronomik bir ürünü olan Tokat bez sucuğu yıllardır üretimi ve tüketimi yapılan bir mamüldür. Çok çabuk bozulan bir ürün olan etin değerlendirilerek katma değer katılması hem endüstriyel boyutta ithalat ve ihracat yapan fabrikaların ekonomik faaliyetlerinin gelişmesini desteklemekte hem de yöreye yapılacak olan gastronomi turizmleri sayesinde kırsal ve bölgesel kalkınmaya katkı sağlamaktadır.

2.3. Tokat Bez Sucuk Tanımı ve Üretimi

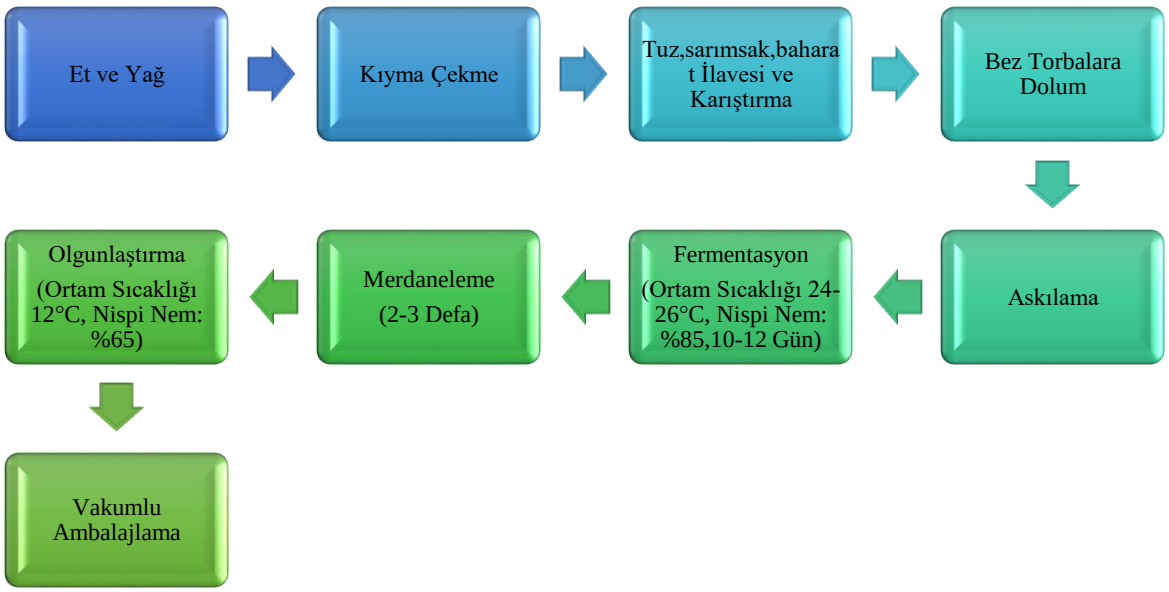
Coğrafi İşaret Sicil Belgesi'nde yapılan tanıma göre Tokat Bez Sucuk; kıyma makinesinden çekilen etin ve yağın tuz, sarımsak ve baharatlarla karıştırıldıktan sonra bez kılıflara doldurulması, askıya asılarak olgunlaştırılması ve merdanelemeyle yassılaştırılması suretiyle üretilen fermente sucuktur. Tokat bez sucuğu'nun ayırt edici özelliği; doğal fermantasyon yönteminin uygulanması, sağlığa zararlı kimyasal maddelerin kullanılmaması, Mermerşahi denilen bezlere dolum yapılıp, merdanelerle havasının alınıp yassı şekil verilmesi ve ısıl işlem uygulanmamasıdır. Ayrıca geleneksel olduğu için tat ve aroma özellikleri daha fazla ortaya çıkmaktadır.

Belgede tescillenen üretim metoduna göre; Tokat Bez Sucuk formülasyonunda 100 kg sucuk harcına (Et:75-80 kg+20-25 kg yağ) ilave edilecek bileşenler ve kullanım oranları (%)Tablo 1' de verilmiştir.

Tablo 1. Tokat bez sucuk üretiminde kullanılan bileşenler

Bileşen	**Kullanım oranı (%)**	**Bileşen**	**Kullanım oranı (%)**
Tuz	1-2	Kimyon	1-2
Sarımsak	1-2	Yenibahar	0.5-1.0
Karabiber	1-2	Sakkaroz	0.2
Acı kırmızıbiber	1-2	Fosfat tuzu	0.1-0.25
Tatlı kırmızıbiber	1-1.5		

Tokat Bez Sucuğun üretimi; temel olarak formülasyon, fermantasyon ve olgunlaştırma/kurutma olmak üzere üç aşamadan oluşur. Formülasyon, sucuk kılıfına doldurulmak üzere et, yağ ve diğer tüm bileşenlerin hesaplanarak hazırlandığı aşamadır. Tokat Bez Sucuk üretiminde kullanılacak yağ, 3 mm gözenek çapındaki aynalı kıyma makinasından çekilerek dondurulur. Kemiğinden ayrılmış dana karkas eti ise; 10 mm gözenek çapındaki aynalı kıyma makinesinden çekilir, üzerine önceden dondurulmuş yağ, formülasyondaki diğer bileşenler ilave edilir ve 10-12°C'yi geçmeyecek sıcaklıkta karıştırılır. Tüm kitle 3 mm gözenek çapındaki aynalı kıyma makinasından çekilerek iyice karıştırılır. Elde edilen sucuk hamuru, fermantasyon ve olgunlaştırma işlemi sonunda 200-250 g olacak şekilde otomatik dolum makinesinde bez kılıflara doldurulur (Şekil 2).



Şekil 2. Tokat bez sucuk üretim akış şeması

Sucuk hamurunun doldurulması, şekil verilmesi, sucuğun korunması, olgunlaşması ve kurutulması için kullanılan sucuk kılıfları; %100 pamuk ipliğinden dokunmuş, 3 cm^2'sinde 40-100 çözgü ve 35-70 atkı bulunan, boyasız beyaz mermerşahi kumaştan yapılır. Sucuğun üretimde kullanılmadan önce; gıda üretimine uygun temizlik ürünleri ile yıkanır, durulanır ve kurutulur.
Sucuk hamuru doldurulduktan sonra kılıfların uçları, paslanmaz alüminyum malzemeden yapılan klipsler ile bağlanır, askılama arabalarına konularak (Şekil 3) nemi ve sıcaklığı ayarlanabilen, hava sirkülasyonuna sahip fermantasyon odalarında/kabinlerinde doğal fermantasyon ve olgunlaştırmaya tabi tutulur.

Şekil 3. Bez kılıflara dolum ve askılama arabalarına asılan Tokat bez sucuk

Tokat Bez Sucuk üretiminde doğal fermantasyon yöntemi uygulanır. Doğal fermantasyon, işletme ortamında bulunan mikroorganizmaların sucuk hamuruna geçmesiyle gerçekleşir. Fermantasyon ve olgunlaştırma aşamasında önemli rol oynayan mikroorganizmalar Lactobacillus, Staphylococcus, Micrococcus cinslerinin üyeleridir. Doğal fermantasyon sırasında florada yer alan Laktobasiller, bileşimde bulunan fermente edilebilir şekerleri fermente ederek sucuğa hafif ekşi tadını veren laktik asidi oluştururlar. Doğal fermantasyonun kontrollü koşullarda yapılmasıyla, asit miktarında belirli bir artış sağlanırken ürün pH değerinde azalış meydana gelir. Bu durum, et proteinlerinin su tutma kapasitesini azaltarak ürünün kuruma hızını ve dilimlenme kabiliyetini artırır. Ayrıca fermente ürünlerin olgunlaşma süresince; yağ ve protein degradasyonunu içeren birçok kimyasal değişim gerçekleşir ve meydana gelen ikincil reaksiyonlar sonucu karakteristik aroma bileşenleri oluşur. Doğal florada bulunan Micrococ'ların lipolitik hidrolizi sonucunda oluşan serbest yağ asitleri, havadaki oksijen ile önce hidroperoksitleri daha sonra ise sucuk aromasına katkı sağlayan aldehitler, ketonlar ve uçucu yağ asitlerini oluştururlar.
Fermantasyon ve olgunlaştırma aşamasında fermantasyon odasının/kabininin başlangıç nispi nem oranı %85, sıcaklığı 24-26 °C'dir. Ortamın nispi nem oranı ve sıcaklığı; günlere bağlı olarak kademeli biçimde ve 10-12 günlük sürenin sonunda, % 65'e ve 12°C'ye düşürülür. Bez kılıflardaki sucuklara, fermantasyon ve olgunlaştırma süresince 2-3 defa merdaneleme işlemi uygulanarak, bez kılıfların içindeki hava boşluklarının uzaklaştırılması ve sucuğun yassı bir şekil alması sağlanır. Fermantasyon ve olgunlaştırma işlemi tamamlanan Tokat Bez Sucuk ambalajlanarak vakumlanır. Vakumlu ambalajlarda 2-4 °C'de 4 ay depolanabilir. Tüketime Hazır Tokat Bez Sucuğun renk ve tonları, kiremit renginden koyu kahverengine kadar değişebilir (Şekil 4). Üretiminde kullanılan bileşen ve miktarlarına bağlı olarak karakteristik koku ve tada sahiptir (Türk Patent, 2022).

Şekil 4. Tüketime hazır Tokat bez sucuk

3. SONUÇ VE ÖNERİLER

Bu çalışmada gastronomik bir ürün olan coğrafi işaretli Tokat bez sucuğunun Coğrafi İşaret Sicil Belgesi'nde bulunan ürün tanımı, ayırt edici özellikleri ve üretim metodu, tescillenen özelliklerinin ne olduğu ve diğer sucuklardan ne gibi ayırt edici özellikleri bulunduğu vurgulanmaya çalışılmıştır.

Tokat bez sucuğu'nun ayırt edici özelliği doğal fermantasyon yönteminin uygulanması, sağlığa zararlı kimyasal maddelerin kullanılmaması, Mermerşahi denilen bezlere dolum yapılıp, merdanelerle havasının alınıp yassı şekil verilmesi ve ısıl işlem uygulanmamasıdır. Ayrıca geleneksel olduğu için tat ve aroma özellikleri daha fazla ortaya çıkmaktadır.

Hazır gıda tüketiminin yaygınlaştığı günümüzde, bireylerin sağlıklı olarak beslenebilmelerini sağlamak son derece önemlidir. Bu nedenle geleneksel gıda ve yemeklerimizin yeniden gündeme getirilerek genç nesillere, yurt içi ve yurt dışında tanıtılması, endüstriyel ölçekte üretim olanaklarının artırılması ve besin değerlerinin ortaya konmasına yönelik çalışmaların yaygınlaşması gerektiği düşünülmektedir. Bu amaçla;

- Tokat bez sucuğunun hem iç pazarda hem de dış pazarda tanıtımına yönelik faaliyetler arttırılabilir.
- Tokat bez sucuğunun yerel ve ulusal basında daha fazla yer bulabilmesi için daha fazla reklam faaliyetlerinde bulunulabilir.
- Sosyal medyanın etkinliğinden faydalanarak Tokat bez sucuğunun daha fazla tanınırlığına imkân sağlanabilir.
- İllerin giriş çıkışlarında ve ulaşımın yoğun olduğu noktalarda Tokat bez sucuğunu tanıtıcı afiş, billboard ve totemlerin kullanılması ürünün bilinirliğini arttırabilir.
- Sokak yemek kültürünün vazgeçilmez ögelerinden biri olan sucuk-ekmek ikilisinin Tokat bez sucuğu ile hazırlanarak bilinirliliğinin arttırılarak yaygınlaştırılması sağlanabilir.
- Özellikle kahvaltı servisi yapılan restoranlarda sucuklu yumurta ikilisinin Tokat bez sucuğu kullanılarak hazırlanması konusunda çalışmalar yapılabilir.
- Spesiyal restoranların şefleri ile görüşülerek Tokat bez sucuğunun tanıtım çalışmaları yapılabilir.
- Doğal ve tarihi alışveriş mekânlarında, bölgedeki alışveriş merkezlerinde, yol kenarına kurulacak ya da kurulmuş olan yiyecek-içecek işletmelerinde Tokat bez sucuğunun satış ve pazarlama faaliyetleri yürütülebilir.

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QUALITY CHARACTERISTICS OF STEAM BEAN PUDDING (*MOIN-MOIN*) ENRICHED WITH FLUTED PUMPKIN LEAVES

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ABSTRACT

The need to diversify the utilization of abundant leafy vegetable in our environment coupled with the efforts to enrich the traditional culinary formed the basis of this study. Steamed bean pudding was enriched with fluted pumpkin leaf slurry at 5, 10 and 15 % levels of inclusion. The enriched pudding was subjected to proximate analysis, antioxidant properties, phenolic content, mineral composition and sensory evaluation. The results showed that the ash content of the samples ranged between 3.80 to 6.64 % and the protein content ranged between 24.52 and 26.27 %. The results of the antioxidant also showed that the radical scavenging ability of the enriched bean pudding samples (11.87 to 20.60 %) was greater when compared with the control pudding (10.87 %), the ferric reducing antioxidant power of the enriched samples (1.36 and 1.80 mgAAE/g) was lower compared with 1.98 mgAAE/g for the pudding without leafy vegetable pudding. Enriched bean pudding with fluted pumpkin leafy vegetable contained higher phenolic content (0.79 and 0.89 mg GAE/g) than the 0.72 mg GAE/g bean pudding without leafy vegetable slurry. The results of the mineral content showed that Magnesium was dominant in the enriched pudding than the other mineral elements evaluated. The results of the sensory evaluation revealed that the preference for the samples decreased as the level of inclusion of the vegetable leaf slurry increased. Findings from the results showed that though the enriched steamed pudding samples nutritional great nutritional benefits, the green colour of the samples affected the acceptability. Therefore, more sensitization of the products is needed to gain wide acceptance.

Keywords: *Bean pudding, nutritional benefits, antioxidant properties, functional foods, consumer awareness.*

1. INTRODUCTION

Consumption of plant protein has been conceived as one of the solutions to address the inadequate intake of protein diets. One of the important protein rich plants is legumes. Leguminous plants are a major class of plant that has gained wide attention to tackle the incidence of low protein intake and its associated illness. Legumes, such as lima beans, peanuts, Bambara nuts etc., are cheap sources of protein with high nutritional content.

Beans are one of the few leguminous grains, produced worldwide, which is economically viable and nutritionally dense. They are cheap dietary source of protein for the poor resource populace of world (Egounlety and Aworh, 2003). Nigeria has been rated as the world highest producer of beans. Interestingly, the most populous black nation has also been seen as the highest consumer of beans in the world. One of the most notable unique characteristics of beans is in its uniqueness to be made into different products to satisfy the need of the populace that see

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variety in diet as the spice of life (Harris, 1998). One of such products from bean is the steamed bean pudding, popularly called Moin-Moin.

Moin-Moin as its fondly called, is traditionally made by steam batter, produced from beans that has been wet-milled. It is usually eaten as protein component to replace animal protein, especially the meat protein (USAID, 2002). Moin-Moin could be consumed using starchy like or carbohydrate source of food, such as bread, gari, pap as condiment. However, Kethireddippali *et al.* (2002) suggested that moimoi can be made into different shapes which is determined by the type of packaging material, such as leaves, milk tin, plastic cup, nylon and tetra pack packaging materials. The packaging materials used for the processing of moimoi is a strong determinant of the safety of the products, due to easy migration of components of the material into the product as a result of the application of heat.

In addition to cowpea grains such as beans, other ingredients needed for making steamed bean pudding include onion, pepper, salt, vegetable oils and salt. However, as popular steamed pudding is, the major nutrient one can derive from this is the protein, which is a reflection of the major materials used for its preparation. Therefore, enriching steamed bean pudding with nutrient dense plant material would be the delight a many puddings consumer.

With the increasing menace of degenerative diseases (Ukegbu et al., 2014) coupled with ever increasing rate of the consumption of steamed bean pudding, (Othman, 2017), supplementation with indigenous green leafy vegetables like *Telfairia occidentalis* (fluted pumpkin), is a veritable choice. Fluted pumpkin leaves are relatively inexpensive but with high quality nutrients. The vegetable contains phytochemicals, protein, and minerals (Famuwagun et al., 2016). Green leafy vegetables are not only rich in nutrients but also possess medicinal properties. The use of fluted pumpkin powder for food supplementation has been reported by Fasogbon et al. (2017) and Odunlade et al. (2017). There is however limited information on the supplementation steamed bean pudding with leafy vegetable, especially flited pumpkin leafy vegetable. Thus, this study aimed to evaluate the effect of addition of fluted pumpkin leaves on on the proximate, mineral, physical, antioxidant, and sensory properties of the steamed bean pudding.

2. MATERIALS AND METHODS

2.1. Materials

Dried white beans (*Phaselous vulgaris*), pepper, onions, seasoning, wrapping leaves, vegetable oil and were obtained from Akinola market Ipetumodu Area, Ile-Ife, Osun State, Nigeria. The leafy vegetable (*ugu* leaves) was obtained from the teaching and research famr, Obafemi Awolowo University, Ile-Ife, Osun State. The tools and implements, such laboratory blender, knife, bucket and spoons were sourced from the Food Processing Laboratory and Food Chemistry and Biochemistry Laboratory of the Department of Food Science and Technology, Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria.

2.2. Methods

The modified method of Okwunodulu et al. (2019) was used to process the steamed bean pudding as shown in Figure 1. The beans were sorted and cleaned to remove foreign materials, stones and unwanted grains that may be present in the beans to prevent contamination. The bean grains were then weighed using a weighing balance to know the actual quantity of the starting material. The bean grains were soaked in a big bowl containing known volume of potable water for two minutes to make de-hulling of the beans easier. Thereafter, the soaked beans were de-hulled to remove the hulls by rubbing the beans against each other in between two hands after which it was washed with potable water, this was done continuously by changing the water until there was no hull in the beans. The washed beans were reweighed to know the quantity of

the beans used after de-hulling and at the same time hulls was dried and weighed in order to determine the quantity of hulls removed. The cleansed weighed beans were then wet milled using a laboratory size blender to a fine slurry to have minimum small particle size. At this stage other ingredients such as red pepper, onions, known quantity of potable water and *ugu* leaves were added and blended together and the quantity of each is as shown in Table 1. The blended beans were mixed uniformly with other ingredients such as salt, seasoning, vegetable oil after proper mixing the slurry was then dispense into aluminum can and arranged properly in a pot and transferred to an electric stove for steaming which was conducted for about 45minutes. During steaming, water was added at interval to prevent burning until the steaming was completed. Cooling of the steamed beans pudding was optional. The process was done to produce four (4) different samples, namely, **BPWE**; bean pudding without enrichment: **BPW5E**; Bean pudding with 5% leafy vegetable: **BPW10E**; Bean pudding with 10% leafy vegetable; **BPW15E**; Bean pudding with 15% leafy vegetable. The fresh leafy vegetable was also analyzed along with the other processed bean puddings.

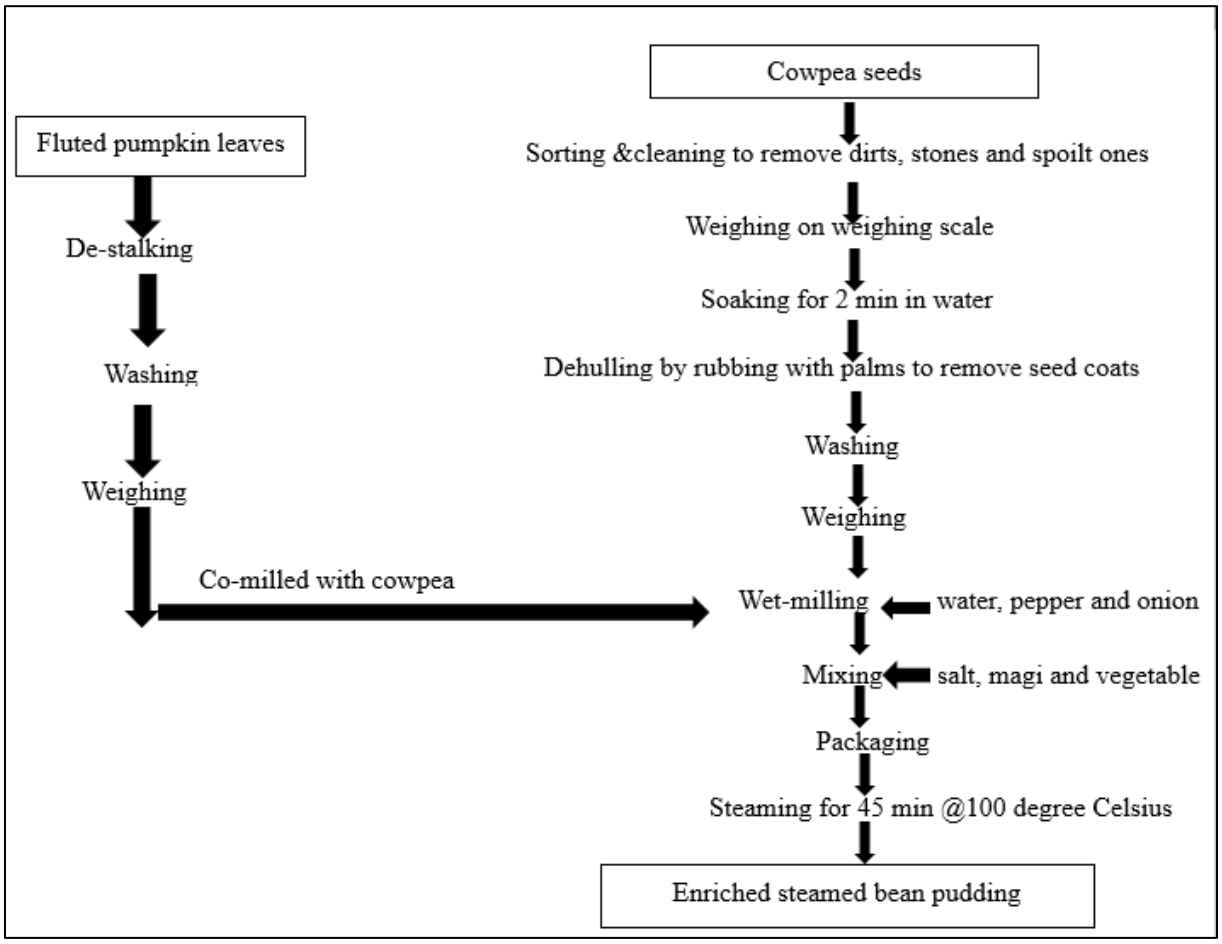

Figure 1. Process flow chart for the processing of steamed bean pudding integrated with fluted pumpkin leafy vegetable

Source: Modified process of Okwunodulu *et al*. (2019)

Table 1. Formulation table for enriched steamed bean pudding

Cowpea (g)	**Fluted pumpkin leaves (g)**	**Onion (g)**	**Pepper (g)**	**Vegetable oil (g)**	**Salt (g)**	**Maggi (g)**
100	-	17	8	30	0.5	2
95	5	17	8	30	0.5	2
90	10	17	8	30	0.5	2
85	15	17	8	30	0.5	2

3. CHEMICAL ANALYSIS

3.1. Preparation of the pudding for analysis

The processed pudding was mashed using the laboratory mortar and pestle. Aliquots of the mashed samples were taken for each of the analysis as described below.

3.2. Proximate composition

3.2.1. Determination of moisture content

Moisture content was determined using the standard AOAC (2012) official method by drying 5 g (W_1) of the sample in a hot air-oven (Uniscope, SM9053, England) at 105 ± 1 ºC until constant weight (W_2) was obtained, the samples was then removed from the oven, cooled in a desiccator and weighed. The result was expressed as percentage of dry matter as shown in the equation:

$$M.C = \frac{(W_1 - W_2)}{W_1} \times 100 \quad (3.1)$$

where,

M.C = Moisture content (%); W_1 = mass of sample before drying (g); W_2 = mass of sample after drying (g)

3.2.2. Ash content determination

Ash content was determined by the official AOAC (2012) method using muffle furnace (Carbolite AAF1100, United Kingdom). Two grams (W_3) of the sample was weighed into already weighed (W_2) ashing crucible and placed in the muffle furnace chambers at 700 ºC until the samples turned into ashes within 3h. The crucible was removed, cooled in a desiccator and weighed (W_1). Ash content was expressed as the percentage of the weight of the original sample as shown in equation below;

$$Ac = \left(\frac{W_1 - W_2}{W_3}\right) \times 100$$

(3.2) where, Ac = Ash content (%); W_1 = mass of crucible + ash (g); W_2 = mass of empty crucible (g); W_3 = mass of sample (g)

3.2.3. Fibre content determination

Crude fibre was determined as described by AOAC (2012) using 2 g (W_3) of sample. About 200 ml of 1.25 % (*v/v*) sulphuric acid was added and the flask was placed on a hot plate and boiled for 30 min. The content was filtered using filter paper (Whatman No.1) and the residue on the filter paper was washed with 50-70 ml distilled water. The washed residue was transferred back into the flask and about 200 ml 1.25 % (w/v) NaOH was added and boiled for 30 min. The content was then filtered as described earlier and the residue obtained was washed with distilled water and then filtered again using filter paper (Whatman No.1). The residue was

then transferred to an ashing dish and dried at 130 ºC for 2 h, cooled in a desiccator and weighed (W_1). This was then ashed at 550 ºC inside the muffle furnace chamber (Carbolite AAF1100, United Kingdom) for 30 min, cooled and reweighed (W_2). The ash obtained was subtracted from the residue and the difference expressed as percentage of the starting material as shown in equation below;

$$\mathrm{Cf} = \left(\frac{W_1 - W_2}{W_3}\right) \times 100 \qquad (3.3)$$

where,
Cf = Crude fibre (%); W_1 = mass of crucible with the dried residue (g); W_2 = mass of crucible with the ash (g), W_3 = mass of sample (g)

3.2.4. Crude protein determination

The total protein content was determined using the Kjeldahl method (AOAC, 2012). Ground sample (0.20 g) was weighed into a Kjeldahl flask. Ten millilitre of concentrated sulphuric acid was added followed by one Kjeltec tablet (Kjeltec-Auto 1030 Analyser, USA). The mixture was be digested on heating racket to obtain a clear solution. The digestate was cooled, and made up to 75 ml with distilled water and transferred onto kjeldahl distillation set up followed by 50 ml of 40 % sodium hydroxide solution, the ammonia formed in the mixture was subsequently distilled into 25 ml, 2 % boric acid solution containing 0.5 ml of the mixture of 100 ml of bromocresol green solution (prepared by dissolving 100 mg of bromocresol green in 100 ml of methanol) and 70 ml of methyl red solution (prepared by dissolving 100 mg of methyl red in 100 ml methanol) indicators. The distillate collected was then titrated with 0.05M HCl. Blank determination was carried out by excluding the sample from the above procedure;

$$Crude\ protein\ content = \left(\frac{1.401 * F * M * ml\ of\ titrant - ml\ of\ blank}{weight\ of\ sample}\right) * 100 \qquad (3.4)$$

Where; Cp = crude protein (%); M = molarity of acid used = 0.1 ($\frac{\mathrm{mol}}{\mathrm{dm}}$); F = kjeldahl factor = 6.25

3.2.5. Crude fat content determination

Crude fat was determined by the AOAC (2012) method using Soxhlet apparatus (Sunbim, India). Approximately 5 grams (W_3) of the ground sample was placed into a thimble which was placed inside Soxhlet extractor and n-hexane was poured into a pre-weighed round bottom flask (W_2), used to extract the oil from the sample. The extraction was carried out for about 6 hours. The solvent was removed from the extracted oil by distillation. The oil in the flask was further dried in a hot-air oven at 90 ºC for 30 minutes to remove residual organic solvent and moisture. This was cooled in a desiccator and flask and its content weighed (W_1). The quantity of oil obtained was expressed as percentage of the original sample used using the equation given

$$crude\ fat = \left(\frac{W_1 - W_2}{W_3}\right) \times 100 \qquad (3.5)$$

Where; W_1 = weight of flask + oil; W_2 = weight of empty flask, W_3 = weight of sample

3.2.6. Carbohydrate content

Carbohydrate was expressed as a percentage of the difference between the addition of other proximate chemical components and 100% as shown in equation below:

Carbohydrate=100- (protein + crude-fat + ash + fibre + moisture). (3.6)

3.3. Mineral Analysis

The analysis for essential mineral elements was investigated using atomic absorption spectrophotometric method (Fashakin et.al., 1991). The sample (0.5 g) was weighed into a digestion flask and 10 ml of nitric acid and 10 ml of HCl was added. The mixture was then digested for 10 min. The digested mixture was filtered using No 1 whatman filter paper. The filtrate was then made up to 50 ml with distilled water. An aliquot was transfer to the Auto-analyser for total phosphorus analysis at 420 nm. The left-over of the digest was used to determine the other elements (calcium, sodium, magnesium, iron, lead, copper, and zinc) using the Atomic Absorption Spectrophotometer (Perkin Elmer, model 402) while sodium and potassium were determined using flame photometry.

3.4. Determination of Antioxidant Properties

3.4.1. DPPH (diphenyl-1-picryhydrazyl) radical scavenging activity

The free radical scavenging ability of the pudding was determined using the stable radical DPPH (2, 2-diphenyl-2-picrylhydrazyl hydrate) as described by (Pownall et al., 2010). One hundred milligram of the mashed bean pudding and the standard glutathione was separately mixed with 10 ml of water to have a final concentration of 10 mg/ml. the mixture was hydrated for 30 min and centrifuged. To one milliliter (1 ml) of the samples and the standard, 1 ml of 0.3 mM DPPH in methanol was added. The mixture was then mixed and incubated in the dark for 30 minutes after which the absorbance was read at 517 nm against a DPPH control containing only 1ml methanol in place of the sample.

The percent of inhibition was calculated from the following equation:

$$DPPH\ radical\ scavengin\ activity = \left(\frac{absorbance\ of\ control - absornace\ of\ sample}{absorbance\ of\ control}\right) \times 100 \quad (3.7)$$

3.4.2. Metal chelating ability assay

The metal-chelating assay was carried out according to the method of Singh and Rajini (2004). Solutions of 2 mM $FeCl_2 \cdot 4H_2O$ and 5 mM ferrozine was diluted 20 times (1 ml of each of the solutions made up to 20 ml with distilled water separately).

One hundred milligram (100 mg) of the mashed pudding was dissolved in 10 ml of water to have the final concentration of 10 mg/ml. the mixture was hydrated for 30 min and later centrifuged. One milliliter (1 ml) of the supernatant was mixed with 1 ml $FeCl_2 \cdot 4H_2O$. After 5 min incubation, the reaction was initiated by the addition of 1 ml of ferrozine (1 ml). The mixture was shaken vigorously and after a further 10 minutes incubation period the absorbance of the solution was measured spectrophotometrically at 562 nm. The percentage inhibition of ferrozine–Fe^{+2} complex formations was calculated using the formula:

$$Metal\ chelating\ activity = \left(\frac{absorbance\ of\ control - absornace\ of\ sample}{absorbance\ of\ control}\right) \times 100 \quad (3.8)$$

3.4.3. Determination of ferric reducing antioxidant power (FRAP)

The FRAP assay uses antioxidants as reductants in a redox-linked colorimetric method with absorbance measured with a spectrophotometer (Benzie and Strain, 1999). A 300 mmol/L acetate buffer of pH 3.6, 10 mmol/L 2, 4, 6-tri-(2-pyridyl)-1, 3, 5-triazine and 20 mmol/L $FeCl_3.6H_2O$ was mixed together in the ratio of 10:1:1 respectively, to give the working FRAP reagent. The mashed pudding (100 mg) was dissolved in dissolved in 10 ml of water and mixed. The mixture was hydrated and centrifuged for 15 minutes. 1 ml of the supernatant was added to 1ml of FRAP reagent. The mixture was well mixed and absorbance measured at 593 nm

against reagent blank (1 ml of distilled water and 1 ml of FRAP reagent) after allowing reaction to complete at exactly 10 minutes.
Different concentration (20, 40, 60, 80, 100 µg/ml) of Fe_2SO_4 was prepared and the procedure was repeated as that of the samples. The reducing power of the samples was extrapolated and expressed as millimolar (mMol) concentration of Fe^{2+}.

3.4.4. Determination of total phenolic content (TPC)

Total phenol content was evaluated using a modified colorimetric method described previously by Singleton (1965). A final concentration of 10 mg/ml of the mashed pudding in 50 methanol was prepared. This mixture was hydrated for 30 min and centrifuged. Five hundred micro-liter (500 µ L) of the supernatant was added to 1 ml of 10 times diluted solution Follin reagent. Immediately, 1 ml of 7% Na_2CO_3 was added. The mixture was then incubated for 30 min at 37^{o}C and the absorbance was read at 765 nm using UV-Vis spectrophotometer (Unicam Heλio α, Cambridge, UK). The measurement was compared to a standard curve prepared with gallic acid solution of different concentrations (0.1, 0.2, 0.4, 0.6, 0.8, 1.0 mg/ml). The total phenolic content was extrapolated from the standard curve of the gallic acid and expressed as milligrams of gallic acid equivalents per gram of fresh weight (mg GAE g^{-1}).

3.5. Procedures for Sensory Evaluation

Four sets of *moin-moin* samples were produced and presented for evaluation by panelists. The panelists were selected based on their familiarity with the product and their ability to differentiate effectively between one sample and the other. All the four samples were evaluated organoleptically using a 7-point hedonic scale. Samples were scored for flavour, colour and overall acceptability. The sensory scores obtained for all samples were subjected to analysis of variance (ANOVA) to determine if there were statistically significant difference in the sensory attributes at 95% confidence level.

3.6. Statistical Analysis

Data obtained from the chemical analyses and sensory evaluation were subjected to analysis of variance and means were separated using Duncan's Multiple Range Test at 95% confidence level

4. RESULTS AND DISCUSSION

4.1. Proximate composition

The moisture content of the enriched pudding ranged between 26.48 and 27.83 %. The moisture content of the pudding without vegetable was 25.56 %. There was significant difference ($p>0.05$) among the enriched samples were significantly higher than the bean pudding without enrichment. the moisture content increased as the level of vegetable enrichment increased in the sample. The values of the moisture content were higher than the 12.50 to 15.00 % reported for steamed pudding made from the blends of cowpea and water yam (Otunola & Afolayan, 2018). This difference could be attributed to higher moisture content in leafy vegetable when compared with water yam. Moisture content is an indicative test for shelf life of food products. The ash content of the samples ranged between 3.80 and 6.64 %. These values were more than the ash content of the pudding without vegetable (3.50 %) and were significantly ($p<0.05$) different from one another. leafy vegetable, especially fluted pumpkin leaves is known to be rich in ash which is a function of the presence of various minerals that have good implications on human health (Odunlade et al., 2017). The high mineral contents in the pudding compared to the samples without enrichment could be the result of vegetable enrichment as shown in Table 2 (7.45 %). The values obtained in this study were higher compared with 1.80 to 1.83 %

reported for steamed bean pudding produced from paste from various types of cowpeas (Okwunodulu et al., 2019)

The fibre content of the enriched samples ranged from 0.93 to 1.48 %. These values were higher when compared with 0.50 % obtained for steamed bean pudding without enrichment. The fibre content of the sample increased with increases in the addition of the leafy vegetable. However, the pudding without enrichment is not expected to contain as much fibre as possible because the cowpea was wet-milled to fine paste. Improving the fibre content of the samples through the addition of the vegetable is a welcomed development as this would help in the easy passage of fecal waste when the pudding is consumed. The results of the fibre content compared well with the pudding obtained using mung beans (Aniebet and Olanrewaju, 2019).

The fat content of the enriched samples ranged between 4.38 and 5.25 %. As shown in Table 2, the contribution of the vegetable to fat content of the samples were in the form of chlorophyll pigment. And the presence of fat in the pudding might be due to the use of vegetable cooking oils in the process. The protein content of the samples in the also ranged between 16.52 and 16.27 %. The pudding enriched with 5 % leafy vegetable (BPW5E) had protein content (16.50 %), which is not significantly different ($p>0.05$) from the value (16.50 %) of the pudding without enrichment. This pattern may suggest that the amount of the vegetable present is not enough to make significant changes in the protein content of the sample. The pudding that contained 10 and 15 % leafy vegetable had protein content which is significantly ($p<0.05$) higher than the other samples that had 5 % and the sample without enrichment. This pattern of result also suggests that the amount of vegetable added (10 and 15 %) are enough to make significant increase in the protein content. Although, the amount of protein in the puddings that contained 10 and 15 % leafy vegetable were statistically significant, it might not be enough from the nutrition point of view. This is because the protein content of the leafy vegetable in its wet form is about 1.34 % (Table 2), but when the leaves are dried and enough moisture is eliminated from the leaves, the protein content increases. The values of the protein content in this study compared well with the values of the pudding obtained from Bambara nut (Aniebet and Olanrewaju, 2018). The carbohydrate content of the samples ranged between 36.53 and 47.89 %. It was observed that the values increased as the level of inclusion of the vegetables reduced in the samples. This pattern could be attributed to the values of other proximate composition in the samples as reported.

Table 2. Proximate composition of steamed bean pudding co-milled with fluted pumpkin leaves

Sample	**Moisture**	**Ash**	**Fibre**	**Fat**	**Protein**	**Carbohydrate**
BPWE	25.56 ± 0.02^{b}	3.50 ± 0.05^{a}	0.50 ± 0.02^{a}	4.06 ± 0.03^{b}	16.50 ± 0.02^{a}	49.88 ± 0.02^{e}
BPW5E	26.48 ± 0.04^{c}	3.80 ± 0.05^{b}	0.93 ± 0.02^{b}	4.38 ± 0.02^{c}	16.52 ± 0.02^{b}	47.89 ± 0.02^{d}
BPW10E	27.28 ± 0.03^{d}	5.88 ± 0.03^{c}	1.00 ± 0.02^{c}	4.86 ± 0.02^{d}	16.61 ± 0.02^{c}	44.37 ± 0.02^{c}
BPW15E	27.83 ± 0.03^{e}	6.64 ± 0.02^{d}	1.48 ± 0.02^{d}	5.25 ± 0.02^{e}	16.27 ± 0.02^{d}	36.53 ± 0.02^{a}
Veg leaves	86.24 ± 0.01^{a}	7.45 ± 0.04^{e}	2.50 ± 0.02^{e}	0.15 ± 0.02^{a}	1.34 ± 0.02^{e}	2.32 ± 0.02^{b}

Values are mean ± s.d. of 3 determinations. Values with different superscript down the column are different significantly ($p<0.05$) from each other

BPWE; bean pudding without enrichment: BPW5E; Bean pudding with 5% leafy vegetable: BPW10E; Bean pudding with 10% leafy vegetable; BPW15E; Bean pudding with 15% leafy vegetable

4.2. Mineral Composition

The results of the mineral content of the samples are shown in Table 3. The Iron content of the samples enriched with leaf vegetables were higher compared with the sample without enrichment. The values reported for pudding that contained 5 % (BPW5E) and 10 % (BPW10E) leafy vegetable were not significantly ($p>0.05$) different from each other. The fluted pumpkin leaf had Iron content of 6.10 mg/100g and this may have contributed to the trend observed in the enriched sample. The values (1.10 and 1.80 mg/ 100 g) reported in this study for the Iron content was lower compared with the 2.30 and 2.50 mg/ 100 for pudding made using other variety of legumes (Okwunodulu et al., 2019). The values obtained for the Sodium content (21.30 to 35.50 mg/ 100 g) of the enriched was significantly higher than 11.00 mg/ 100g for the pudding without enrichment. The trend of results was also similar to that of the Calcium content (20.80 to 36.20 mg/ 100 g), Copper content (4.90 to 5.20 mg/ 100 g) and Magnesium content (34.30 to 42.30 mg/ 100 g). The results showed that the fluted pumpkin leaves added to the bean pudding made significant contributions to the selected mineral content of the samples. For instance, the Magnesium and Calcium contents of the leaves were 250.70 and 146.20 mg/ 100 g respectively and these values significantly reflected in the contents of the enriched bean pudding. According to the FND (2005), the body needs an average of 1000 mg of calcium and 8 mg of Iron per day. The level of these nutrients in the pudding can conveniently contribute to this daily needs of nutrients. For instance, the enriched pudding would contribute between 15 to 20 % of Iron and 5 to 6.67 % of the daily needs of Calcium per day. These trends suggest that fluted pumpkin is a good ingredient for enriching steamed bean pudding.

Table 3. Some Mineral composition of steamed bean pudding co-milled with fluted pumpkin leaves

Sample	**Iron content (mg/ 100 g)**	**Sodium content (mg/ 100 g)**	**Calcium content (mg/ 100 g)**	**Copper content (mg/ 100 g)**	**Magnesium content (mg/ 100 g)**
BPWE	0.21 ± 0.03^{d}	11.00 ± 0.02^{e}	18.20 ± 0.02^{e}	4.70 ± 0.02^{d}	27.80 ± 0.02^{e}
BPW5E	1.10 ± 0.02^{c}	21.30 ± 0.03^{d}	20.80 ± 0.02^{d}	4.90 ± 0.02^{d}	34.30 ± 0.02^{d}
BPW10E	1.30 ± 0.02^{c}	29.00 ± 0.03^{c}	36.20 ± 0.04^{c}	5.20 ± 0.02^{c}	42.30 ± 0.02^{c}
BPW15E	1.80 ± 0.02^{b}	35.50 ± 0.03^{b}	40.40 ± 0.02^{b}	5.80 ± 0.02^{b}	44.30 ± 0.02^{b}
Veg leaves	6.10 ± 0.02^{a}	38.80 ± 0.03^{a}	146.20 ± 0.02^{a}	8.30 ± 0.02^{a}	250.70 ± 0.02^{a}

Values are mean ± s.d. of 3 determinations. Values with different superscript down the column are different significantly ($p<0.05$) from each other

Key:

BPWE; bean pudding without enrichment: BPW5E; Bean pudding with 5% leafy vegetable: BPW10E; Bean pudding with 10% leafy vegetable; BPW15E; Bean pudding with 15% leafy vegetable

4.3. Antioxidant Properties

The 1,1-diphenylpicrylhydrazine radical scavenging activities (DRSA) is based on a decolorization assay that measures the capacity of antioxidants to directly react with the DPPH radical by monitoring its absorbance at 517 nm. It is a stable organic nitrogen-centered free radical with a dark purple color but becomes colorless when reduced to its non-radical form by an electron-donating compound, which enables estimating antioxidant capacity (Saidi *et al*., 2014). The results of the DPPH radical scavenging activities of the enriched and not enriched steamed bean pudding is shown in Figure 2. The values obtained for the enriched samples ranged between 15 to 34 %. The values were significantly ($p<0.05$) higher than the value

(obtained for the sample of pudding that was not enriched. The results showed increased in the scavenging activities of the samples as the level of inclusion increased. the results of the enriched samples reflect the beneficial outcome of the leafy vegetable in enhancing the scavenging activities of the pudding. By these results, it shows that the enriched samples possessed stronger ability to donate radicals to chain reaction and terminate oxidative process. The ability of the puddings to chelate transitions metal that could result to oxidation is shown by its metal chelating activities (MCA) and this is presented in Figure 3. The MCA principle involves the formation of colored complexes with ferrous iron molecules when a test compound competes with a synthetic chelator (Nam *et al*., 2008). The extent of color change, which accompanies the complex compound formation, is used to estimate the chelating activity of the antioxidant test compound. As shown on Figure 4, there was no significant difference ($p>0.05$) in the metal chelating activities of the enriched samples (BPW5E, BPW10E, BPW15E) but significantly ($p<0.05$) different from the sample of pudding that was not enriched (BPWE). These values were also lower when compared with the standard (glutathione) as presented in Figure 3.

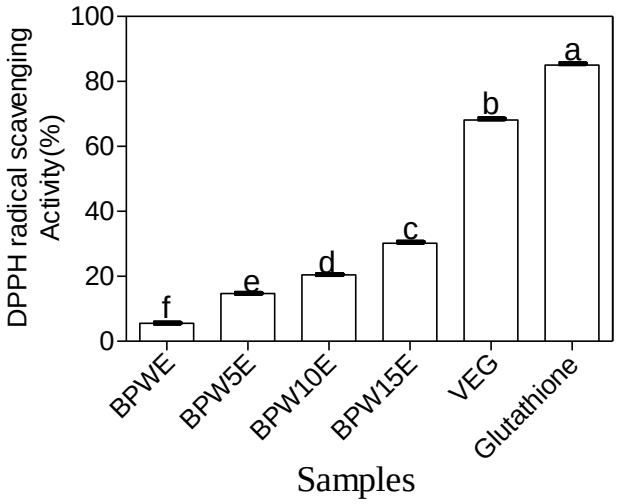

Figure 2. DPPH radical scavenging activity of steamed bean pudding co-milled with fluted pumpkin leaves

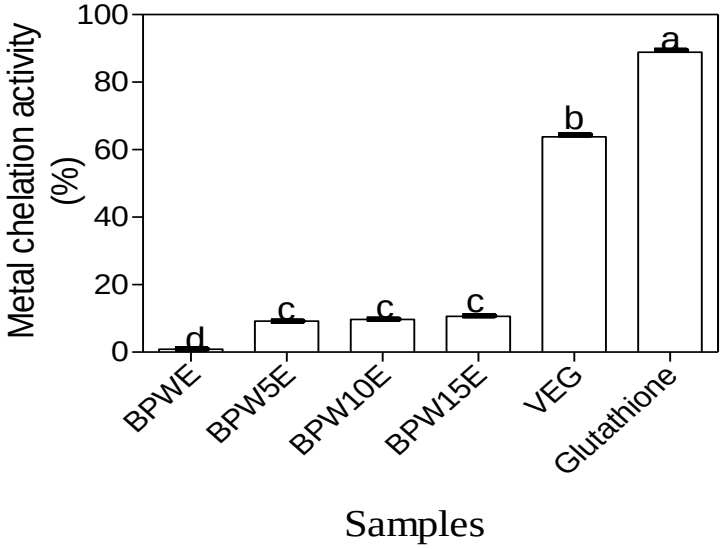

Figure 3. Metal chelating activity of steamed bean pudding co-milled with fluted pumpkin leaves

Key:

BPWE; bean pudding without enrichment: BPW5E; Bean pudding with 5% leafy vegetable: BPW10E; Bean pudding with 10% leafy vegetable; BPW15E; Bean pudding with 15% leafy vegetable

The non-significant values of the three enriched samples could be attributed to the fact that the quantity of leaves added to the samples during preparation could not cause any significant difference in the chelating activities.

The ferric reducing antioxidant power (FRAP) assay estimates the potential of antioxidant compounds to donate electron/hydrogen ions and interrupt propagation of chain reactions involving free radicals (Dorman *et al*., 2003). The FRAP of the steamed bean pudding is shown in Figure 4. The results showed the values of the enriched samples were significantly ($p<0.05$) different from one another and significantly higher ($p<0.05$) when compared with the sample that was not enriched. It can be inferred from the results that enriched pudding had greater ability to donate ferric electron to stop the elongation of chain reactions.

The results of the phenolic content of the samples, is shown in Figure 5. the results showed that the higher the level of addition of the leaves to the recipe, the greater the amount of phenolic content on the steamed pudding. The enriched samples also had higher amount of phenolic content than the sample that did not contain leafy vegetable. It is important to note that phenolic test is an indicative test that shows the quantity of phenols that would contribute to the antioxidant properties of the samples. The results in Figure 4, therefore validate the previous results as shown in the other antioxidant assays and as earlier presented in this study.

4.4. Sensory Evaluation

Three sensory attributes of the samples; colour, flavour and overall acceptability were evaluated. As shown in Table 4, addition of the leaves to the pudding ingredient influenced the colour perception of the panelists. Samples that contained the leaves were rated low, compared with the sample without leafy vegetable. The higher the leafy vegetable, the lower the likeness of the colour and this was significantly visible in the pictures of the samples as shown in Plate 1(a-d). However, samples that contained 5 and 10 % leafy vegetables were not significantly different ($p<0.05$) in terms of the colour, as observed by the panelists.

Th results of the flavour characteristics of the samples were similar to that of the colour. As shown in Table 4, the scores of the sample that did not contain leafy vegetable was significantly ($p<0.05$) higher than those that contained leafy vegetables. However, samples BPW5E and BPW10E that contained 5 and 10 % leafy vegetable were not significantly different ($p>0.05$) from each other.

In the overall acceptability of the samples, the sample that did not contain leafy vegetable was accepted more than the ones that contain leafy vegetable. Just like the other parameters, samples BPW5E and BPW10E that contained 5 and 10 % leafy vegetable were not significantly different ($p>0.05$) from each other. It is important to note here that the low ratings of the sensory parameters of the samples that contained leafy vegetables is not a demarking factor of the products, rather it should be a selling point, with respect to the nutritional properties of the samples

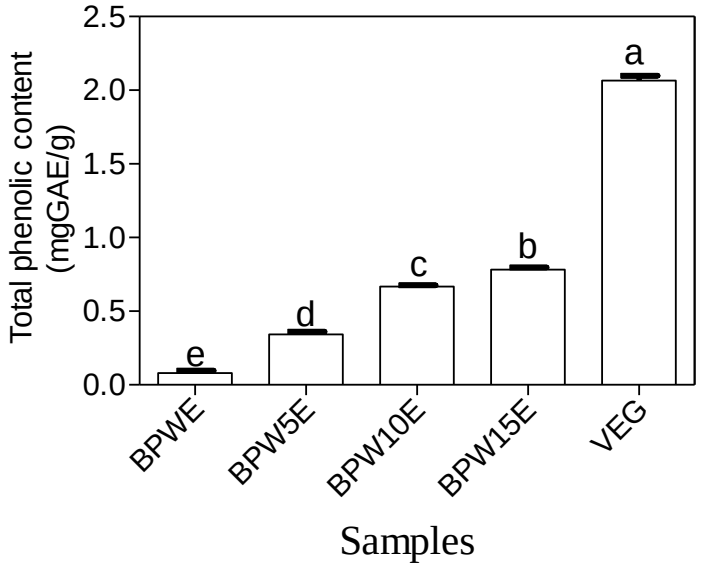

Figure 4. Total phenolic content of steamed bean pudding co-milled with fluted pumpkin leaves

Table 4. Sensory evaluation of steamed bean pudding co-milled with fluted pumpkin leaves

	Colour	**Flavour**	**Overall acceptability**
BPWE	6.70 ± 1.57^{a}	6.50 ± 0.16^{a}	6.40 ± 0.55^{a}
BPW5E	4.80 ± 1.62^{b}	5.90 ± 0.25^{ab}	5.40 ± 0.73^{ab}
BPW10E	4.80 ± 1.62^{b}	6.10 ± 0.44^{ab}	5.40 ± 0.23^{ab}
BPW15E	4.30 ± 0.68^{b}	5.40 ± 0.63^{b}	5.00 ± 0.92^{b}

Values are mean ± s.d. of 20 panelists. Values with different superscript down the column are different significantly ($p<0.05$) from each other

BPWE; bean pudding without enrichment: BPW5E; Bean pudding with 5% leafy vegetable: BPW10E; Bean pudding with 10% leafy vegetable; BPW15E; Bean pudding with 15% leafy vegetable

4.5. Conclusion

Addition of fluted pumpkin leaves with cowpea for moin-moin production enhanced the phenolic content of the products, improved the DPPH radical scavenging activities and ferric reducing antioxidant power, enhanced the metal chelating activities of the product compared with the control, total ash and fibre content of the products, mineral constituents such as the Sodium, Iron, Calcium and Magnesium, The use fluted pumpkin leaves as ingredient in the steam bean pudding reduced the preference for, Colour, Flavour and overall acceptability by the selected panelists as the level of inclusion of the leaves increased. The study has established that fluted pumpkin leaves have potentials to be used to improve the nutrient content of steamed bean pudding and this should be encouraged. Enriching the pudding with the vegetable resulted in lower consumer acceptability of the product, majorly due to the colour and flavour. Increased publicity of the product with respect to the nutrient composition of the enriched product could enhance the acceptability. At present, the optimum addition level could not be established, especially with chemical composition, however, the result of sensory studies suggests that the level of addition should not go beyond 10 %.

Plate 1a: Controlled product without leafy

Plate 1b: Steamed bean pudding with 5% enrichment level

Plate 1c: Steamed bean pudding with 10 % level of enrichment with leafy vegetable (BPW10E)

Plate 1d: Steamed bean pudding with 15 % level of enrichment with leafy vegetable (BPW15E)

4.6. Recommendation

The study has established that fluted pumpkin leaves have potentials to be used to improve the nutrient content of steamed bean pudding and this should be encouraged. Enriching the pudding with the vegetable resulted in lower consumer acceptability of the product, majorly due to the colour and flavour. Increased publicity of the product with respect to the nutrient composition of the enriched product could enhance the acceptability. At present, the optimum addition level could not be established, especially with chemical composition, however, the result of sensory studies suggests that the level of addition should not go beyond 10 %

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CHARACTERIZATION AND EVALUATION OF END-USE QUALITIES OF *ORYZA SATIVA L-ORYZA GLABERRIMA* HYBRID AND *ORYZA GLABERRIMA* SPECIE CULTIVATED IN IBAJI LGA OF KOGI STATE, NIGERIA

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ABSTRACT

Oryza glaberrima (*Oje-Igbale)* and *Oryza sativa L-Oryza glaberrima* hybrid (*Adede-agidi)* are two rice varieties cultivated in Ibaji LGA of Kogi State, Nigeria, and each of them is used for only a singular purpose. Studies were carried out to find out the characteristics of these grains and further processes it could be subjected to in order to contribute in the strive for food security. Three (3) samples each, of the two different rice varieties' paddy, were procured, cleaned, a portion parboiled, milled and thereafter analyzed for their physical and cooking, attributes. Un-parboiled paddy of the two rice varieties were dehusked, milled into flour and samples used to determine their physicochemical properties. For the physicochemical properties, the starch content of *Oje-Igbales*' were of hard gel consistency (29.32- 38.11 mm) and intermediate-amylose content (20.78- 24.68 %) depicting it will be a good variety for high temperature treatment processes. The starch content of the *Adede-agidis*' were of soft gel consistency (66.43– 72.52 mm), low- and intermediate-amylose content (18.47- 20.23 %) depicting it will be suitable for breakfast cereals, fermented rice cakes and baby foods. This research provides knowledge on the characteristics and other end use qualities of *Oje-Igbale* and *Adede-agidi* for value addition.

Keywords: *Rice, quality characteristics, oje-igbale, adede-agidi, oryza glaberrima, oryza sativa.*

1. INTRODUCTION

Rice is a staple food in Nigeria, generally considered a semi-aquatic annual grass plant, although it survives as a perennial plant in the tropics. Rice is grown in all ecological and dietary zones of Nigeria, with different varieties possessing adaptation traits of each ecology (Sanni *et al*., 2005). A hybrid of *Oryza sativa- Oryza glaberrima* specie named *Adede-agidi* in Ibaji dialect which is high yielding and able to withstand biotic and abiotic stresses of Africa ecology is the most common variety grown in Ibaji Nigeria. *Adede-agidi is* used solely in preparing whole cooked rice grain for consumption. A small amount of the *Oryza glaberrima* specie named *Oje-Igbale* in ibaji dialect is also grown in Ibaji, which is used solely for preparing dumpling. Ibaji is a Local Government Area in Kogi State, Nigeria, in the south of the state separated from Edo State to the west by the Niger River, and bordering Delta State in the south. Its headquarters are in the town of Onyedega on the Niger River in the northwest of the area at 6°53′00″N 6°41′00″E/ 6.88333°N 6.68333°E. It has an area of 1,377 km² and a population of 128,129 (Anon. 2021) with over 90 percent of the inhabitants being farmers who feed their families with their produce and make proceeds from them. *Adede-agidi* is strictly consumed as cooked whole grains eaten accompanied with sauce while *Oje-Igbale* is strictly consumed by milling the de-husked grain into flour and processed into rice dumpling which is eaten accompanied with local soups. Both have the same husk colour but *Oje-Igbale* has a red

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coloured bran instead of white like the *Adede-agidi* and other common rice grains cultivated in other parts of Nigeria.
Some of the most important uses and processing applications of rice include boiled or steamed whole grain rice for consumer use; dry breakfast and baby-food cereals; brewers rice; canned rice, quick cooking and other convenience and specialty food products; rice flour as a thickener and rice starch, for industrial and other processes; and preparations for certain types of fermented foods (Webb and Stermer, 1972**).** Rice end-use depend on the inherent characteristics of the rice grain which include amylose content, gel consistency, gelatinization temperature and physical dimensions**.** There is a need to know other end-use quality of *Oje-Igbale* and *Adede-agidi* through characterization for value addition thereby contributing to food security. It is recognized that indigenous foods and dietary diversity among indigenous foods within an ecosystem can be powerful sources of nutrients and thus mediums for better health and food security **(**Xikombiso, 2016**)**.

2. MATERIALS AND METHODS

2.1. Materials

Three (3) samples each of *Oje-Igbale* and *Adede-agidi* rice varieties paddy were purchased from different farmers in different location in Ibaji LGA of Kogi state and coded, OJ1, OJ2 and OJ3 and AA1, AA2 and AA3, respectively.

2.2. Methods

The samples were taken to the Food Processing Laboratory of Food Science and Technology, University of Nigeria Nsukka for parboiling and milling with Engelberg dehuller. A portion of the paddy of the two different rice varieties were not parboiled, but dehulled and milled to flour for determining functional properties.

2.2.1. Determination of Functional Properties

2.2.1.1. Gel consistency (GC) determination

Gel Consistency (GC) of rice samples was determined according to the method of Cagampang *et al*. (1973). One- hundred milligram (100 mg) rice flour of 12 % moisture was placed in 13 x 100mm culture tubes. The powders were wet with 0.2 ml 95 % ethanol containing 0.025 % thymol blue. The tube was shaken and 2.0ml of 0.2N KOH added immediately and the mixture dispersed. The tubes were covered with glass marbles and placed for 8 minutes in a boiling water bath. Afterwards, the samples were removed and kept at room temperature for 5 minutes, and then cooled in ice cold water for 15 minutes. The tubes were removed afterwards from ice water and laid horizontally over a ruled paper graduated in millimetres and the length of the gel from the bottom of the test tube was measured after 30-60 minutes. The sample is categorized according to the standard as shown in foot note of Table 1.

2.2.1.2. Amylose content determination

Amylose Content (AC) was determined according to the method as described by Juliano (1971). One hundred milligram (100 mg) of rice flour of the two varieties were poured into a 100 ml volumetric flask. 1ml of 95% ethanol and 9 ml of 1 N NaOH was added to the rice flour and the mixture heated for 10 minutes in boiling water bath. After heating, the mixture was cooled and made up to 100 ml volume with distilled water. Five milliliter (5 ml) of the 100 ml solution was taken and put into another 100 ml volumetric flask. 1 ml of 1 N acetic acid was added and 2 ml Iodine-potassium iodide solution added subsequently. The volume of the mixture was made up to 100 ml with distilled water. The sample was shaken and allowed to stand for 20

minutes and the per cent Transmittance determined at 620 nm using a colorimeter. Amylose content of the samples was determined in reference to a standard curve (graph) and expressed on percent basis as shown in equation 1:

$$\text{Amylose (\%)} = \frac{\text{Amylose content of standard x Absorbance of rice sample}}{\text{Absorbance of standard sample}} \quad (1)$$

Amylopectin (%) = 100 - % Amylose

2.2.2. Physical Properties of the Rice varieties

2.2.2.1. Determinations of grain dimensions

Rice grain dimensions- grain length, and width were determined using a digital vernier calliper (0.1-100 mm A&D Company Limited) according to the method by Danbaba (2013).

2.2.2.2. Determination of grain length

Ten (10) milled whole rice grain samples of each variety were randomly selected and the length of the grains measured using a digital calliper (0.1-100 mm A&D Company Limited). The mean value of each variable was determined and noted. The value obtained was recorded as each samples' grain length.

2.2.2.3. Determination of grain shape

Ten (10) milled whole rice grain samples of each variety were randomly selected and the width of the grains determined with a digital calliper (0.1-100mm A&D Company Limited). The mean value of each variable was obtained and the length/ width ratio of the samples calculated as shown in equation 2:

$$\frac{L}{W}\,ratio = \frac{\text{Average length of rice } L_1 \text{ (mm)}}{\text{Average width of rice } Wd_1 \text{ (mm)}} \quad (2)$$

Where:
L1 = length of whole rice grain
Wd1= width of whole rice grain

The value obtained was recorded as grain shape for each sample.

2.2.2.4. One-thousand grain weight (W_1):

One hundred (100)-milled kernel representative sample (triplicates) having a moisture content of 14% for each variety were randomly selected. The weight of each sample was determined using a 500g capacity weighing scale (Electronic Pocket Scale Model EHA251). The value obtained was multiplied by 10. The mean weight of the samples were obtained and noted as W_1.

2.2.2.5. Determination of volume of raw rice grains

Volume of raw rice grain was determined by displacement method as described by Gariboldi (1979). One hundred raw rice grains were placed in a measuring cylinder containing 20 ml of water (V_1). The new volume of water after the raw rice grains were added to the measuring cylinder was noted as (V_2). The volume of raw grains (V_3) were obtained by subtracting the Volume of water containing raw rice grains from the initial volume of water contained in the measuring cylinder (equation 3).

$$V_3\,(ml) = V_2 - V_1 \qquad (3)$$

Where V_3 = volume of raw grain; V_2= volume of water after the raw rice grains were added to the measuring cylinder; V_1 = 20 Ml of water which was initial volume of water in the measuring cylinder before grains were added to the measuring cylinder.

2.2.2.6. Density of raw rice grain

Density of the rice grain samples were obtained by dividing the weight of raw rice grain with its volume (equation 4).

$$\text{Density (g/ml)} = \frac{\text{weight of raw rice grain } W_1\,(g)}{\text{Volume of raw rice grain } V_3\,(ml)} \qquad (4)$$

2.2.3. Cooking Analysis

2.2.3.1. Minimum and optimum cooking time

The minimum and optimum cooking time were determined according to the method as described by (Odenigbo *et al*., 2014). One hundred head rice grain were placed in a beaker containing 60ml of water. The rice grains were cooked in boiling distilled water (V_4= 60 ml) at 100 ±1 ºC in a water bath. Measurements were taken after 10 min of cooking and every minute thereafter. The measurement involves collection of 5 grains from the cooking vessel and pressing between two glass slides. The time when minimum of 95% of the collected boiled grains no longer displayed opaque core or un- gelatinized centres is recorded as the MCT (Minimum Cooking Time). The rice was allowed to simmer for another 2 min to ensure that the core of all grains had been gelatinized. This additional 2 min after the MCT is referred to as Optimum Cooking Time (Odenigbo *et al*., 2014**)**.

2.2.3.2. Quantity of water absorbed

Quantity of water absorbed by rice samples was determined as described by (Gariboldi, 1973**)**. The remaining distilled water after the rice has reached its Optimum Cooking Time was measured in a volumetric flask and its volume recorded (V_5). Quantity of water absorbed was obtained by subtracting the volume of remaining distilled water from the initial volume of water used in cooking rice samples as shown in equation 5.

Quantity of water absorbed V_6 (ml) = 60 – V_5 (5)

2.2.3.3. Volume expansion ratio

Volume expansion ratio was determined according to the method as described by (Danbaba, 2013). One hundred head rice sample cooked for 20 minutes in boiling water bath 60ml, after 20 minutes, the cooked grains was strained and placed on a filter paper to blot excess water. The cooked grains were placed in a measuring cylinder containing 20 ml of distilled water V_1, the volume of water and cooked grains was noted as V_7. The difference between the final volume and initial volume was obtained V_8. The volume expansion ratio calculated as follows equation 6.

Volume expansion ratio = $\frac{V_8}{V_3}$ (6)

Where:

V_8= volume of cooked rice and

V_3= volume of raw rice.

2.2.3.4. Weight increase

The increase in weight of rice samples was obtained as described by (Gariboldi, 1973)**.** The cooked rice grains were removed from water bath and allowed to drain off excess water. One hundred (100) cooked rice grains were weighed (W_2) and multiplied by 10. The increase in weight was obtained by subtracting the weight of cooked rice grains from the uncooked rice grains as shown in equation 7.

$$\text{Weight increase (g)} = W_2 - W_1 \qquad (7)$$

2.2.3.5. Elongation ratio

Elongation ratio of rice grain samples was determined according to the method of (Odenigbo *et al*., 2014**)**. Ten (10) optimum cooked grains sample was measured using a vennier calliper. Average length of the cooked grains was divided by average length of 10 uncooked grains sample (L_1) and their Elongation ratio were obtained as shown in equation 8.

$$\text{Elongation ratio} = \frac{\text{Average length of cooked grains}}{\text{Average length of uncooked grains (L1)}} \qquad (8)$$

2.2.3.6. Water uptake ratio (WUR)

Water Uptake Ratio was determined according to the method as described by (Danbaba, 2013). Four (4) grams of whole milled kernel rice sample was measured in triplicates and cooked in 60 ml of water for 20 minutes. The sample was removed from heat and the cooked grains strained and placed on a filter paper to remove excess water and weighed and calculated as shown in equation 9.

$$\text{Water uptake ratio} = \frac{\text{Weight of cooked rice sample}}{\text{Weight of raw milled rice sample}} \qquad (9)$$

2.2.4. Statistical Analysis

Completely Randomised Design (CRD) was used for this study. The data generated from all analysis and sensory evaluation were subjected to statistical analysis of variance (ANOVA) using SPSS (version 20). Means were separated using the Duncan's Multiple Range Test (Akande e*t al.* 2017).

3. RESULTS AND DISCUSSION

3.1. Physicochemical properties of rice varieties

Table 1 shows the functional properties of *Adede-agidi* and *Oje-Igbale* rice varieties.

Table 1. Physicochemical properties of *Adede-agidi* and *Oje-Igbale* rice varieties

Rice Samples	**Gel Consistency (mm)**	**Gel Consistency Behaviour**	**Amylose (%)**	**Amylopectin (%)**	**Classification based on Amylose content**
AA1	66.43^{d}±0.04	Soft	19.47^{b}±0.02	80.47^{d}±0.02	Low
AA2	68.60^{e}±0.01	Soft	20.23^{c}±0.04	79.22^{c}±0.02	Intermediate
AA3	72.52^{f}±0.02	Soft	18.47^{a}±0.01	81.54^{e}±0.02	Low
OJ1	29.23^{a}±0.04	Hard	20.78^{d}±0.00	79.25^{c}±0.04	Intermediate
OJ2	38.11^{c}±0.01	Hard	24.68^{e}±0.02	78.34^{c}±0.01	Intermediate
OJ3	32.67^{b}±0.00	Hard	24.20^{e}±0.05	75.83^{b}±0.04	Intermediate

Values are means ± standard deviation of duplicate determination. Means in the same column carrying similar superscript are not significantly ($P< 0.05$) different. Gel consistency: Soft gel consistency = 61 -100 mm; medium = 41 -60 mm; hard =26 -40 mm

Amylose content: waxy (1-2% amylose), very low amylose content (2-9% amylose), low amylose content (10-20% amylose), intermediate amylose content (20-25% amylose) and High amylose content (25-33% amylose)

KEY: AA1 –AA3 (Adede-agidi rice variety from three different farmers)

OJ1--OJ3 (Oje-igbale rice variety from three different farmers)

The gel consistency value of the *Oje-Igbale* rice varieties ranged from 29.23– 38.11 mm while that of *Adede-agidi* ranged from 66.43– 72.52 mm. Significant ($p < 0.05$) differences exists between the gel-consistency of the two rice varieties. Gel consistency measures the tendency of the starch content of the cooked rice to harden after cooling, the values of *Oje-Igbale* (29.23–38.11 mm) showed its rice starch to be of hard gel-consistency while the values of *Adede-agidi* (66.43– 72.52 mm) denotes its rice starch to be of soft gel-consistency. Rice varieties of that of hard gel consistency harden when cooked and cooled and not preferred for consumption as whole grains but find use in canned rice products, prepared convenience products, rice noodle manufacture, dumpling and any other high temperature treatment processes due to its resistance to splitting into cooking water during boiling (http://betuco.be, 2019). Rice of soft gel consistency are tender when cooked, hardened slightly when cooled and preferred for consumption of which *Adede-agidi* possess. The hard gel consistency of *Oje-igbale,* explains why it is not cooked as a whole grain for consumption but used in making dumpling, while the tenderness of Adede-agidi explains why it is preferred for consumption as cooked whole grains. *Adede-agidi* rice varieties with soft gel consistency can also find application in making baby foods. Results from Oko *et al.* (2012) showed the gel-consistency of the samples to range between 43.00 - 54.00 mm and were described as rice of medium gel-consistency. Different categories of gel-consistency is shown in footnote of Table 1.

AA1 and AA3 had amylose content of 19.47 and 18.47, respectively which makes them low-amylose rice grains while AA2 had amylose content of 20.23 % which makes it intermediate amylose rice grain. Low-amylose rice grains are desirable in making breakfast cereals, baby foods and risottos while ntermediate amylose rice grains can be used in making fermented rice cakes. Amylose content of *Oje-Igbale* variety ranged from 20.78- 24.68 % and makes them intermediate-amylose rice grains. Differences between amylose content of same varieties could be as a result of ecology where the grains were planted since the grains were procured from different farmers at different locations. The amylose content in rice is considered the single most important characteristics used in describing and predicting rice cooking and processing qualities (Nkama *et al.*, 2011). High amylose grains cook dry, are less tender, and become hard upon cooling while low amylose grains cook moist and sticky and find use in baby cereals and risottos. Intermediate amylose rice are preferred in most rice-growing areas of the world for consumption, because it is tender and non-sticky. Rice of the same amylose content are usually differentiated from themselves with their degree of gel consistency.

Rice varieties of intermediate amylose- hard gel consistency are less tender compared to that of intermediate amylose-soft gel-consistency. Low amylose– soft gel consistency rice varieties (AA1 and AA3) are most tender and suitable for use in baby foods, cooked whole grains and breakfast cereals because of their ability to produce relatively stable gel which tends to harden slowly during storage. They can also be used as popped and puffed rice as a result of expansion in volume (Juliano, 1979). In making fermented rice cakes, varieties with intermediate amylose - soft gel consistency (AA2) are used because of their optimum volume expansion on steaming and their soft texture while intermediate amylose hard-gel consistency grains (*Oje-Igbales*) will find application in canned rice products, rice noodle manufacture, dumpling and any other high temperature treatment processes.

3.2. Physical dimensions

Table 2 shows the dimensions of the uncooked rice grains. The length of *Adede-Agidi* samples ranged from 5.42 - 5.92 mm, making it a medium-grain rice. The length of *Oje-Igbale* variety ranged from 6.48 to 6.69 mm which makes it a long-grain rice. Significant ($p < 0.05$) differences exists in all the dimensions of the raw rice grain varieties. Cooked grains of medium-grain rice varieties are moist and tender and have a greater tendency to cling together than long grain rice and is desirable in making baby foods, whole cooked grains, breakfast cereals and risottos (Anonymous, 2019; Anonymous, 2019[b]).

Table 2. Dimensions and classification of *Adede-agidi* and *Oje-Igbale* rice varieties

Rice Samples	Length (mm)	Classification	Width (mm)	Length : width ratio	Classification	Weight (g)	Classification	Volume (ml)	Density (g/ml)
AA1	5.70^{b}±0.12	Medium	2.25^{c}±0.01	2.51^{b}±0.01	Bold	19.02^{a}± 0.00	Moderately heavy	11.62^{b}± 0.02	1.73^{b}±0.00
AA2	5.42^{a}±0.02	Medium	2.23^{c}±0.02	2.44^{a}±0.01	Bold	20.67^{d}± 0.02	Heavy	11.63^{b}± 0.01	1.74^{b}±0.03
AA3	5.92^{c}±0.02	Medium	2.27^{c}±0.02	2.62^{c}±0.01	Bold	19.83^{b}± 0.01	Moderately heavy	10.49^{a}± 0.01	1.83^{c}±0.02
OJ1	6.65^{e}±0.02	Long	2.12^{b}±0.02	3.17^{e}±0.02	Slender	21.72^{e}± 0.06	Heavy	13.20^{d}± 0.02	1.86^{c}±0.00
OJ2	6.48^{d}±0.08	Long	2.14^{b}±0.01	3.01^{d}±0.02	Slender	20.34^{c}± 0.02	Heavy	12.68^{c}± 0.01	1.62^{a}±0.02
OJ3	6.69^{e}±0.02	Long	2.01^{a}±0.01	3.35^{f}±0.03	Slender	22.01^{f}± 0.01	Heavy	12.64^{c}± 0.01	1.73^{b}±0.01

Values are means ± of duplicate determination standard deviation. Means with different superscript within the same column differ significantly ($p<0.05$). Length= Extra-long-≥ 7.0; long- 6.00 to 6.99; medium- 5.0 to 5.99; short <5.0. Shape= Slender- >3.0; bold -2.0 to 3.0; round- < 2.0. Weight= Extra-heavy- >25g; heavy- 20 to 25 g; moderately heavy <20g.

KEY: AA1 –AA3 (Adede-agidi rice variety from three different farmers)

OJ1--OJ3 (Oje-igbale rice variety from three different farmers

Medium grain rice varieties have low to intermediate amylose content which describes the *Adede-agidi* varieties. Milled rice of typical long-grain varieties usually cook dry and fluffy when boiled or steamed (Webb and Stermer, 1972; Anonymous, 2019; Anonymous, 2019[b]). The cooked grains lie separate and are generally preferred for use in prepared products such as canned rice, canned soups, dry soup mixes, frozen dishes, and other convenience-type rice-containing foods (Webb and Stermer, 1972). Long-grain and extra-long-grain rice have intermediate to high amylose content which describes the *oje-igbale* varieties. Results from Danbaba *et al* (2020) showed the samples studied to be 6.69 -5.44 mm, indicating long-grain to medium grain rice and were within reported range.

Adede-*agidi* varieties are bold grains (2.44- 2.62 mm) while *Oje-Igbale* rice varieties are slender grains (3.01 – 3.35 mm). These rice varieties will make use of different post-harvest equipment due to differences in their length-width ratio in order to reduce number of brokens and obtain high head-rice. Length: width ratio (shape) is said to be probably the most meaningful of the determinations since it is used in sizing rice with slotted sieves or precision graders (Webb and Stermer 1972). The knowledge of length-width ratio is used in sorting, grading, cleaning, milling and other post-harvest processing operations. Rice with bold grains usually have low amylose while rice with slender grains have intermediate to high amylose content. According to Danbaba *et al* (2020) ten rice varieties studied reported range of 2.17-3.25 indicating some were bold grains in shape while others were slender in shape.
AA1 (19.02 g) and AA3 (19.83 g) are moderately-heavy grains, while AA2 (20.67 g) are heavy-grains. The values of *Oje-Igbales* ranged from 20.34- 22.01 g making them heavy grains. Heavy grains have high amylose content and absorb more water when cooked while moderately heavy grains have low to intermediate amylose content. Grains higher in weight will sell at a higher price in international trade when rice is sold on weight basis and will be more profitable to the seller. Range of 16.97 -20.05 g was recorded for ten rice varieties studied by Danbaba *et al* (2020) showing they were moderately-heavy and heavy grains.
The volume of *Adede-agidi* variety ranged from 10.49- 11.63 ml and that of *Oje-Igbale* ranged from 12.64- 13.20 ml, significant ($p < 0.05$) difference existed in the volume of *Oje-Igbale* and *Adede-agidi*. Grains highest in volume will occupy more storage space during packaging, transportation and sales of agricultural produce. In international trade when rice is traded in volume, grains highest in volume will be beneficial to the seller because it will occupy more storage space while those of low volume will be beneficial to the buyer. In transportation of rice grains, grains of less volume will attract less transportation cost than those of high volume. Results from Danbaba *et al* (2020) showed the samples were within reported range (10.05 – 14.34 mm^3).

3.3. Cooking Quality

The cooking characteristics of the rice varieties include its elongation ratio (ER), weight increase (WI), volume expansion ratio (VER), water uptake ratio (WUR), minimum and optimum cooking time and volume of water absorbed (VWA).

3.4. Cooking characteristics of *Adede-agidi* and *Oje-Igbale* rice varieties

Table 3 shows the cooking characteristics of *Adede-agidi* and *Oje-Igbale* rice varieties. Significant ($p < 0.05$) differences existed in the VER within and between rice varieties.
The volume expansion ratio of the two rice varieties exceeded 300 % with the *Oje-Igbales* having the highest VER (3.86- 4.35). The rice varieties with high VER would produce rice more in volume than those with lower VER when cooked and Food vendors prefer rice varieties with high VER in order to make more profit from its high expansion.
The Elongation ratio (ER) of samples ranged from 1.30- 1.43. ER of rice can be influenced by both the length to width ratio and the amylose content (Singh *et al.*, 2005; Danbaba *et al.*, 2011). ER is desirable to consumers who love long-grain rice. The result obtained was within the range reported by Sanusi *et al.* (2017), Danbaba *et al.* (2020) and Odenigbio *et al.* (2014).

Table 3. Cooking characteristics of *Adede-agidi* and *Oje-Igbale* rice varieties

Rice Samples	Elongation ration	Weight increase	Volume expansion ratio	WUR	MCT (mins)	OCT (mins)	VWA (ml)
AA1	1.33^{ab}±0.01	29.35^{c}±0.04	3.45^{c}±0.03	2.32^{b}±0.03	20.50^{a}±0.02	22.49^{a}±0.02	18.34^{a}±0.02
AA2	1.30^{a}±0.00	28.34^{b}±0.02	3.35^{b}±0.03	2.27^{ab}±0.02	19.34^{b}±0.02	21.38^{b}±0.00	22.10^{b}±0.02
AA3	1.35^{bc}±0.00	28.03^{a}±0.04	3.01^{a}±0.01	2.22^{a}±0.03	23.21^{c}±0.01	24.23^{c}±0.01	19.01^{c}±0.01
OJ1	1.41^{de}±0.01	34.35^{e}±0.04	4.35^{f}±0.03	2.68^{d}±0.00	27.85^{d}±0.01	29.87^{d}±0.01	22.94^{e}±0.02
OJ2	1.43^{e}±0.02	34.13^{d}±0.04	4.21^{e}±0.01	2.51^{c}±0.01	32.34^{f}±0.02	34.34^{f}±0.01	22.66^{d}±0.01
OJ3	1.37^{cd}±0.01	36.04^{f}±0.05	3.86^{d}±0.00	2.87^{e}±0.02	29.41^{e}±0.01	31.34^{e}±0.01	23.06^{f}±0.05

Values are means± standard deviation of duplicate determination. Means in the same column carrying similar superscript are not significantly ($P< 0.05$) different.

KEY: AA1 –AA3 (Adede-agidi rice variety from three different farmers)

OJ1--OJ3 (Oje-igbale rice variety from three different farmers)

There was significant ($p < 0.05$) difference between the water uptake ratio of the grains. The water uptake ratio (WUR) of the *Adede-agidi* rice variety ranged from 2.22 – 2.32. The WUR of the *Oje-Igbale* rice variety ranged from 2.51 – 2.87. Water uptake ratio (WUR) is a measure of the rate at which the rice grains take up water and increase in volume and weight. Grains with high WUR increased more in weight than those with low WUR. High WUR is as result of high amylose content and it is desirable in rice varieties for canning purposes. In other words *Oje-igbale* can be a good rice variety for canned rice products. The values obtained were lower than most of the values obtained by Sanusi *et al.* (2017); higher than the results reported by Danbaba *et al.* (2020) but within the range of the values reported by Odenigbo *et al* (2014).

Significant ($P < 0.05$) differences existed in the minimum and optimum cooking time of *the Adede-agidi* rice variety. *Adede-agidis* had optimum cooking time of 21.38- 25.23 minutes while the *Oje-igbales*, had optimum cooking time of 29.87- 34.34 minutes. The variation in cooking time between and within samples can be as a result of the gelatinization temperature since the gelatinization time correlates positively with the cooking time of the rice. The rice which takes longer time to gelatinize contains higher amylose. It has been shown that the higher the gelatinization temperature, the longer it takes to cook rice (Frei and Becker, 2003) and the cooking time was observed to be dependent on the gelatinization temperature. The differences within samples can be as a result of environmental factors where the grains were grown. The *Adede-agidis* cooked for a short period of time less than the *Oje-Igbale* that takes longer time. This characteristics can be attributed to the higher amylose content of *Oje-Igbale*. The values obtained were higher compared to the values obtained by Danbaba *et al.* (2020), Sanusi *et al.* (2017) and Odenigbio *et al.* (2014).

Significant ($P < 0.05$) differences existed in the Volume of water absorbed (VWA) between and within rice samples. The *Adede-agidi* rice variety had VWA of 18.34 – 22.10ml /1000 grains. The *Oje-Igbale* rice variety had VWA of 22.60 – 23.06 ml. VWA is a direct measure of the amount of water required to cook the rice grains to its optimum eating quality. It was observed that the *Adede-agidi* rice varieties imbibed less water when cooked than the *Oje-Igbale* variety. This may be attributed to the higher amylose content and water affinity sites of the *Oje-Igbale* rice samples.

4. CONCLUSION AND RECOMMENDATIONS

The *Oje-Igbale* rice variety are of longer length, intermediate amylose-hard gel consistency, and will be suitable in canned rice products, convenience-type rice-containing foods and rice noodle manufacture along its use as dumpling. Its starch content could be exploited in producing rice noodles. The *Adede-agidis* being of low amylose– soft gel consistency rice varieties (AA1 and AA3) are suitable for use in baby foods, breakfast cereals popped rice, puffed rice, along its use as cooked whole grain. In making fermented rice cakes, AA2 with intermediate amylose - soft gel consistency can be used. *Oje-Igbale* also has high OCT and VWA which is not desired in whole grain cooking, because of more expended heat energy and water, respectively but it is desired in making dumpling to form a stiff paste. This research has provided knowledge on the characteristics and different obtainable end use quality of *Oje-Igbale* and *Adede-agidi* other than their use in making dumpling and being prepared as cooked whole grain, respectively. This knowledge should be used by food industries.for value addition in pursuit for food security

Conflict of interests

The authors have not declared any conflict of interests.

Acknowledgement

The authors acknowledge the Department of Food Science and Technology for providing their Food Processing Laboratory and milling equipment use to process and mill the rice.

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ARI ÜRÜNLERİ VE GIDALARDA KULLANIMI

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ÖZET

Biyoaktif bileşenlerce zengin olan arı ürünlerinden geçmişten günümüze kadar tıp, kozmetik ve gıda sanayi başta olmak üzere birçok sektörde faydalanılmaktadır. Hastalıkların tedavisi, gıdaların zenginleştirilmesi ve muhafazası için kullanılan arı ürünlerinden biri olan bal en yaygın kullanılan arı ürünüdür. Propolis, arı sütü, arı poleni, arı zehiri, balmumu, apilarnil ve arı ekmeği daha az bilinen ve tüketilen arı ürünleri olmasına rağmen bileşimindeki maddeler nedeniyle gıdaların muhafazasında ve zenginleştirilmesinde en az bal kadar etkilidir. Ticari değeri yüksek olan arı ürünlerine olan ilgi giderek artmaktadır. Güncel çalışmalar az bilinen bu ürünlerinin gıdalarda kullanımına yönelik hızla artan sayıda çalışmalar yapıldığını ve özellikle gıda ürünlerinin kalitesini arttırmada ve raf ömrünü uzatmadaki etkisinin incelendiğini göstermektedir. Yapılan çalışmalar arı ürünlerinin protein, karbonhidrat, vitamin, mineral ve fenolik madde miktarı bakımından oldukça zengin olduğunu kanıtlamaktadır. Et, süt, tahıl ürünleri gibi gıdalara ilave edildiğinde gıdaların besin bileşimini iyileştirdiğini, oksidasyonu ve mikrobiyal gelişimi engelleyerek daha uzun süre muhafaza edilmesini sağladığı belirlenmiştir. Keskin tadı, kokusu ve pahalı olması nedeniyle propolis ve arı sütü bal kadar yaygın kullanılmamaktadır.

Arı ürünlerinin kimyasal bileşimi mevsim, coğrafi özellik, bitki orijini gibi faktörlere bağlı olarak değişmektedir. Bal karbonhidrat bakımından zengin bir ürünken arı poleni protein bakımından zengindir. Arı sütünün ise su içeriği yüksektir. Protein, lipit, yağ ve mineral maddeler bakımından zengin olan arı sütü asidik bir tada sahiptir. Arı ekmeği ise çoğunlukla polenle karıştırılmasına rağmen biyoaktif bileşen bakımından polenden daha zengindir ve serin ortamda muhafaza edilerek hızlı tüketilmelidir. Arı ekmeği bekledikçe biyolojik aktivitesini kaybetmektedir. Yurt dışında kullanılan apilarnil ise esansiyel aminoasitlerin tamamını içermektedir.

Bu çalışmada arı ürünleri ve gıdalarda kullanımı ile ilgili yapılan literatür çalışmaları gözden geçirilmiştir.

Anahtar Kelimeler: *Arı ürünleri, gıda, antimikrobiyal aktivite.*

BEE PRODUCTS AND USAGE IN FOOD

ABSTRACT

Bee products, which are rich in bioactive components, have been used in many sectors, especially medicine, cosmetics and food industry from past to present. Honey, which is one of the bee products used for the treatment of diseases, for the enrichment and preservation of foods, is the most widely used bee product. Although propolis, royal jelly, bee pollen, bee venom, beeswax, apilarnil and bee bread are less known and consumed bee products, they are at least as effective as honey in preserving and enriching foods due to the ingredients in their composition. The interest in bee products with high commercial value is increasing. Recent studies show that a rapidly increasing number of studies have been conducted on the use of these little-known products in foods, and their effect on increasing the quality of food products and extending their shelf life has been examined. Studies show that bee products are very rich in terms of protein, carbohydrates, vitamins, minerals and phenolic substances. It has been

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determined that when added to foods such as meat, milk, cereal products, it improves the nutritional composition of foods, prevents oxidation and microbial growth, and ensures longer preservation. Propolis and royal jelly are not as widely used as honey due to their sharp taste, smell and expensiveness.
The chemical composition of bee products varies depending on factors such as season, geographical feature, plant origin. While honey is a carbohydrate-rich product, bee pollen is rich in protein. Royal jelly has a high water content. Royal jelly, which is rich in protein, lipid, oil and mineral substances, has an acidic taste. Although bee bread is mostly mixed with pollen, it is richer than pollen in terms of bioactive components and should be kept in a cool environment and consumed quickly. As the bee bread waits, it loses its biological activity. Apilarnil, which is used abroad, contains all of the essential amino acids.
In this study, literature studies on bee products and their use in food were reviewed.

Keywords: *Bee products, food, antimicrobial activity.*

1. GİRİŞ

Türkiye'nin coğrafi özellikleri ve doğal bitki örtüsü arı yetiştiriciliği açısından oldukça geniş imkanlar sunmaktadır. Bölgelerdeki coğrafi farklılık ve bitki örtüsü arı ürünlerinin zenginleşmesine ve çeşitlenmesine katkı sağlamaktadır. Arıcılık faaliyetleri sonucunda başta bal olmak üzere propolis, arı poleni, arı sütü, arı zehri, arı ekmeği, apilarnil ve balmumu gibi arı ürünleri elde edilebilmektedir (Mutlu vd., 2017; Niyaz ve Demirbaş, 2017). Bal, arı ürünleri arasında tüketiciler tarafından en çok bilinen arı ürünüdür. Arı zehri ve propolis ise en az bilinen arı ürünleridir (Niyaz ve Demirbaş, 2017; Saral ve Yılmaz Yavuz, 2020). Yapılan çalışmalar tüketicilerin, yeterli bilgiye sahip olmadıkları için arı ürünlerini az tükettiklerini ve arı ürünleriyle zenginleştirilerek üretilen sağlıklı gıdaların tüketimi arttırmada faydalı olabileceğini bildirmişlerdir (Saral ve Yılmaz Yavuz, 2020). Bunun yanı sıra arı ürünlerinin yapısal özellikleri de tüketimini sınırlandırmaktadır. Yüksek şeker ve viskozitesi balın taşıma, depolama ve işlenmesinde sorunlara yol açmaktadır. İçeriğindeki glikoz nedeniyle kristallenebilen bal hem satın almayı olumsuz etkilemekte hem de faz ayrımıyla meydana gelen su aktivitesindeki artış mikroorganizma gelişimine neden olabilmektedir (Cui vd., 2008; Shi vd., 2013; Mutlu ve Erbaş, 2018). Alerjik etkisi nedeniyle arı poleni; az üretildiği için pahalı olan arı sütü; keskin tat ve kokusu yanında ekstrakte edilerek kullanılması gerektiği için propolis düşük tüketim oranına sahip diğer arı ürünleridir.
Gıda okur yazarlığının artmasıyla beraber toplumda sağlıklı ve fonksiyonel gıdalara olan talep artış göstermiştir. Besleyici değeri yüksek olan ve eski çağlardan beri ilaç olarak da kullanılabilen arı ürünleri farklı yaş grupları tarafından tüketilmektedir (Niyaz ve Demirbaş, 2017; Saral ve Yılmaz Yavuz, 2020). Arı ürünlerinin tüketimini sınırlandıran olumsuz etkileri azaltarak ya da ortadan kaldırarak fonksiyonel gıda üretmeyi amaçlayan araştırıcılar arı ürünlerini çeşitli gıdalara ilave etmiş ve yeni ürünler üretmişlerdir. Farklı gıda ürünlerine ilave edilen arı ürünleri gıdaların besin bileşimi etkilemiş ve teknolojik kalitesinde değişimler meydana getirmiştir. Bu çalışmada arı ürünleri ve arı ürünlerinin ilavesiyle elde edilen gıda ürünlerinin kalitesi hakkında bilgi verilecektir.

2. ARI ÜRÜNLERİ VE KULLANIMI

2.1. Bal

Türk Gıda Kodeksi'nde bal; "Bitki nektarlarının, bitkilerin canlı kısımlarının salgılarının veya bitkilerin canlı kısımları üzerinde yaşayan bitki emici böceklerin salgılarının bal arısı tarafından toplandıktan sonra kendine özgü maddelerle birleştirerek değişikliğe uğrattığı, su içeriğini düşürdüğü ve petekte depolayarak olgunlaştırdığı doğal ürün" olarak tanımlanmaktadır

(Anonim, 2012). Bal, elde edildiği kaynağa bağlı olarak salgı ve çiçek balı olarak ikiye ayrılmaktadır. Balın elde edildiği bitki orjinindeki ve coğrafi özelliklerdeki farklılıklar, çevresel faktörler ve iklim gibi faktörler balın bileşimini etkilemektedir. Bal yapısında %15-20 su, %28-45 fruktoz, %19-40 glukoz, %0.1-2.0 mineral, %0.2-0.7 aminoasit, B1, B2, nikotinik asit ve C vitamini gibi çeşitli vitaminleri ve formik, malik, laktik, sitrik ve oksalik gibi organik asitleri bulundurmaktadır (Karadal ve Yıldırım, 2012; Mutlu vd., 2017). Yapısında bulunan tokoferoller, riboflavin, askorbik asit, flavanoidlerin yanı sıra kumarik, ferulik, kafeik ve benzoik asit gibi fenolik asitler balın hem fenolik madde içeriğinin hem de antioksidan aktivitesinin artmasını sağlamaktadır. Balların fenolik madde içeriği ve antioksidan aktivitesi bileşiminde olduğu gibi çeşitli faktörlere bağlı olarak değişmektedir. Balın antioksidan aktivitesini etkileyen en önemli faktörlerden biri ise nektarın toplandığı bitkidir. Bala ait bazı özellikler balın antioksidan aktivitesi hakkında fikir vermektedir. Yapılan çalışmalarda koyu renkli balların açık renkli ballara ve yine multifloral balların monofloral ballara oranla daha yüksek antioksidan aktiviteye sahip olduğu belirtilmiştir (Ajibola vd., 2012; Özcan ve Ölmez, 2014; Marshall vd., 2015; Mutlu vd., 2017). Monofloral balların %45'in üzerinde bitki poleni bulundurduğu bildirilmiştir (Kambur vd., 2015; Karlıdağ ve Keskin, 2020). Bu durum farklı kaynaklardan toplanan antioksidan aktiviteye sahip bileşen çeşitliliğinin azalmasına yol açıyor olabilir.

Toplandığı kaynağa ve çevresel koşullara bağlı olarak balın tadı, rengi, aroması, antioksidan aktivitesi ve biyoaktif bileşenlerinin değişmesi tüketici tercihlerini etkilemektedir. Türkiye'de genellikle multifloral ballar tercih edilmesine rağmen son yıllarda tüketicilerin monofloral ballara olan ilgisi artmaktadır. Bu tercihi etkileyen faktörlerden biri ise monoforal ballarda balın ticari değerinin kolay belirlenebilmesi ve balda yapılan hilelerin önlenebilmesidir (Kus vd., 2014; Kaygusuz vd., 2016).

Arı ürünlerinden bilinirliği en yüksek olan bal tek başına tüketilebildiği gibi gıdaları zenginleştirmek ya da tatlandırmak amacıyla üretimde ürüne ilave edilmektedir. Gıda ürünlerine bal ilavesi, direkt ya da balın çeşitli dolgu maddeleriyle kurutulmasıyla üretilen bal tozu şeklinde yapılabilmektedir. Bal ilavesiyle gıda ürünlerinin besin değeri arttırılabilmekte ya da balın antimikrobiyal özelliklerinden faydalanarak ürünün korunması mümkün olmaktadır. Örneğin zengin besin bileşimi ve yüksek su aktivitesi nedeniyle çabuk bozulan gıdalar arasında yer alan süt araştırıcılar tarafından bal ilave ederek depolanmış ve depolama süresince mikrobiyal gelişimi kontrol edilmiştir. Araştırıcılar bal ilave edilen sütlerin depolama süresince kontrol sütüne oranla mikrobiyal gelişimin yaklaşık %50-55 az olduğunu bildirmiştir (Krushna vd., 2007). Bir diğer önemli süt ürünü olan yoğurda bal ilave edilen çalışmada ise 28 günlük depolamada çörek otu balı ilave edilen yoğurtlarda maya ve küf gelişiminin gözlenmediği bildirilmiştir. Aynı çalışmada çörek otu balı ilave edilme oranının artmasıyla yoğurdun pH değerinin arttığı ve buna bağlı olarak serum ayrılmasının daha fazla olduğu bildirilmiştir.

Peynire bal solüsyonu ilave eden araştırıcılar %15 oranında bal ile muamele ettikleri yumuşak peynirlerin kuru madde ve protein değerinin arttığını, raf ömrünün uzadığını bildirmişlerdir. Araştırmada ayrıca 12 hafta boyunca depolanan peynirlerde *Aspergillus flavus, Aspergillus niger, E.coli* ve *Streptococcus aureus* gibi mikroorganizmaların gelişmediği belirtilmiştir (Belewu ve Morakinyo, 2009). Bal ile kaplanan peynirlerin antioksidan aktivitesi ise başka bir çalışmada ele alınmış ve bal ile kaplanan peynirlerin antioksidan aktivitesi kontrol grubundan yüksek çıkmıştır. En yüksek antioksidan aktivite ise İtalyan korungası bal ile kaplanan parmesan peynirinde belirlenmiştir. Araştırıcılar koyu renkli kestane balının açık renkli okaliptüs balına göre daha yüksek antioksidan aktiviteye sahip olduğunu ve kestane balı ile kaplanan peynirlerin antioksidan aktivitesinin okaliptüs balı ile kaplananlara oranla yüksek çıktığını belirtmiştir (Simonetti vd., 2020).

Süt gibi çabuk bozulan ürünlerden bir diğeri de et ve et ürünleridir. Bal, propolis, arı sütü gibi arı ürünlerinin yüksek antioksidan ve antimikrobiyal etkisi bozulmayı önleyip ürünlerin raf ömrünün uzamasına yardımcı olmaktadır. Bu amaçla arı ürünleri et ürünlerinin raf ömrünü uzatmak amacıyla ürünlere ilave edilmektedir. Tavuk, balık ve et ürünlerine arı ürünleri uygulayan araştırmacılar en yüksek antioksidan aktivitenin arı sütü ve propoliste gözlendiğini bildirmişlerdir. Fiğ, akasya, karabuğday ve karışım balının da kullanıldığı çalışmada karışım balının monofloral ballara oranla daha yüksek aktivite gösterdiğini bildirmiştir (Nagai vd., 2006). Etlerin pişirilmesinde kurumaması ve sulu olması tüketiciler tarafından arzu edilen özelliklerdendir. Bu amaçla etlerin marine edilmesi lezzetlendirilmesi için çeşitli karışımlar kullanılmaktadır. Tavuk etinin marinasyonuna %30'a kadar ilave edilen balın pişirmede daha sulu, lezzetli ve tüketiciler tarafından arzulana renkte ürünler elde edilmesi sağlanmaktadır (Hashim vd., 1999). Bir diğer kanatlı eti olan hindi etine toz bal ilave ederek pişiren ve oksidatif stabilitesini inceleyen araştırıcılar bal ilave edilme oranının artmasıyla oksidatif stabilitenin arttığını bildirmişlerdir. Araştırıcılar %20 oranında bal tozu eklenen çiğ ve pişmiş hindi etinin oksidatif stabilitesinin en yüksek değere sahip olduğu belirtilmiştir (Antony vd., 2000).
Süt ürünlerinde olduğu gibi pastörize edilmemiş meyve sularında da hızla mikrobiyal bozulma meydana gelebilmektedir. Araştırıcılar taze meyve suyuna bal ilave ederek *B. alvei, B. polymyxa, B. subtilis* and *S. Aureus, P. aeruginosa, K. pneumonia, Enterobecter ve E. coli* gibi mikroorganizmaların gelişiminin inhibe edilebileceğini bildirmiştir (Iqbal vd., 2015).
Kek üretiminde kullanılan bal tozunun mineral ve nem değerini arttırdığı, %50 oranında şeker ile ikame edildiğinde duyusal olarak kabul edilebilir olduğu bildirilmiştir (Demir ve Kılınç, 2019). Bal tozu ilave edilen keklerde tekstürün daha yumuşak olduğu ve yedi günlük depolamada kontrol grubuna göre daha düşük sertlik değerine sahip olduğu bildirilmiştir. Ayrıca bal tozu ilave edilen keklerin fenolik madde ve antioksidan aktivite değeri ilave edilme oranına bağlı olarak artış göstermiştir (Acun, 2021).
Balda bulunan ve antioksidan özellik gösteren bileşenler yağlı ürünlerin oksidasyona karşı korunmasına yardımcı olmaktadır. Bu amaçla antep fıstığı ezmesine şeker yerine %10 oranında ilave edilen bal oksidasyonu azaltmış ve ürünün daha uzun süre muhafaza edilebilmesine katkı sağlamıştır (Shakerardekani vd., 2020).

2.2. Propolis

Bal arılarının (Apis mellifera L.) tarafından yaprak, tomurcuk ve gövde gibi bitki kısımlarından topladıkları salgıları bal mumu ve enzim gibi maddeler ile birleştirerek ürettikleri reçinemsi maddeye propolis denir (Bayram 2015, Chen v.d. 2018, Olegario v.d. 2019; Acun ve Gül, 2020). Propolis elde edildiği kaynağa bağlı olarak %40-70 reçine; %25-30 balmumu; %3-5 uçucu yağ; %5 Mg, Na, K, Ca gibi mineral madde; protein; B1, B2, C, A E gibi vitaminler ve diğer maddeler bulunabilmektedir (Albayrak ve Albayrak 2008, Bogdanov 2017, Keskin v.d. 2020).
Yapılan birçok çalışmada propolisin antioksidan, antimikrobiyal, antiviral, antikanserojen, antimikotik ve antialerjik etki gösterdiği bildirilmiştir (Albayrak ve Albayrak 2008; Catchpole vd. 2018; Moreno vd. 2020; Hochheim vd. 2019; Acun ve Gül, 2020). Zengin fenolik içeriğe sahip olan propolis gıda, kozmetik ve ilaç sanayi başta olmak üzere birçok sektörün ilgisini çekmiş ve kullanılabilirliği ile ilgili çeşitli araştırmalara konu olmuştur. Hazır çorba, peynir, yoğurt, dondurma, kıyma, balık köftesi, portakal suyu, patates püresi, top kek gibi birçok ürüne ilave edilen propolisin ürün raf ömrüne etkisi incelenmiştir. İlave edildiği ürünlerde mikrobiyal gelişimi engelleyen ya da azaltan propolis lipit oksidasyonunu da geciktirerek ürün raf ömrüne olumlu yönde katkı sağlamıştır. Ayrıca ilave edildiği ürünlerde toplam fenolik madde ve antioksidan aktivitenin artmasını sağlamıştır (Aly ve Elewa, 2007; Gao vd. 2011; Bahtiti 2013; Apaydın, 2015; Spinelli vd. 2015; El-Demery vd. 2016; Mehmetoğlu 2019; Yang vd. 2017; Acun, 2021).

2.3. Arı Poleni

Bitkilerin erkek organlarında meydana gelen polen arılar tarafından toplanarak bir miktar tükürükle yapıştırılarak pelet haline getirilir ve bu ürüne arı poleni denir (Silici, 2015). Arı poleni bileşimi diğer arı ürünlerinde olduğu gibi coğrafi özellikler, iklim, toplandığı bitki ve toplanma şekline göre değişiklik göstermektedir (Karataş vd., 2000). Yapılan çalışmalarda arı poleninin ortalama %30-50 karbonhidrat, %25-40 oranında protein ve %4-20 arasında streoller ve yağ asitleri gibi lipitler, B1, B2, B6 vitaminleri ve mineraller bulunaktadır (Gonzalez-Paramas vd., 2006, Campos vd., 1997, Bogdanov, 2011; Silici, 2015). Protein içeriği yüksek olan arı poleni yavru arıların protein ihtiyacını karşılamak amacıyla toplanmaktadır (Karlıdağ ve Keskin, 2020) Polenle ilgili yapılan çalışmalarda antioksidan ve antimikrobiyal etkisinin olduğu, patojen bakterilerin gelişimini önlediği bildirilmiştir (Basim vd., 2006; Almaraz-Abarca vd., 2007; LeBlanc vd., 2009; Özcan vd., 2020). Galangin, mirisetin gibi flavonaidlerin yanında kafeik asit, kumarik asit ve ferulik asit gibi fenolik bileşenleri de bulunduran polen doğal bir antioksidandır (Sandıkçı Altunatmaz ve Yılmaz Aksu, 2016). Yapılan çalışmalar lipit peroksidasyonunun önlenmesine katkı sağladığını bildirmektedir (Silici, 2015)

Bal kadar yaygın tüketimi olmayan arı poleni Özcan vd. (2020) tarafından yoğurda ilave edilmiş ve ürün kalitesine etkisi incelenmiştir. %3 oranına kadar polen ilave edilerek üretilen yoğurtlarda polen ilavesiyle viskozitenin artığı, pH'nın düştüğü bildirilmiştir. Ayrıca polen ilave edilme oranının artmasıyla mangan, magnezyum, çinko, kalsiyum, potasyum, fosfor gibi mineral miktarının arttığı belirtilmiştir.

2.4. Arı Ekmeği (Perga)

Önemli arı ürünlerinden biri olan perganın hammaddesi arı polenidir. Arı poleninin enzim ve bal ilavesiyle arılar tarafından petek gözlerine depolanması ve fermantasyona uğratılmasıyla elde edilir (Silici, 2015; Karlıdağ ve Keskin, 2020). Polene oranla daha fazla biyoaktif bileşen içeren perga serin kuru ve ışıksız ortamda depolanmalıdır. Bir yıldan fazla depolanan perganın aktivitesinin kaybolduğu ve hızlı tüketilmesi gerektiği bildirilmektedir (Karaman vd., 2016).

Perga %20-22 protein, %24-35 karbonhidrat, %1-1,5 lipit, %2-3 mineral, yaklaşık %3 laktik asit bulundurmaktadır. Perga esansiyel aminoasitlerin tamamını ve Ca, Fe, Na, Mg gibi önemli minerallerin yanı sıra A, B1, B2, C, E ve K vitaminlerini içermektedir (Arıgül-Apan vd., 2021). Gıdalarda kullanımı yaygın olmayan perga gıda olarak faklı yaş grupları tarafından kullanılabilmektedir. Zengin besin içeriği nedeniyle beden ve zihin yorgunluğunu gidermede, yaşlanmayı geciktirmede, dikkat bozukluğunun azaltılmasında fayda sağlamaktadır (Karaman vd., 2017).

2.5. Arı Sütü

Besin değeri oldukça yüksek olan, asidik tada sahip, propolis gibi keskin kokulu, beyaz renkli ve kremsi görünüme sahip arı sütü besleyici işçi arıların mandibular ve hipofaringal bezlerinden salgılanmaktadır (Karlıdağ ve Keskin, 2020). Kraliçe arının hayatı boyunca beslenmesini sağlayan arı sütünün 2/3'ü sudan oluşmaktadır. Karbonhidrat, protein, vitamin ve mineralce zengin olan arı sütünün en önemli bileşeni ise 10-hidroksidekonik asittir ve miktarı arı sütünün kalitenin belirlenmesini sağlar (Sabatini vd., 2009).

Yapısındaki bileşenler sayesinde birçok sağlık sorunu üzerine olumlu katkısı olduğu bildirilen arı sütünün pahalı olması gıdalarda kullanımını sınırlandırmıştır. Literatürde Nagai vd. (2006) tarafından tavuk, balık ve et ürünlerine arı sütü uygulaması yaptığını ve arı sütü ile muamele edilen ürünlerin en yüksek antioksidan aktiviteye sahip olduğu bildirilmiştir. Soylu ve Bayram (2020) tarafından ise bal, propolis, ekinezya, civanperçemi ve arı sütü kullanılarak fonksiyonel bir gıda üretilmiştir. Üretilen gıdanın prolin, vitamin ve mineral bakımından zengin olduğu bildirilmiştir.

2.6. Balmumu

Kovan içinde petek örmede kullanılan bal mumu kovan içindeki yabancı maddeleri kaplamaya da yardımcı olmaktadır. İşçi arıların salgı bezlerinden salgılanan ve bal ile karıştırılan bal mumu yapısındaki karoten nedeniyle sarımsı renktedir ve parafine benzer yapıdadır ancak parafinden oldukça kompleks bir yapıya sahiptir. Bal mumu %31 yağ asidi, %31 monohidrik alkol, %16 hidrokarbon, %13 hidroksi asit ve diğer maddeleri içermektedir (Karlıdağ ve Keskin, 2020; Arıgül-Apan vd., 2021).

Bal ve propolis ile birlikte tarihte mumyalamada kullanılan bal mumu günümüzde kozmetik, ayakkabı, mum, boya ve dişçilikte kullanılmaktadır (Karlıdağ ve Keskin, 2020). Ayrıca gıda sanayinin de ilgisini çeken bal mumu yenilebilir film üretiminde ve oleojel üretiminde kullanılmıştır (Güldaş vd., 2016; Kara, 2019). Bal mumu ile kaplanan peynirlerde mikrobiyal bozulma, enzimatik bozulma, lipit oksidasyonu ve ağırlık kaybının azaldığı, dolayısıyla raf ömrünün uzadığı bildirilmiştir (Güldaş vd., 2016).

2.7. Arı Zehiri (Apitoksin)

%88 su ve %12 peptit, fosfolipit, şekerler, asitler, enzimler ve biyoaktif aminlerden oluşan arı zehiri suda çözünebilen, berrak, keskin kokulu ve acımsı bir sıvıdır (Mesci ve Esim, 2020; Karlıdağ ve Keskin, 2020). Kuru zehir ise açık sarı renkli olup oksidasyona uğradığında kahverengiye dönüşebilmektedir. Uygun şartlarsa saklanırsa birkaç yıl süreyle kullanılabilmektedir. Kuru zehirin yapısında yaklaşık %40-55 peptit, %16 protein bulunmaktadır. Ayrıca %3-4 oranında Ca, P, Mg gibi minerallerin yanı sıra %3-4 oranında uçucu bileşenlerde bulunmaktadır (Karlıdağ ve Keskin, 2020; Arıgül-Apan vd., 2021).

Yapısındaki bileşenler nedeniyle antitümoral, antimikrobiyal, antidiyabetik etki gösteren arı zehiri multiple skleroz (MS), romatid artrit, migren, sinüzit tedavisi gibi hastalıkların tedavisinde kullanılabilmektedir. Son yıllarda popüler olan ve tamamlayıcı tıp yöntemlerinden biri olarak anılan apiterapide yaygın olarak kullanılan arı zehiri günümüzde kanserin bazı tiplerinde tedavi amacıyla kullanılabilmektedir (Mesci ve Esim, 2020; Acun, 2020).

2.8. Apilarnil

Ekşi tadı olan ve sarı renkteki apilarnil erkek arı larvalarının pupa dönemine geçmeden 3-7 günlük süreçte hasat edildikten sonra öğütülüp süzülmesiyle elde edilir. %25-35 kuru madde içeren apilarnilde %9-12 protein, %6-10 karbonhidrat, %5-8 lipit, %2 mineral madde ve %3 diğer maddeler bulunmaktadır. Koloni bölgesi, larva yaşı ve üretim dönemi kimyasal bileşimi üzerine etki etmektedir. Apilarnilde esansiyel aminoasitlerin tamamı bulunmaktadır ve erkeklere özgü hormonları fazlaca bulunduğundan erkeklerde kas ağırlığını artırmaktadır (Karlıdağ ve Keskin, 2020). Diğer arı ürünleri gibi P, Mg, Zn gibi mineral maddeleri içeren apilarnil A, B1 ve B2 gibi vitaminleri içermektedir. D vitamini bakımından balık yağından 10 kat zengin olan apilarnil, protein bakımından da kırmızı etten sonra gelmektedir (Arıgül-Apan vd., 2021). İçeriğindeki fenolik bileşenler nedeniyle antioksidan aktiviteye sahiptir (Karlıdağ ve Keskin, 2020).

Sinir sistemi tedavisi ve hücre yenileme özelliği nedeniyle vücuda zindelik kazandırmaktadır. Birçok ülkede kozmetik ve tıbbi amaçlı kullanılmaktadır (Karlıdağ ve Keskin, 2020).

2. SONUÇ

Biyoaktif bileşen bakımından oldukça zengin olan arı ürünleri hastalıkların tedavisi ve gıda olarak kullanılabilmektedir. Bunun yanında gıdaların raf ömrünün uzatılmasında ya da zenginleştirilmesinde gıda katkısı olarak arı ürünlerinden faydalanılmaktadır. Toplandıkları bitkinin orjini başta olmak üzere iklim, depolanma gibi birçok faktör ürünlerin bileşimlerini değiştirmektedir. Yine de hemen hemen tamamı antioksidan, antimikrobiyal etkiye sahip olan arı ürünleri gıdaların besin bileşiminin iyileştirilmesine ve uzun süre muhafaza edilebilmesine

katkı sağlamaktadır. İnsan sağlığı üzerine olumlu etkileri tespit edilen bu ürünlerin doz miktarı ve alerjen etkileri göz önünde bulundurularak çeşitli gıda ürünlerinde kullanılabilirliğinin artacağı tahmin edilmektedir. İlave edildiği ürünün besin bileşimini arttıran arı ürünleri ile ilgili günümüzde birçok çalışma yapılmıştır. Polen ilave edilen ürünlerin protein oranında artış görülürken, bal ilave edilen ürünlerde şeker ve mineral madde artışı meydana gelmektedir. Ayrıca ürünlerin tekstürü üzerine de etki eden arı ürünlerinin gıdalarda kullanımı yaygınlaştırılarak tüketiminin ve bilinirliğinin arttırılması önemlidir.

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ASSESSMENT OF QUALITY CHARACTERISTICS OF TABLE WINE FROM TAMARIND (*TAMARINDUS* INDICA) AND PASSION FRUIT (*P*ASSIFLORA *EDULIS*)

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ABSTRACT

Background and Objectives: Table wine is produced from red grapes. However, there are some tropical indigenous fruits such as tamarind and passion fruits that are cheap, available and underutilized. This work was to assess the quality characteristics of table wine from tamarind (*Tamarindus indica*) and passion fruit (*Passiflora edulis*)· Materials and Methods: Table wine was formulated from the blends of tamarind (*Tamarindus indica)* and passion fruit (*Passiflora edulis*) juice. The fruit must was fermented with *Sacchromyces cerevisae* isolated from fresh palm wine and commercial brewer's yeast. The blended ratios were divided into two groups, the first six was fermented with isolate from palm wine while the remaining fermented with commercial brewer's yeast. After 14 days' fermentation, the wine was subjected to sensory evaluation for colour, flavour, taste, aftertaste, tartness, astringency, mouthfeel, clarity and overall acceptability using 20- man semi trained panelist. The formulated table wine was assessed for chemical composition, minerals, micro-nutrient, physiochemical parameters· Results: It show that the protein 0.88 to 4.88 (PTFA) and fat ranged from 0.2 (PFAA and GRFW) to 0.8 (TPFE). Carbohydrate ranged from 1.25 (TFAA) to 10.59 (PFAA) while moisture content ranged from 88.22 (PTFE) to 96.59 (TFAA), and ash ranged from 0.006 (TPFA) to 0.017 % (PTFD). The potassium and phosphorus ranged from 5.76 (sample TFAA) to 17.17mg/100 (TPFC) and 49.22 (TFAA) to 56.73mg/100 (PTFE), respectively. Vitamin A and C ranged from 1.07 (GRFW) to 3.02mg/100ml (PTFE) and 1.33 (TFAA) to 2.03mg/100ml (PTFE). The pH (before fermentation) recorded 2.60 for sample TPFA and 3.10 (PFAA). After fermentation, it tended to be more acidic to the range of 2.40 (TPFA, TPFB, PTFA and PTFB) to 2.90 (PFAA). The total soluble solids in degree Brix before fermentation was from 9.20 (PTFA) to 11.900 (PTFB) and after fermentation from 6.70 (TPFC) to 8.80 (^{0} Brix) (PTFB and PTFC), while titrable acidity ranged from 2.40 (sample TPFA) to 3.24 % (TPFE), specific gravity before fermentation ranged from 1.00 (GRFW) to 1.075 kg/m^3 (TPFA) and after fermentation 1.002 (GRFW) to 1.010 kg/m^3 (TPFB). Alcohol value of the formulated table wine ranged from 5.94 (PTFA) to 9.05 (%) ABV (PFAA). The methanol and pectin content ranged from 0.031 (sample TPFD) to 0.041 mg/L (TPFA and PTFE) and 0.12 (TPFC) to 2.30 (%) (TPFE).

Conclusion: Formulating wine from the blends of tamarind and passion fruit fermented with *Saccharomyces cerevisae* from two different sources (isolate from palm wine and commercial brewer's yeast) had a high acceptability.

Keywords*: Fermentation, passion fruit, sacchromyces cerevisae, table wine, tamarind fruit*.

1. INTRODUCTION

Drink that contains from 5 to 95 % ethanol is an alcoholic beverage. The major physiologically active component of most alcoholic beverages is ethyl alcohol (ethanol), the remaining fractions are often called congeners (Jung *et al.*, 2010). Alcoholic beverages are divided into three classes — wines (Alcohol content: 9 - 16 % Alcohol by volume), beers (Alcohol content: 4 - 6 % Alcohol by volume), and spirits contain between 3 and 40 % Alcohol by volume.

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Based on this classification, wine (from Latin *vinum*) is an alcoholic beverage made from fermented grapes juice or other fruits juice. Due to a natural chemical balance, grapes ferment without the addition of sugars, acids, enzymes, water, or other nutrients. Yeast consumes the sugar in the grapes and converts it to ethanol and carbon dioxide (Johnson,1989) The production of home-made wine has been practiced with various fruits such as apple, pear and strawberry, cherries, plum, banana, pineapple, oranges, cucumber, watermelon, guava, among others. Using species of *Saccharomyces cerevisiae* which converts the sugar in the fruit juices into alcohol and organic acids, that later react to form aldehydes, esters and other chemical compounds which also help to preserve the wine (Fleet 2003, Duarte *et al.*,2010; Isitua and Ibeh,2010). Yeasts from other sources such as palm wine have also been used in the production of fruit wine (Ayogu, 1999).

Tamarind (*Tamarindus indica*) endemic to tropical Africa, it is a leguminous tree in the family *Fabaceae*. The tree bears out edible pod-like fruit which are used in almost all cuisines round the globe. There are several other uses as well and it includes traditional medicine and metal polish. Attaining a maximum crown height of 12 to 18 metres (40 to 60 feet), it is a long-lived, medium-growth bushy tree with fruit that tastes sweet and sour. The fruit contains tartaric acid with rich nutritional profile (Anon, 2004).

Meanwhile, passion fruit (*Passiflora edulis)* is a species of passion flower that produces a fruit about the size of an egg and is used all around the world in culinary and medicinal practices. It is native to certain areas in South America, and there are two main varieties: the yellow passion fruit and the purple passion fruit. Both are grown worldwide and edible (Anon, 2010). The aim of this work was to assess the quality characteristics of table wine from tamarind (*Tamarindus indica*) and passion fruit (*Passiflora edulis*).

2. MATERIALS AND METHODS

2.1. Materials

2.1.1. Procurement of raw materials

Tamarind *(Tamarindus indica)* fruit was purchased from Maiduguri Monday market in Maiduguri, Borno State, Nigeria. Yellow variety of Passion fruit *(Passiflora edulis)* was obtained from Department of Crop Science, University of Nigeria Nsukka. Freshly tapped palm wine was purchased from Enugu-Ezike market, Nsukka., Enugu state. Brewery's yeast was purchased from over- head bridge market in Onitsha, Anambra State, and the yeast from palm wine was molecularly characterized in the Bioscience Department, International Institutes of Tropical Agriculture (IITA) Ibadan, Oyo State.

2.2. Methods

2.2.1. Sample preparation

The tamarind fruit and passion fruit were sorted for extraneous foreign materials, spoilt and rotten fruits which would affect the keeping quality of the drink were removed, and the good fruit washed.

2.2.2. Processing of tamarind pulp into juice

Tamarind pulp (Figure 1) was processed by the method described by Onwuka and Nwaokorie (2006). Tamarind juice was processed by weighing 3.5 kg of the sorted and washed fruit. Then, 8.5 litres of water was boiled and mixed with the fruit and left for 5 minutes to dissolve the fruit pulp. After which the fruits were manually press to extract the juice into the hot water. After

removal of the seed, the juice was sieved with muslin cloth to obtain a clearer filtrate and left in stainless steel vat for blending with it counterpart fruit (passion fruit) as shown in Figure 4.

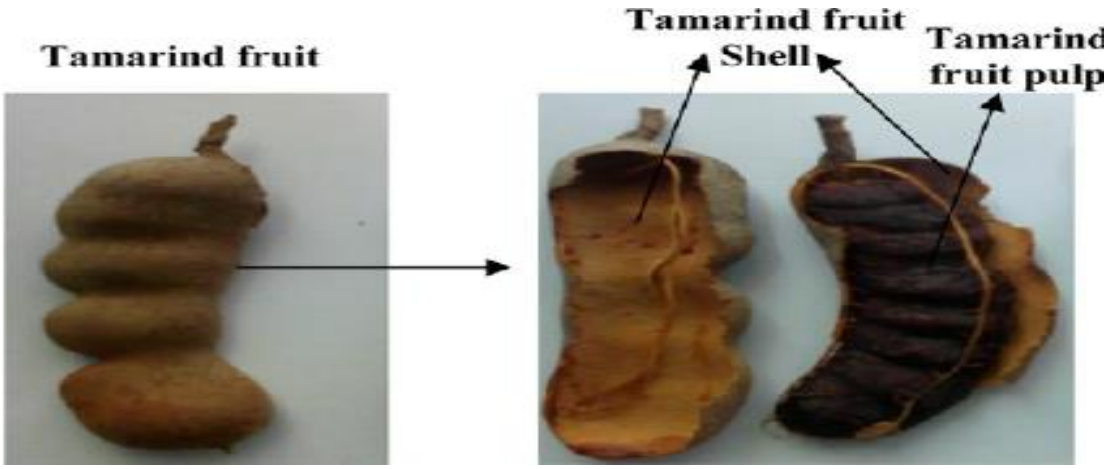

Figure 1a. Images of tamarind fruit and its major parts

Figure 1b**.** Depoded tamarind to be processed into juice

2.2.3. Processing of passion fruit into juice

Passion fruit (Figure 2) was processed into juice. The ripened passion fruit was sorted, weighed (14.5 kg), washed, and cut with knife to extract the juice and the seeds which were embedded in the endocarp. The seeds were separated from the juice by passing it through sieve 2 mm mesh to obtain the juice. A clearer juice was obtained by passing it through a muslin cloth. The total volume of juice obtained was 4.5 litres and 3 litres of distilled water was added to make up the total volume of 7.5 litres and left in the stainless vat for blending with tamarind juice (Figure 5).

Figure 3. Passion fruit to be processed into juice

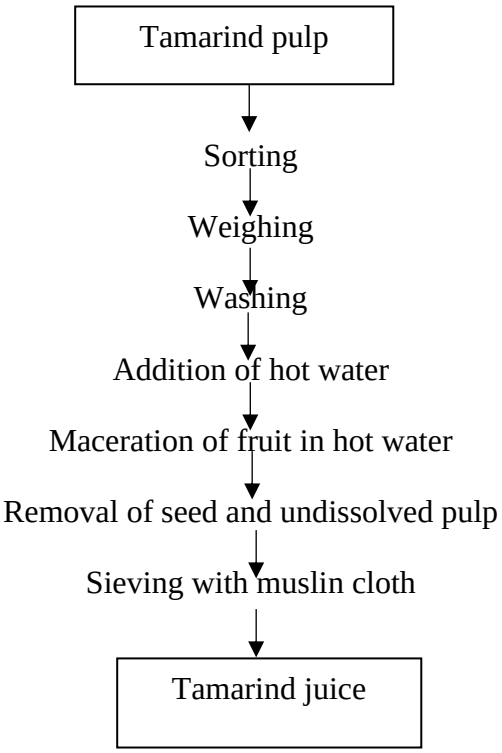

Figure 4. Modified flow chart of processing method of tamarind pulp into juice
Source: Onwuka and Nwaokorie (2006)

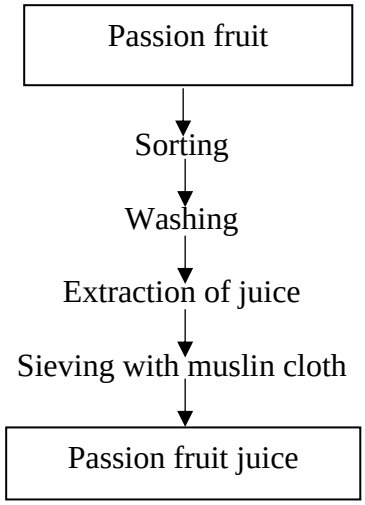

Figure 5. Modified flow chart processing method of passion fruit pulp into juice
Source: Onwuka and Nwaokorie (2006).

2.3. Preparation of isolate for inoculation (Pitching) into the fruit must for fermentation
Palm wine isolate was pitched into fruit juice Ezeonu and *et al., (*2011). The isolate from palm wine was inoculated into Sabouraud dextrose agar (SDA) broth (100 ml), and was left in the broth to grow for 72 hours. After which 6 pieces of centrifuge tubes were sterilized, the grown isolate in the Sabouraud dextrose agar (SDA) broth was transferred into each centrifuge tube and centrifuge for 10 minutes at 600 revolutions per minute (making the cells settled at the bottom of the tube), the SDA broth decanted. Sterilized distilled water was poured into the centrifuge tubes for washing of the isolated cells and centrifuged for 10 minutes, (600

revolution/minute), the washing procedure was repeated for two more times. After cell washing, distilled water was added to the tubes to make it up to 10 ml and thoroughly shake before inoculated into the fruit must for fermentation.

2.4. Production of tamarind and passion fruit blend wine

Tamarind juice (8.5 litres) and passion fruit juice (7.5 litres) were blended into twelve different ratios of tamarind: passion fruit (1000:0, 900:100, 800:200, 700:300, 600:400, 500:500, 0: 1000 ml) as shown in Table 1. Apart from the 1000 ml unblended tamarind and passion fruit juice, other blends were divided into two batches, (the first batches (five) were made to be fermented with isolate from palm wine while the second batches (five) were made to be fermented with commercial brewery's yeast). After which the batches were poured into fermenting vat.

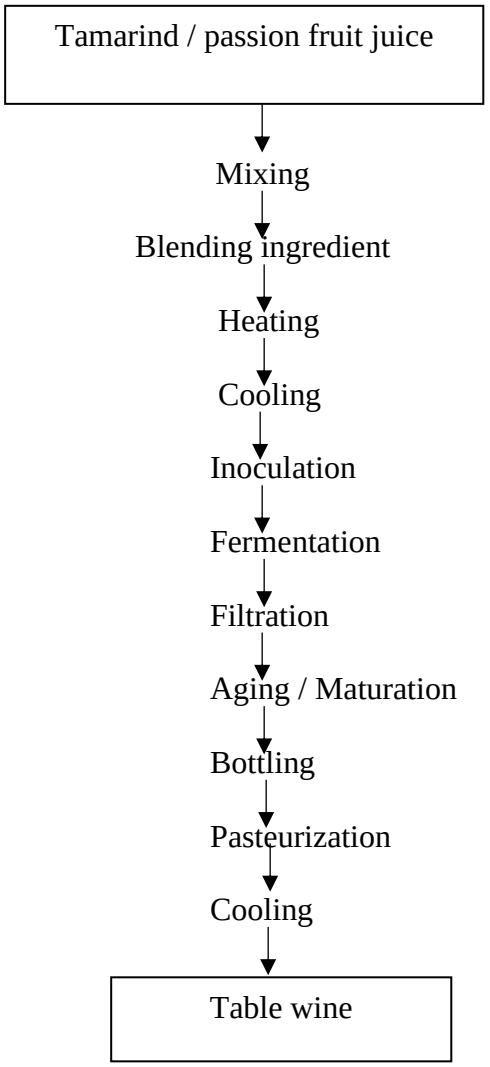

Figure 6. Modified flow chart for production of tamarind and passion fruit blended wine
Source: Onwuka and Nwaokorie (2006)

Then 90 g of sugar as source of carbon, 0.2 g 0f sodium metabisulphite to prevent the growth of other microbes, 5 g of ammonium sulphate as source of nitrogen was added to the must and it was pasteurized at 85 ^{o}C for 15 minutes, left to cool at room temperature. The isolated cell (10 ml) from palm which has been washed with distilled water and centrifuged was pitched into six portions of the blends, while the remaining six portions were inoculated with commercial brewer's yeast 50 ml which have been activated the previous day before inoculation. The must

was fermented aerobically for 4 days, anaerobically for 8 days and aged for 2 days, it was bottled and pasteurized again for 85 ^{o}C for 5 minutes to stop fermentation and cooled (Figure 6).

Table 1. Proportion of the formulated must for table wine production from tamarind and passion fruit blend

Sample	**Tamarind (ml**	**Passion fruit (ml)**	**Fermenting yeast**
TFAA	1000	0	Palm wine isolate
TPFA	900	100	Palm wine isolate
TPFB	800	200	Palm wine isolate
TPFC	700	300	Palm wine isolate
TPFD	600	400	Palm wine isolate
TPFE	500	500	Palm wine isolate
PFAA	0	1000	Brewer's yeast
PTFA	900	100	Brewer's yeast
PTFB	800	200	Brewer's yeast
PTFC	700	300	Brewer's yeast
PTFD	600	400	Brewer's yeast
PTFE	500	500	Brewer's yeast
GRFW	0	0	-

Key: TFAA = 1000ml tamarind fruit juice fermented with isolate from palm wine;
TPFA = 900ml tamarind + 100ml Passion fruit fermented with isolate from palm wine;
TPFB = 800ml tamarind + 200ml Passion fruit fermented with isolate from palm wine;
T PFC =700ml tamarind + 300ml Passion fruit fermented with isolate from palm wine;
TPFD = 600ml tamarind + 400ml passion fruit fermented with isolate from palm wine;
TPFE = 500ml tamarind + 500ml passion fruit fermented with isolate from palm wine;
PFAA = 1000ml passion fruit fermented with commercial brewer's yeast;
PTFA =900ml tamarind + 100ml passion fruit fermented with brewer's yeast;
PTFB= 800ml tamarind + 200ml passion fruit fermented with brewer's yeast;
PTFC= 700ml tamarind + 300ml passion fruit fermented with brewer's yeast;
PTFD = 600ml tamarind +400ml passion fruit fermented with brewer's yeast;
PTFE = 500ml tamarind +500ml passion fruit fermented with brewer's yeast;
GRFW = Commercial grape fruit wine (control).

Figure 7. Tamarind and passion fruit blend for table wine production undergoing fermentation

Figure 8. Bottled formulated table wine from tamarind and passion fruit blend

Figure 9. Formulated table wine from the blend of tamarind and passion fruit displayed in transparent disposable cups

2.5. Sample analysis

2.5.1. Sensory evaluation of formulated table wine from tamarind and passion fruit blend

The setup for the sensory evaluation of the formulated table wine is shown in Plates 3 to 5. The sensory properties of the formulated table wine were evaluated according to the method described by Ihekoronye and Ngoddy (1985). A semi- trained 20 panelist consisting of post-graduate students of department of Food Science and Technology, University of Nigeria Nsukka were trained for the evaluation. Various sensory attributes (colour, flavor, taste, aftertaste, tartness, astringency, mouthfeel, clarity, overall acceptability) were evaluated. The degree of acceptance/ preferences among the formulated table wine samples for each sensory quality was measured on nine- point Hedonic scale, where "9" represent extremely like and ''1'' represent extremely dislike.

2.5.2. Determination of selected micronutrients

2.5.2.1. Determination of pro-vitamin A content

Pro-vitamin A was determined using a modified spectrophotometric method described by AOAC (2010) as expressed in mg/100ml. Two millilitres (2 ml) of the formulated wine was inserted in a test tube, 5 ml of n-hexane was added to the 2 ml of the sample in the test tube and shake thoroughly to observe separation of two layers. UV- spectrophotometer was set at 470 nm and the blank was set at zero with the hexane after which the formulated sample was filled in the curvette and read from the UV- spectrophotometer (UV-Vis spectrophotometer 752P, Techmel and Techmel USA).

$$\text{Quantity of Vitamin A (mg/100ml)} = \frac{\text{Absorbance x dilution factor x volume of curvet x 1000}}{\text{Extinction coefficient (E)}}$$

2.5.2.2. Determination of vitamin C content

Ascorbic acid content (expressed in mg/100ml) was measured using spectrophotometric method by Bajaj and Kaur (1981). One millilitre (1 ml) of the sample was put in a test tube, 4 ml of oxalic acid EDTA extracting solution was added, then 1 ml of orthophosporic acid, and then 1 ml of 5 % tetraoxosulphate (VI) acid was added to this mixture, 2 ml of ammonium molybidate was added and then, 3 ml of water. The solution was then allowed to stand for 30mins. After which the absorbance at 760nm was measured with a spectrophotometer (UV-Vis spectrophotometer 752P, Techmel and Techmel USA). The concentration of ascorbic acid in sample was then extrapolated from a standard ascorbic acid.

$$\text{Concentration of Ascorbic acid in (mg/100ml)} = \frac{\text{Absorbance x D.F x 100}}{1.583}$$

Where, DF = dilution factor; 1.583 = is the value for ascorbic acid standard

2.5.2.3. Determination of phosphorus content

Phosphorus determination was done according to the method of Person(1976). One millilitre (1 ml) of the sample was put in a test tube and 2 ml of phosphor molybodate was added to the sample, and was left for 30 minute. The solution was read in UV- spectrophotometer (UV-Vis spectrophotometer 752P, Techmel and Techmel USA) at 470 nm with the blank reading 0.144.
Concentration of phosphorus (mg) = Absorbance x 92.25
Where, 92.25 = is the working standard or extinction coefficient of phosphorus from the standard.

2.5.2.4. Determination of potassium content

The potassium content was determined with the colorimetric method. Two millilitres (2 ml) of the formulated sample was digested with concentrated tetraoxosulphate (VI) acid. During digestion, hydrogen perioxide was added to obtained clear solution, after which it was cooled and made up with 100 % distilled water. One mililitre (1 ml) of the digested sample was inserted into a test tube, followed by 5 ml of distilled water and 0.1ml of potassium reagent was added, shaken thoroughly and left to stand for 15 minutes. The result obtained was read with spectrophotometer (UV-Vis spectrophotometer 752P, Techmel and Techmel USA) at 560nm.

$$\text{Potassium (mg)} = \frac{125 \times \text{Absorbance} \times 100}{1000}$$

2.5.2.5. Determination of methanol content

Spectrophotometric determination of methanol was done based on Zhan (2010). Two mililitres (2 ml) of the sample was oxidized with acid permanganate, after which Sodium nitroprusside was added and allowed to stand for 30 minutes. The result of the sample was read in visible spectrophotometer at 481 nm. Then a standard with pure methanol was determined.

$$\text{Amount of methanol (mg/L)} = \frac{\text{Absorbance} \times \text{dilution} \times \text{standard (0.012)} \times 100}{1000}$$

2.5.2.6. Determination of pectin content

Pectin was determined based on calorimetric method of Ranganna(1995). To a 50 ml beaker, 5 ml of sample was added 10 ml 0f distilled water as well as 5 ml of 0.1 M sodium hydroxide and then allowed to stand overnight. Five millilitres (5 ml) 0.1 M acetic acid was added.

$$\text{Amount of pectin in (mg/100ml)} = \frac{\text{Absorbance} \times \text{dilution factor (20)} \times 100}{1000}$$

2.5.3. Proximate analysis of the formulated table wine from tamarind and passion fruit blends

2.5.3.1. Determination of moisture content

Moisture was determined using the hot air oven method describe in AOAC(2010). Two millilitres (2ml) of the sample (W_1) was inserted into a moisture dish (W_2) and dried in Electrothermal Blast Drying Oven ((DHG – 9030A) for 3 hours at 105 ^oC. The sample was cooled by placing in a desiccator before weighing again to obtain final weight after drying (W_3). The percentage of moisture content was calculated as

$$\text{Moisture content (\%)} = \frac{W_3 - W_1}{W_2 - W_1} \times \frac{100}{1}$$

Where, W_1 = Weight of sample, W_2 Weight of crucible + sample before drying, W_3 = Weight of crucible and after drying.

2.5.3.2. Determination of ash content

The ash content was determined using the AOAC (2010) method. Two millilitres 2 (ml) of the sample ($W_{1)}$ was transferred in to a weighed porcelain dish ($W_{2)}$, and dried at 100 ^oC for 3 hours in a mechanized convention oven (Phonix furnace, model 534). The dish was removed and placed in a muffle furnace for ignition at 550 ^oC for 12 hours to remove carbon after drying in the oven. The muffle furnace was turned off and allowed to cool at 25 ^oC to avoid losing the fluffy ash (W_3). The percentage ash content of the sample was calculated as

$$\text{Ash content (\%)} = \frac{W_3 - W_1}{W_2} \times \frac{100}{1}$$

Where, W_1 = Weight of empty crucible, W_2 = weight of sample, W_3 = weight of ash + crucible.

2.5.3.3. Determination of crude protein

The crude protein content was determined using the AOAC (2010) method where a Soxhlet apparatus reflux condenser and 500 ml round bottom flask. Then, 2 ml of the sample was put into different filter paper and folded. Crude protein for each was determined by inserting one of the filter paper containing one sample into a Kjeldahl round bottom flask. After which, 20 ml of concentrated tetraoxosulphate (VI) acid and 2 tablets of Kjeldahl catalyst were added. The apparatus was assembled and the solution was digested until the solution was clear. It was distilled by adding 200 ml of distilled water and 50 ml of a 45 % of sodium hydroxide (NaOH) and sodium thiosulphate to avoid loss of ammonia in the process. After wards, 60 ml of boric acid and 3 drops of methyl red were then added to a 100 ml conical flask and placed at receiver end. The apparatus was set until it got to the 100 ml point inside the conical flask. The solution was titrated with 0.1 M sodium hydroxide (NaOH) and the titre value was recorded and calculated as:

$$\text{Protein content (\%)} = \frac{0.00140 \times 6.25 \times T}{5W}$$

Where; W= Weight of sample; 6.25 = protein conversion factor; T= Titre value

2.5.3.4. Determination of crude fat

The fat content was determined using Soxhlet extraction method described by AOAC (2010). A sample of 300 ml petroleum ether was poured into a round bottom flask and the Soxhlet apparatus was setup at a temperature of 50 ^{o}C. Then, 2 ml of the sample was placed in a label thimble. The extractor was sealed with cotton wool. Heat was applied to reflux the apparatus for six hours. The thimble was removed with care. The petroleum was recovered for reuse. When the flask was free of ether, it was removed and dried at 105 ^{o}C for 1hour in an oven. The flask was cooled in a desiccators and weighed.

$$\text{Fat (\%)} = \frac{\text{Weight of fat}}{\text{Weight of sample}} \times \frac{100}{1}$$

2.5.3.5. Determination of carbohydrate content

The percentage of carbohydrate was carried out by difference.
Carbohydrate content (%) = 100 – (% protein + % fat % ash + % crude fibre + % moisture).

2.5.4 Physiochemical analysis of the formulated table wine from tamarind and passion fruit blends

2.5.4.1 Determination of percentage alcohol content

The alcohol content of the formulated table wine was determined with the use of alcohol meter. It was achieved by pouring 200 ml of the sample into a 250 ml measuring cylinder. Then, the alcohol meter was dipped into the measuring cylinder containing the formulated sample. When dipped, a floating of the apparatus would be observed and reading taken from the calibrated alcohol meter.

2.5.4.2. Determination of total sugar (total soluble solids) in ºBrix
The total sugar was determined using pocket refractometer. It was achieved, by cleaning the lens of the refractometer with distilled water with soft material (tissue paper or cotton wool). After which the apparatus is powered on and about 1ml of the formulated sample was dropped on the lens of the apparatus and the reading was displayed on the screen and which was taken immediately.

2.5.4.3. Determination of pH
The pH was measured using the potentiometric method of AOAC (2010). Five millilitres (5 ml) of the sample was pipetted into a beaker and the pH was determined by dipping the electrode into the sample and the reading taken on the screen of the meter.

2.5.4.4. Determination of titratable acidity
The AOAC (2010) method was used to determine titratable acid. Five millilitres (5 ml) of the sample was taken and titrated with 0.1 alkali (NaOH) using 0.5 ml phenolphthalein as indicator. Titration continued until there was change in colour to pink end point. Titration was repeated to get an average result. The titratable acidity was calculated using the equation.

$$\text{Titratable acidity} = \frac{\text{M (NaOH)} \times 0.09 \times 100 \times \text{T}}{\text{Volume of sample}}$$

Where T= titre value; M = molar concentration of (NaOH)

2.5.4.5. Determination of specific gravity
The specific gravity of the formulated wine sample was determined with the use of specific gravity bottle. The procedure was carried out by first weighing the empty bottle, rinsing the bottle with distilled water and filling the specific gravity with distilled water to take the weight of the bottle with water. Then, the bottle was filled with the formulated sample and weighed. The specific gravity is calculated as follows.

$$\text{Specific gravity} = \frac{W_3 - W_1}{W_2 - W_1}$$

Where, W_1 = weight of empty bottle; W_2 = Weight of empty bottle + water; W_3 = weight of empty bottle + sample.

2.6. Data analysis and Experimental design
The experimental design was carried out using Completely Randomized Designed (CRD). The mean and standard deviation calculated using one- way analysis of variance (ANOVA) using computer software for solving solution (SPSS) version 21. Means were separated using Duncan multiple range test. Significance was accepted at $p < 0.05$ according to Steel and torrie (1980).

3. RESULTS AND DISCUSSION

3.1. Alcohol, pectin and methanol content of formulated table wine produced from tamarind and passion fruit blend
Alcohol and pectin content of the formulated table wine are shown in the Table 2. It could be observed from the values that there was a significant ($p < 0.05$) difference in the alcohol production after two weeks of fermentation of the formulated wine produced from tamarind

and passion fruit blends fermented with the same micro- organism but different sources (that is, the isolate from palm wine and the commercial brewer's yeast). Comparing the two sources of fermenters (that is, isolate from palm wine and commercial brewer's yeast), it could be deduced that there was similarity in pattern of alcohol production after subjecting them to the same fermentation condition and treatment. Samples TPFB, TTPFC, TPFD, and TPFE of the palm wine isolate produced alcohol by volume (ABV) of 7.97, 7.29, 8.51 and 8.78 % while samples PTFBT, PTFC, PTFD, and PTFE of the commercial brewer's yeast produced alcohol by volume of (ABV) of 7.37, 7.97, 8.24 and 8.51 %, respectively. But there was a variation in the 100 % tamarind fruit, (sample TFAA fermented with isolate from palm wine) and 100 % passion fruit (sample PFAA, fermented with commercial brewer's yeast) which recorded 6.21 % (ABV) and 9.05 % ABV respectively. This variation could be as a result of the fact that the passion fruit has high inherent sugar which led to higher alcohol production in the passion fruit. It was observed that the result of the alcohol content obtained was contrary to the result of Ayogu (1999) using *Saccharomyces cerevisiae* species isolated from the fermenting sap of *Elaesis guineansis* (palm wine) as a source of yeast for wine made from pineapple fruits . One of these isolates was used to pitch a pineapple must prepared as the fermenting medium, a high ethanol yield of 10·2 % (v/v) was obtained when compared with a commercial wine yeast (control) which gave 7·4 % (v/v).

Table 2. Alcohol, methanol and pectin content of formulated table wine produce from tamarind and passion fruit blend

Sample	**Alcohol (%) ABV**	**Pectin (%)**	**Methanol (Mg/L)**
TFAA	6.21^{e} ±0.90	1.47^{cd} ±0.03	0.040^{a} ±0.10
TPFA	8.51^{bc} ±0.01	1.21^{f} ±0.01	0.041^{a} ±0.01
TPFB	7.97^{cd} ±0.50	1.32^{e} ±0.02	0.040^{a} ±0.10
TPFC	7.29^{d} ±0.01	0.127^{ef} ±0.03	0.040^{a} ±0.20
TPFD	8.51^{bc} ±0.02	1.43^{d} ±0.03	0.031^{a} ±0.11
TPFE	8.78^{bc} ±0.02	2.30^{a} ±0.10	0.042^{a} ±0.08
PFAA	9.05^{b} ±0.02	1.88^{b} ±0.08	0.039^{a} ±0.01
PTFA	5.94^{e} ±1.50	0.92^{g} ±0.02	0.041^{a} ±0.01
PTFB	7.37^{e} ±0.07	0.27^{I} ±0.07	0.041^{a} ±0.01
PTFC	7.97^{cd}±0.50	0.59^{h} ±0.10	0.039^{a} ±0.09
PTFD	8.24^{bc}±0.04	0.61^{h} ±0.90	0.040^{a} ±0.20
PTFE	8.51^{bc}±0.01	1.54^{c} ±0.04	0.041^{a} ±0.21
GRFW	11.50^{a}±0.10	0.14^{j} ±0.04	0.040^{a} ±0.30

Values are means ± standard deviation of triplicate determinations. Values with different superscripts on the same column are significantly different ($p< 0.05$).

Key: TFAA = 1000ml Tamarind fruit juice fermented with Isolate from palm wine;
TPFA = 900ml tamarind + 100 ml Passion fruit fermented with isolate from palm wine;
TPFB = 800ml tamarind + 200 ml Passion fruit fermented with isolate from palm wine;
TPFC = 700ml tamarind + 300 ml Passion fruit fermented with isolate from palm wine;
TPFD = 600ml tamarind + 400ml passion fruit fermented with isolate from palm wine;
TPFE = 500ml tamarind + 500ml passion fruit fermented with isolate from palm wine;
PFAA = 1000ml passion fruit fermented with commercial brewer's yeast;
PTFA = 900ml tamarind + 100ml passion fruit fermented with brewer's yeast;
PTFB = 800ml tamarind + 200ml passion fruit fermented with brewer's yeast;
PTFC = 700ml tamarind + 300mlpassion fruit fermented with brewer's yeast;
PTFD = 600ml tamarind +400ml passion fruit fermented with brewer's yeast;
PTFE = 500ml tamarind +500ml passion fruit fermented with brewer's yeast;
GRFW = Commercial grape fruit wine (control).

There was a significant ($p< 0.05$) difference in the pectin value of the formulated table wine (Table 2). Pectins are a group of heterogeneous polysaccharides found in the intercellular regions and cell walls of most fruits and vegetables (Siragusa *et al.*,1985). The highest value is found in the sample TPFE (50 % tamarind and 50 % passion fruit blend of from palm wine, which is 2.30 %, followed by 1.88 % in the sample PFAA, (100 % passion fruit fermented with commercial brewer's yeast), and 1.47 % pectin content value for tamarind(100 % fermented with isolate from palm wine), the lowest value was the commercial grape fruit wine 0.14 %.
There was no significant ($p < 0.05$) difference in the methanol value of the formulated table wine (Table 2). The values ranged from 0.042 mg/L 50 % tamarind and 50 % passion fruit blend (fermented with yeast isolated from palm wine), followed by 100 % tamarind (1000 ml) which had a value of 0.400 mg/L, 100 % passion fruit recorded 0.039 mg/L while the 0.031 mg/L was found in the sample TPFD (60 % tamarind and 40 % passion fruit). Methyl alcohol (also known as methanol) is the simplest, lowest molecular weight alcohol, yet it is the most toxic of all, due to its metabolic products- formaldehyde and formic acid according to Cortes *et al.*, (2005) Acute methanol poisoning symptoms resemble those of ordinary alcoholic intoxication followed by the presence of severe upper abdominal pain, visual disturbance sometimes proceeding to incurable blindness and prolonged coma, which may terminate in death from respiratory failure. The fatal dose varies but is usually from 100 mL to 200 mL methanol. Permanent blindness has been claimed to have been caused by as little as 10mL (Public Health of England,2015 and 2016). The methanol content obtained was below the permissible Level (0.05 mg/L) set by National Agency for Food, and Drug Administration Agency, NAFDAC as reported by Vallejo-Cordoba *et al*., (2004). Also, the value obtained in the formulated table wine blended with tamarind and passion fruit was far below the standard stipulated by The Food and Drug Administration of the United States of America (FDA) which reported that the No Observed Adverse Effect Level (NOAEL) in humans for methanol is 71 to 84 mg/kg body weight (bw)/day. Since this No Observed Adverse Effect Level (NOAEL) was derived from studies in humans, the FDA developed an Acceptable Daily Intake (ADI) of 7.1 to 8.4mg/kg bw/day by using a safety factor of 10 (FDA,1993). An individual weighing 70 kg would have to consumed about 1.25 litres of wine (almost two 750 mL bottles) a day with a methanol content of 400 mg/L (the maximum methanol limit recommended by OIV (International organization for Vine and Wine) for red wines to reach the low end of this ADI range.

3.2. Proximate composition (%) of formulated table wine from tamarind and passion fruit blend

The proximate composition (%) of the formulated wine sample is shown in the Table 3, with the significant ($p < 0.05$) differences in the protein, fat, carbohydrate, moisture and ash content. The protein content ranged from 0.88% samples PTFC and PTFD to 4.88 % sample PTFA.
The fat content of the formulated table wine fell within the range of 0.7 % in (sample TPFA) to 0.2 % (samples PFAA) and (GRFW). 100 % tamarind (sample TFAA) and 100 % passion fruit (sample PFAA) had 0.4% and 0.2% fat, respectively. It was observed that the value was in line with the United Nations Department of Agriculture (USDA) data for fat which read 0.12 and 0.7 % but for fresh tamarind and passion fruits, respectively the slight variation could be as a result of complex substances breakdown during fermentation.
The carbohydrate content of the formulated table wine was found to be highest in 100 % passion fruit (sample PFAA) which was 10.59 % and the lowest in 100% tamarind (sample TFAA) which was 1.25 %. This was followed by the control (sample GRFW) having 3.22 % with other tamarind and passion fruit blends varying from 6.48 % (sample PTFA) to 9.35 % (sample PTFC).

Moisture content had the highest value which is often predominantly found in fruit and vegetables. The 100 % tamarind and the control sample had the highest value of 96.59 and 96.26 %, respectively. This could be as a result of water added to the tamarind fruit in order to extract the juice from the pulp, the lowest value is found in the 100% passion fruit which was 87.89%. The values 88.51 % for sample (TPFA), 88.23 % for sample (PTFA) and 88.22 % for sample (PTFE) are also similar to the result of 88.1 for local grape fruit juice used for wine production as reported by Owuka and Nwaokorie (2006).

Table 3. Proximate composition (%) formulated table wine from tamarind and passion fruit blend

Sample	Protein	Fat	Carbohydrate	Moisture	Ash
TFAA	$1.75^{d} \pm 0.05$	$0.40^{bc} \pm 0.10$	$1.25^{f} \pm 0.05$	$96.59^{a} \pm 0.11$	$0.01^{abc} \pm 0.00$
TPFA	$2.63^{c} \pm 0.07$	$0.70^{ab} \pm 0.20$	$8.15^{c} \pm 0.05$	$88.51^{g} \pm 0.09$	$0.01^{d} \pm 0.00$
TPFB	$2.63^{c} \pm 0.17$	$0.30^{c} \pm 0.10$	$7.48^{c} \pm 0.12$	$89.58^{e} \pm 0.08$	$0.012^{bcd} \pm 0.00$
TPFC	$3.50^{b} \pm 0.10$	$0.30^{c} \pm 0.20$	$5.89^{d} \pm 0.01$	$90.31^{c} \pm 0.09$	$0.01^{cd} \pm 0.00$
TPFD	$1.75^{d} \pm 0.15$	$0.40^{bc} \pm 0.20$	$7.45^{c} \pm 0.05$	$90.39^{c} \pm 0.11$	$0.01^{abc} \pm 0.00$
TPFE	$1.31^{e} \pm 0.09$	$0.80^{a} \pm 0.10$	$7.46^{c} \pm 0.04$	$90.42^{c} \pm 0.20$	$0.01^{abc} \pm 0.00$
PFAA	$1.31^{e} \pm 0.19$	$0.20^{c} \pm 0.10$	$10.59^{a} \pm 0.01$	$87.89^{I} \pm 0.01$	$0.009^{d} \pm 0.00$
PTFA	$4.88^{a} \pm 0.02$	$0.40^{bc} \pm 0.30$	$6.48^{d} \pm 0.02$	$88.23^{h} \pm 0.13$	$0.013^{abc} \pm 0.00$
PTFB	$1.750^{d} \pm 0.10$	$0.30^{c} \pm 0.10$	$7.79^{c} \pm 0.11$	$90.14^{d} \pm 0.060$	$0.02^{ab} \pm 0.00$
PTFC	$0.88^{f} \pm 0.08$	$0.50^{bc} \pm 0.20$	$9.35^{b} \pm 0.15$	$89.26^{f} \pm 0.06$	$0.01^{d} \pm 0.00$
PTFD	$0.88^{f} \pm 0.02$	$0.40^{bc} \pm 0.10$	$8.99^{b} \pm 1.50$	$89.71^{e} \pm 0.09$	$0.02^{a} \pm 0.03$
PTFE	$1.750^{d} \pm 0.0$	$0.30^{c} \pm 0.10$	$9.72^{b} \pm 0.18$	$88.22^{h} \pm 0.20$	$0.01^{abc} \pm 0.00$
GRFW	$1.31^{e} \pm 0.01$	$0.20^{c} \pm 0.10$	$3.22^{e} \pm 0.80$	$96.26^{b} \pm 0.04$	$0.01^{d} \pm 0.00$

Values are mean ± standard deviation of triplicate determinations. Values with different superscripts on the same column are significantly ($p < 0.05$).
Key: TFAA = 1000ml Tamarind fruit juice fermented with isolate from palm wine;
TPFA = 900ml tamarind + 100ml Passion fruit fermented with isolate from palm wine;
TPFB = 800ml tamarind + 200ml Passion fruit fermented with isolate from palm wine;
TPFC = 700ml tamarind + 300ml Passion fruit fermented with isolate from palm wine;
TPFD = 600ml tamarind + 400ml passion fruit fermented with isolate from palm wine;
TPFE = 500ml tamarind + 500ml passion fruit fermented with isolate from palm wine;
PFAA = 1000ml passion fruit fermented with commercial brewer's yeast;
PTFA = 900ml tamarind + 100ml passion fruit fermented with brewer's yeast;
PTFB= 800ml tamarind + 200ml passion fruit fermented with brewer's yeast;
PTFC = 700ml tamarind + 300mlpassion fruit fermented with brewer's yeast;
PTFD = 600ml tamarind +400ml passion fruit fermented with brewer's yeast;
PTFE = 500ml tamarind +500ml passion fruit fermented with brewer's yeast;
GRFW = Commercial wine (control).

Least of the proximate data is found in the ash content of the formulated table wine, (which varies from 0.009 % to 0.013 %). lowest value was found in sample PFAA (0.009 %) and the highest in sample PTFA (0.013 %).

3.3. Micronutrient composition of formulated table wine from tamarind and passion fruit blend

The micro-nutrient composition of the formulated wine from blend of tamarind and passion fruit is shown in Table 4. There were significant ($p < 0.05$) differences found in Pro- vitamin A content of the formulated wine (Table 4) where the values ranged from 0.15 mg/100ml sample TFAA (100 % tamarind using the palm wine isolate) to 3.02 mg/100ml in sample PTFB. The control sample (GRFW) which is the commercial grape wine recorded 1.07 mg/100ml and the sample PFAA (100 % passion fruit using brewer's yeast) was 2.72 mg/100ml.

The vitamin C had a significant ($p < 0.05$) difference among all the formulated samples. The least vitamin C content was found in sample TFAA (100% tamarind fruit from palm wine isolate) which read 1.33 mg/100ml followed by the control (sample GRFW the commercial grape wine) with a value of 1.35 mg/100ml. Highest value of vitamin C in the formulated tamarind and passion fruit blend wine was found in sample PFAA, which is the 100% passion fruit, having 2.08 mg/100ml vitamin C. This could be because passion fruit is rich in vitamin C as recorded in the literature.

Table 4. Micronutrient of formulated table wine from tamarind and passion fruit blend

Sample	**Potassium (mg/ 100 ml)**	**Phosphorus (mg/100 ml)**	**Pro-vitaminA (mg/100 ml)**	**Vitamin C (mg/100 ml)**
TFAA	$5.76^{k} \pm 0.03^{k}$	$49.26^{a} \pm 0.01$	$0.15^{f} \pm 0.03$	$1.33^{h} \pm 0.03$
TPFA	$7.01^{j} \pm 0.01^{j}$	$51.19^{a} \pm 0.01$	$1.81^{d} \pm 0.17$	$1.68^{ef} \pm 0.12$
TPFB	$9.96^{c} \pm 0.01^{c}$	$49.81^{a} \pm 0.01$	$1.78^{d} \pm 0.20$	$1.49^{gh} \pm 0.06$
TPFC	$17.17^{a} \pm 0.01^{a}$	$49.99^{a} \pm 4.04$	$1.82^{d} \pm 0.13$	$1.70^{ef} \pm 0.10$
TPFD	$9.8^{d} \pm 0.09^{d}$	$55.53^{a} \pm 0.03$	$1.86^{d} \pm 0.09$	$1.47^{gh} \pm 0.03$
TPFE	$9.40^{f} \pm 0.01^{f}$	$56.73^{a} \pm 0.07$	$2.46^{c} \pm 0.04$	$1.57^{fg} \pm 0.17$
PFAA	$9.57^{e} \pm 0.030^{e}$	$54.70^{a} \pm 0.20$	$2.75^{b} \pm 0.05$	$2.08^{a} \pm 0.01$
PTFA	$11.10^{b} \pm 0.064^{b}$	$56.08^{a} \pm 0.01$	$2.72^{b} \pm 0.12$	$1.71^{ef} \pm 0.19$d
PTFB	$7.80^{h} \pm 0.153^{h}$	$54.79^{a} \pm 24.75$	$3.02^{a} \pm 0.01$	$1.87^{bcd} \pm 0.030$
PTFC	$10.06^{c} \pm 0.025^{c}$	$54.61^{a} \pm 6.93$	$2.72^{b} \pm 0.02$	$1.88^{bc} \pm 0.08$
PTFD	$7.36^{i} \pm 0.10^{i}$	$51.84^{a} \pm 0.67$	$2.66^{b} \pm 0.14$	$1.83^{cde} \pm 0.07$
PTFE	$9.46^{ef} \pm 0.03^{ef}$	$50.37^{a} \pm 0.12$	$2.41^{c} \pm 0.09$	$2.03^{ab} \pm 0.01$
GRFW	$8.92^{g} \pm 0.02^{g}$	49.22 ± 0.08^{a}	1.07 ± 0.02^{e}	1.35 ± 0.05^{h}

Values are means ± standard deviation of triplicate determinations. Values with different superscripts on the same column are significantly different ($p < 0.05$).
Key: TFAA = 1000ml Tamarind fruit juice fermented with Isolate from palm wine;
TPFA = 900ml tamarind + 100ml Passion fruit fermented with isolate from palm wine;
TPFB = 800ml tamarind + 200ml Passion fruit fermented with isolate from palm wine;
TPFC = 700ml tamarind + 300ml Passion fruit fermented with isolate from palm wine;
TPFD = 600ml tamarind + 400ml passion fruit fermented with isolate from palm wine;
TPFE = 500ml tamarind + 500ml passion fruit fermented with isolate from palm wine;
PFAA = 1000ml passion fruit fermented with commercial brewer's yeast;
PTFA = 900ml tamarind + 100ml passion fruit fermented with brewer's yeast;
PTFB= 800ml tamarind + 200ml passion fruit fermented with brewer's yeast;
PTFC = 700ml tamarind + 300mlpassion fruit fermented with brewer's yeast;
PTFD = 600ml tamarind +400ml passion fruit fermented with brewer's yeast;
PTFE = 500ml tamarind +500ml passion fruit fermented with brewer's yeast;
GRFW = Commercial grape fruit wine (control).

The potassium content (Table 4) of the formulated table wine differed significant ($p < 0.05$) difference with sample TPFC (70 % tamarind + 30 % passion fruit) having the highest value which is 17.17 mg/100ml using palm wine isolate while the lowest was found in the 100 % tamarind (sample TFAA) was 5.76 mg/ 100ml. Sample PFAA (100 % passion fruit) had a value of 9.57 mg/100ml. The control sample (GRFW) had 8.92 mg/100ml.
Phosphorus content of the formulated table wine ranged from 56.73 mg/100ml sample TPFE to 49.26 (mg/100ml) sample TFAA, with no significant ($p > 0.05$) difference. According to United States Department of Agriculture[23], nutrient data based report on the potassium content of unprocessed tamarind and passion fruit are (2 mg/100ml) and (348 mg/100ml) respectively while the phosphorus content of tamarind and passion fruit are (27 mg/100ml) and (68 mg/100ml), respectively. However, the value differed from the formulated sample after processing, where the fruits used to formulate table wine had potassium of tamarind and passion fruit of 5.76 mg/100ml, 9.57 mg/100ml respectively (Table 4). For tamarind, potassium content

of the formulated wine was slightly above the value for the unprocessed fruit recorded by the USDA while that of potassium in the processed passion fruit is far below USDA (2016) standard. For phosphorus in the processed passion fruit was 54.7 mg/100ml which was slightly below the USDA value and that of tamarind fruit which was 49.26 mg/100ml highly above the unprocessed fruits USDA (2016).

3.4. Physiochemical properties of formulated table wine from tamarind and passion fruit blend

3.4.1. pH of the formulated table wine from tamarind and passion fruit blend

Table 5 shows pH of the formulated table wine from the blends of tamarind and passion fruit juice. The pH (before and after fermentation) showed no significant ($p > 0.05$) difference. From the values obtained, it was observed that the two fruits used in the table wine formulation (tamarind and passion fruits) were very high acid fruit. This could be as a result of high content of organic acid (tartaric, malic and citric acids) which made the pH of the wine to be low (acidic) before and more acidic after fermentation. Studies have shown that during fermentation of fruits, low pH is inhibitory to spoilage organisms but increases conducive environment for the growth of desirable organisms (Reddy and Reddy 2005; Chilaka *et al.*,2010).

Table 5. pH of the formulated table wine from tamarind and passion fruit blends

Samples	pH (before fermentation)	pH (after fermentation)
TFAA	$2.70^{a} \pm 0.10$	$2.50^{b} \pm 0.208$
TPFA	$2.60^{a} \pm 0.20$	$2.40^{b} \pm 0.20$
TPFB	$2.70^{a} \pm 0.20$	$2.40^{b} \pm 0.20$
TPFC	$2.80^{a} \pm 0.10$	$2.50^{b} \pm 0.10$
TPFD	$2.90^{a} \pm 0.50$	$2.70^{b} \pm 0.20$
TPFE	$2.90^{a} \pm 1.50$	$2.70^{b} \pm 0.10$
PFAA	$3.10^{a} \pm 1.0$	$2.90^{b} \pm 1.70$
PTFA	$2.70^{a} \pm 0.50$	$2.40^{b} \pm 0.50$
PTFB	$2.60^{a} \pm 0.30$	$2.40^{b} \pm 0.50$
PTFC	$2.80^{a} \pm 0.50$	$2.50^{b} \pm 0.10$
PTFD	$2.90^{a} \pm 0.60$	$2.50^{b} \pm 0.20$
PTFE	$2.90^{a} \pm 0.70$	$2.50^{b} \pm 0.40$
GRFW	$3.50^{a} \pm 0.10$	$4.90^{a} \pm 0.50$

Values are mean ± standard deviation of triplicate determinations. Values with different superscripts on the same column are significantly ($p < 0.05$).

Key: TFAA = 1000ml tamarind fruit juice fermented with isolate from palm wine;
TPFA = 900ml tamarind + 100ml Passion fruit fermented with isolate from palm wine;
TPFB =800ml tamarind + 200ml Passion fruit fermented with isolate from palm wine;
TPFC = 700ml tamarind + 300ml Passion fruit fermented with isolate from palm wine;
TPFD =600ml tamarind + 400ml passion fruit fermented with isolate from palm wine;
TPFE = 500ml tamarind + 500ml passion fruit fermented with isolate from palm wine;
PFAA= 1000ml passion fruit fermented with commercial brewer's yeast;
PTFA = 900ml tamarind + 100ml passion fruit fermented with brewer's yeast;
PTFB= 800ml tamarind + 200ml passion fruit fermented with brewer's yeast;
PTFC = 700ml tamarind + 300mlpassion fruit fermented with brewer's yeast;
PTFD = 600ml tamarind +400ml passion fruit fermented with brewer's yeast;
PTFE = 500ml tamarind +500ml passion fruit fermented with brewer's yeast;
GRFW = Commercial grape fruit wine (control).

Also, low pH is known to give fermenting yeasts a competitive advantage in natural (Reddy and Reddy;Chilaka *et al.*, 2010). The pH (before fermentation) ranged from 2.6 to 3.10, the

least pH value was found in the sample PTFB (2.6) and the highest pH value was in sample PFAA (100% passion fruit juice). The pH of the passion fruit juice before fermentation fell within the value for passion fruit juice in accordance with the pH 3.0 – 4.0 of the passion fruit as recorded by Sanchez (1979) for fruit wine production in the Philippines. Furthermore, the pH of the 100 % tamarind (sample TFAA) before fermentation (2.7) was close to the result (2.96)of Hamacek *et al* (2012) who carried out a research on nutritional composition of tamarind (*Tamarind indica L.*) from the Cerrado of Minas, Brazil. The pH (after fermentation) had pH of 2.4 to 2.9, which showed a drop in value of 0.2 to 0.4. The decrease in pH could be due to accumulation of organic acids during fermentation and this reduces the influence of bacteria that could lead to spoilage. Therefore, the wines would have a good keeping quality.

3.4.2. Total soluble solid (^{0} Brix) of the formulated table wine from tamarind and passion fruit

Table 6 shows the total soluble content of the formulated table wine from the blend of tamarind and passion fruit. There was a significant ($p< 0.05$) differences in the total soluble solids (^{0} Brix), the total soluble solid (^{0} Brix) before fermentation ranged from 11.90 (sample PTFB) to 9.20 (sample PTFA). The total soluble solid (^{0}Brix) after fermentation fell between 6.40 to 8.80 in sample PTFA and PTFC at a temperature of 30.30 ^{0}C and 30.40 ^{0}C, respectively. The drop in the total soluble solids could be due to the yeast (the isolate from palm wine and that of commercial brewer's yeast) had converted the inherent sugar and the added sugar which serves as carbon source to microorganism in the must to alcohol and carbon dioxide, therefore causing a decrease in the total soluble solids of the formulated wine sample.

Table 6. Total soluble solid (^{0} Brix) parameter of formulated table wine from tamarind and passion fruit blend

Samples	TSS (^{0}Brix) before Fermentation	TSS (^{0} Brix) after Fermentation
TFAA	11.10^{d} ±0.02	8.00^{abc} ±1.00
TPFA	11.50^{b} ±0.10	8.30^{ab} ±0.10
TPFB	10.30^{ef} ±0.10	7.70^{abcd} ±0.20
TPFC	9.80^{hi} ±0.10	6.70^{de} ±0.10
TPFD	9.90^{gh} ±0.00	7.10^{cde} ±0.10
TPFE	10.40^{e} ±0.10	7.20^{bcde} ±0.10
PFAA	10.200^{f} ±0.10	7.10^{cde} ±1.00
PTFA	9.20^{j} ±0.10	6.40^{e} ±0.10
PTFB	11.90^{a} ±0.10	8.80^{a} ±0.10
PTFC	11.30^{c} ±0.10	8.80^{a} ±0.10
PTFD	11.00^{d} ±0.00	8.70^{a} ±0.10
PTFE	10.00^{g} ±0.00	7.70^{abcd} ±1.50
GRFW	9.70^{i} ±0.10	7.70^{abcd} ±0.40

Values are means ± standard deviation of triplicate determinations. Values with different superscripts on the same column are significantly ($p <0.05$).

Key: TFAA = 1000ml Tamarind fruit juice fermented with Isolate from palm wine;
TPFA = 900ml tamarind + 100ml Passion fruit fermented with isolate from palm wine;
TPFB = 800ml tamarind + 200ml Passion fruit fermented with isolate from palm wine;
TPFC = 700ml tamarind + 300ml Passion fruit fermented with isolate from palm wine;
TPFD = 600ml tamarind + 400ml passion fruit fermented with isolate from palm wine;
TPFE = 500ml tamarind + 500ml passion fruit fermented with isolate from palm wine;
PFAA = 1000ml passion fruit fermented with commercial brewer's yeast;
PTFA = 900ml tamarind + 100ml passion fruit fermented with brewer's yeast;
PTFB = 800ml tamarind + 200ml passion fruit fermented with brewer's yeast;
PTFC = 700ml tamarind + 300mlpassion fruit fermented with brewer's yeast;
PTFD = 600ml tamarind +400ml passion fruit fermented with brewer's yeast;
PTFE = 500ml tamarind +500ml passion fruit fermented with brewer's yeast;
GRFW = Commercial grape fruit wine (control).

3.4.3. Titratable acidity and specific gravity of formulated table wine from the blends of tamarind and passion fruit

The titratable acidity of the formulated table wine (Table 7) had a significant ($p< 0.05$) difference, with very high value ranging from 2.47 (%) to 3.24 (%) in sample TPFA and TPFE, respectively except for sample GRFW (control) which had 0.67 (%). These disparities could be related to high composition of organic acid content of the two fruits used (tamarind and passion fruit.). The data obtained was similar to the result of Santos *et al*, (2016) who reported that a particular cultivar (George) of blueberry wine has a titratable acidity of 2.1.

Table 7. Specific gravity and titratable acidity of the formulated table wine from tamarind and passion fruit blends

Samples	**Specific gravity (kg/m^3) before fermentation**	**Specific gravit (kg/m^3) after fermentation**	**Titratable acidity (%)**
TFAA	$1.058^{a} \pm 0.01$	$1.012^{a} \pm 0.03$	$2.85^{bc} \pm 0.05$
TPFA	$1.075^{a} \pm 0.01$	$1.012^{a} \pm 0.02$	$2.47^{e} \pm 0.03$
TPFB	$1.069^{a} \pm 0.01$	$1.010^{ab} \pm 0.00$	$2.79^{bcd} \pm 0.01$
TPFC	$1.060^{a} \pm 0.01$	$1.006^{ab} \pm 0.00$	$2.84^{bc} \pm 0.06$
TPFD	$1.069^{a} \pm 0.01$	$1.006^{ab} \pm 0.00$	$2.57^{e} \pm 0.03$
TPFE	$1.069^{a} \pm 0.01$	$1.004^{ab} \pm 0.00$	$3.24^{a} \pm 0.04$
PFAA	$1.073^{a} \pm 0.070$	$1.006^{ab} \pm 0.00$	$2.790^{bcd} \pm 0.11$
PTFA	$1.052^{ab} \pm 0.01$	$1.008^{ab} \pm 0.00$	$2.88^{b} \pm 0.02$
PTFB	$1.031^{ab} \pm 0.01$	$1.006^{ab} \pm 0.00$	$3.20^{a} \pm 0.10$
PTFC	$1.069^{a} \pm 0.05$	$1.010^{ab} \pm 0.00$	$2.70^{d} \pm 0.10$
PTFD	$1.071^{a} \pm 0.03$	$1.010^{ab} \pm 0.00$	$2.75^{cd} \pm 0.05$
PTFE	$1.071^{a} \pm 0.06$	$1.008^{ab} \pm 0.00$	$2.74^{cd} \pm 0.06$
GRFW	$1.000^{b} \pm 0.00$	$1.00^{ab} \pm 0.00$	$0.67^{f} \pm 0.01$

Values are mean ± standard deviation of triplicate determinations. Values with different superscripts on the same column are significantly ($p< 0.05$) different.
Key: TFAA = 1000ml Tamarind fruit juice fermented with Isolate from palm wine;
TPFA = 900ml tamarind + 100ml Passion fruit fermented with isolate from palm wine;
TPFB = 800ml tamarind + 200ml Passion fruit fermented with isolate from palm wine;
TPFC = 700ml tamarind + 300ml Passion fruit fermented with isolate from palm wine;
TPFD =600ml tamarind + 400ml passion fruit fermented with isolate from palm wine;
TPFE = 500ml tamarind + 500ml passion fruit fermented with isolate from palm wine;
PFAA = 1000ml passion fruit fermented with commercial brewer's yeast;
PTFA = 900ml tamarind + 100ml passion fruit fermented with brewer's yeast;
PTFB = 800ml tamarind + 200ml passion fruit fermented with brewer's yeast;
PTFC = 700ml tamarind + 300mlpassion fruit fermented with brewer's yeast;
PTFD = 600ml tamarind +400ml passion fruit fermented with brewer's yeast;
PTFE = 500ml tamarind +500ml passion fruit fermented with brewer's yeast;
GRFW = Commercial grape fruit wine (control)

In addition, the titratable acidity 2.85 % of the 100 % tamarind (sample TFAA) correspond with the titratable acidity 2.38 of Hamacek *et al* (2012) who carried out a research on nutritional composition of tamarind (*Tamarind indica L.*) from the Cerrado of Minas, Brazil. However, the result obtained in the formulated wine of the blends of tamarind and passion fruit had a varying composition of wine from passion fruit, water melon and pineapple wine which ranged from 0.90-0.93, 0.85-0.90 and 0.80-0.83 %, respectively (Chilaka *et al.*,2010). Also, the titratable acidity obtained in this research was far above the result obtained by Ogodo *et al.* (2015) for mixed fruits (pawpaw, banana and watermelon) wine using *Saccharomyces cerevisiae* isolated from palm wine which ranged from 0.35 to 0.88 %.

There is a significant ($p < 0.05$) differences in the specific gravity of the formulated table wine (Table 7). From the data generated, it could be deduced that there was a decrease in the value, which signifies a reduction in the relative density from the must to the wine formulated. The decrease in the relative density could be as a result of the microbial activity of the *Saccharomyces cerevisae*, breaking down complex and weighty substances in the must into light and volatile product (alcohol and carbon dioxide) which corresponds to the increase in ethanol content of the wine since as the alcohol concentration increases, the density of the wine decreases as reported by Oji *et al.* (2016) on fermentation of pawpaw juice into wine using palm wine yeast[29]. The specific gravity (before fermentation) fell between 1.031 to 1.075kg/m^3, while the specific gravity (after fermentation) was within 1.004 to 1.010 kg/m^3 with the control sample (GRFW) having the least value of 1.002. kg /m^3.

3.5. Sensory scores of formulated wine from the blends of tamarind and passion fruit blends

The Table 8 shows the sensory scores of the formulated table wine blended in different ratio of tamarind and passion fruit, and fermented with the same microorganism (*Sacchromyces cerevisae*) of two different sources (commercial brewer's yeast and isolate from palm wine). Sensory evaluation has become a popular research tool in the food and beverage industries and is defined by the Institute of Food Technologists as "A scientific discipline used to evoke, measure, analyze and interpret reactions to those characteristics of foods and materials as they are perceived by the senses of sight, smell, taste, touch and hearing" (Lawless and Heymann, 1998). The scores obtained after sensory evaluation of the formulated table wine showed significant ($p < 0.05$) difference in colour, flavor, taste, aftertaste, clarity and overall acceptability of the formulated wine. The colour ranged from 5.55 to 6.90 in sample PTFC and PTFE, while flavor ranged from 6.00 to 7.20 in sample PFAA and PTFE. However, taste ranged from 5.25 to 7.15 in sample PFAA and PTFE. There was no significant ($p > 0.05$) difference in the tartness, astringency and mouthfeel. According to the tasters, the colour of the wine was neither liked nor disliked, this could be due to the colour of the tamarind as it was blended with passion fruit, except for sample PFAA (100 % passion fruit) which looks pleasant due to it light yellow juicy passion fruit colour which remain unchanged after processing.

Secondary or fermentation aromas/flavor which come from esters of alcohol and higher alcohols and a number of volatile compounds, gives wines fruity and vinous character (Amerine and Singleton, 1977;Boulton *et al.*,1999) The flavor of the formulated wine was highly accepted by the panelists. The flavor was dominated with the flavor of the passion fruit which made the wine very much inviting. The taste of the blended wine samples was accepted by the panelist compared to the 100 % passion fruit, which were unblended. Aftertaste of the formulated wine sample was generally accepted by the tasters. Acidity contributes greatly to the stability of a wine (Boulton *et al.,* 1999) Due to the acidic nature of the two combine fruit used in the formulation of wine, 60 % of the tasters neither liked nor disliked the tartness of the wine except for few tasters because of the individual differences. The overall acceptability of the formulated wine and the control sample were moderately liked. Astringency and mouthfeel were not obviously observed by the panelist. The clarity of the formulated wine was neither liked nor disliked by the panelist which could be as a result of non- addition of pectinase to bring a better clarity.

From the sensory scores obtained, the wine was acceptable which was in accordance with the general acceptability of wine from tropical fruit (pawpaw and banana wine, pawpaw and watermelon, pawpaw, watermelon and banana, banana and watermelon wine)[33.]

Table 8. Sensory scores of formulated table wine from tamarind and passion fruit

Sample	Colour	Flavour	Taste	Aftertaste	Tartness	Astringency	Mouthfeel	Clarity	Overall aceptability
TFAA	$5.85^{cde} \pm 1.42$	$6.85^{a} \pm 1.27$	$6.40^{abc} \pm 1.75$	$6.40^{ab} \pm 1.66$	$5.80^{a} \pm 2.12$	$5.90^{a} \pm 1.99^{a}$	$6.70^{a} \pm 1.6$	$5.85^{ab} \pm 1.49$	$6.80^{abc} \pm 1.15$
TPFA	$5.75^{de} \pm 1.44$	$6.65^{ab} \pm 1.39$	$6.10^{abc} \pm 1.65$	$6.20^{ab} \pm 1.50$	$6.45^{a} \pm 1.64$	$6.30^{a} \pm 1.34^{a}$	$6.20^{a} \pm 1.47$	$6.00^{a} \pm 1.52$	$6.65^{ab} \pm 1.22$
TPFB	$5.75^{d\ e} \pm 1.41$	$6.45^{ab} \pm 1.99$	$5.75^{bc} \pm 2.19$	$5.40^{b} \pm 1.98$	$5.30^{a} \pm 2.36$	$5.40^{a} \pm 1.53^{a}$	$5.40^{a} \pm 1.69$	$5.75^{b} \pm 158$	$6.00^{cd} \pm 1.37$
TPFC	$5.85^{cde} \pm 1.59$	$7.05^{a} \pm 0.99$	$6.15^{abc} \pm 1.81$	$6.25^{ab} \pm 1.74$	$6.20^{a} \pm 1.64$	$6.00^{a} \pm 1.97^{a}$	$6.15^{a} \pm 1.75$	$6.25^{a} \pm 1.51$	$6.60^{abc} \pm 1.69$
TPFD	$6.00^{cde} \pm 1.56$	$6.65^{ab} \pm 1.30$	$5.60^{bc} \pm 1.69$	$5.75^{ab} \pm 1.94$	$5.55^{a} \pm 2.42$	$5.20^{a} \pm 2.21^{a}$	$5.95^{a} \pm 1.70$	$5.90^{a} \pm 1.65$	$6.15^{c} \pm 1.26$
TPFE	$6.85^{cde} \pm 1.35$	$6.95^{ab} \pm 1.05$	$5.90^{abc} \pm 1.65$	$5.40^{b} \pm 1.93$	$5.45^{a} \pm 1.76$	$5.85^{a} \pm 1.93^{a}$	$5.75^{a} \pm 1.99$	$5.90^{a} \pm 1.74$	$6.00^{cd} \pm 1.45$
PFAA	$7.45^{ab} \pm 1.80$	$6.00^{b} \pm 2.03$	$5.25^{c} \pm 2.40$	$5.60^{b} \pm 2.11$	$5.30^{a} \pm 2.29$	$5.10^{a} \pm 2.29^{a}$	$5.40^{a} \pm 2.01$	$6.45^{a} \pm 2.09$	$5.25^{d} \pm 2.02$
PTFA	$5.75^{ab} \pm 1.99^{ab}$	$6.85^{bc} \pm 1.23$	$6.45^{abc} \pm 1.63$	$6.45^{ab} \pm 1.32$	$6.00^{a} \pm 1.62$	$5.85^{a} \pm 1.87^{a}$	$6.10^{a} \pm 1.74$	$6.15^{a} \pm 2.03$	$6.30^{bc} \pm 1.83$
PTFB	$5.90^{cde} \pm 1.86$	$6.50^{ab} \pm 1.43$	$5.80^{bc} \pm 1.57$	$5.95^{ab} \pm 1.91$	$5.50^{a} \pm 2.19$	$5.25^{a} \pm 2.05^{a}$	$6.50^{a} \pm 1.27$	$6.05^{a} \pm 1.82$	$6.10^{c} \pm 2.07$
PTFC	$5.55^{e} \pm 1.53^{e}$	$6.80^{ab} \pm 1.28$	$5.90^{abc} \pm 2.07$	$5.75^{ab} \pm 1.68$	$5.85^{a} \pm 2.08$	$5.45^{a} \pm 1.98^{a}$	$5.45^{a} \pm 2.08$	$5.85^{a} \pm 1.78$	$6.20^{bcd} \pm 1.54$
PTFD	$6.00^{cde} \pm 1.34^{cde}$	$6.50^{ab} \pm 0.76$	$6.55^{abc} \pm 0.82$	$6.15^{ab} \pm 1.14$	$6.00^{a} \pm 1.25$	$5.70^{a} \pm 1.75^{a}$	$5.95^{a} \pm 1.57$	$5.95^{a} \pm 1.47$	$6.35^{bcd} \pm 1.04$
PTFE	$6.90^{b\ c} \pm 1.65^{bc}$	$7.20^{a} \pm 1.15$	$7.15^{a} \pm 1.04$	$6.95^{a} \pm 1.70$	$6.25^{a} \pm 1.71$	$6.35^{a} \pm 1.38^{a}$	$6.65^{a} \pm 1.78$	$6.35^{a} \pm 1.66$	$7.25^{ab} \pm 1.33$
GRFW	$8.40^{a} \pm 0.99^{a}$	$7.30^{a} \pm 1.38$	$6.70^{ab} \pm 1.89$	$6.90^{a} \pm 1.80$	$6.45^{a} \pm 2.09$	$5.50^{a} \pm 2.704^{a}$	$6.40^{a} \pm 2.21$	$7.10^{a} \pm 2.19$	$7.40^{a} \pm 1.42$

Values are means ± standard deviation of 20 panelists. Values with different superscripts on the same column are significantly ($p < 0.05$) different.
Key: TFAA = 1000 ml tamarind fruit juice fermented with isolate from palm wine; TPFA = 900 ml tamarind + 100 ml passion fruit fermented with isolate from palm wine; TPFB = 800 ml tamarind + 200 ml Pasion fruit fermented with isolate from palm wine; TPFC = 700 ml tamarind + 300 ml passion fruit fermented with isolate from palm wine; TPFD =600 ml tamarind + 400 ml passion fruit fermented with isolate from palm wine; TPFE = 500 ml tamarind + 500 ml passion fruit fermented with isolate from palm wine; PFAA = 1000 ml passion fruit fermented with commercial brewer's yeast; PTFA =900 ml tamarind + 100 ml passion fruit fermented with brewer's yeast PTFB= 800 ml tamarind + 200 ml passion fruit fermented with brewery's yeast; PTFC = 700ml tamarind + 300mlpassion fruit fermented with brewery's yeast; PTFD = 600ml tamarind +400 ml passion fruit fermented with brewer's yeast; PTFE = 500 ml tamarind +500 ml passion fruit fermented with brewer's yeast; GRFW = Commercial grape fruit wine (control).

5. CONCLUSION

From the study, it could be deduced that formulating wine from the blends of tamarind and passion fruit fermented with *Saccharomyces cerevisae* from two different sources (isolate from palm wine and commercial brewer's yeast) had a high acceptability (in terms of taste, aftertaste, flavor, mouth feel and clarity). The quantity of alcohol by volume (ABV) produced in the blend of the same ratio (fermented with isolate from palm wine as well as commercial brewer's yeast.) had similar pattern of alcohol produced except for the fruit with no blend (100 % tamarind and 100% passion fruit) showing a variation in the volume of alcohol produced.

Significance statement

This research implies that the microorganism, *Saccharomyces cerevisae* either in the freshly isolated form from the palm wine or in the freeze-dried form has the same alcohol production capacity. The methanol content of the formulated wine fell in the range of 0.042 to 0.039 mg/L, which was below the permissible standard value of NAFDAC (0.05 mg/L), thereby making the formulated wine safe for consumption.

Acknowledgement

The authors appreciate Professor Kayode Paul Baiyeri, Department of Crop Science, University of Nigeria, Nsukka, Enugu State and Dr· Okorie Okoro Ndukwe of the Department of Crop Science and Horticulture, Faculty of Agriculture, Nnamdi Azikiwe University, Awka, Anambra State, all in Nigeria, West Africa, for the supplies of the passion fruits.

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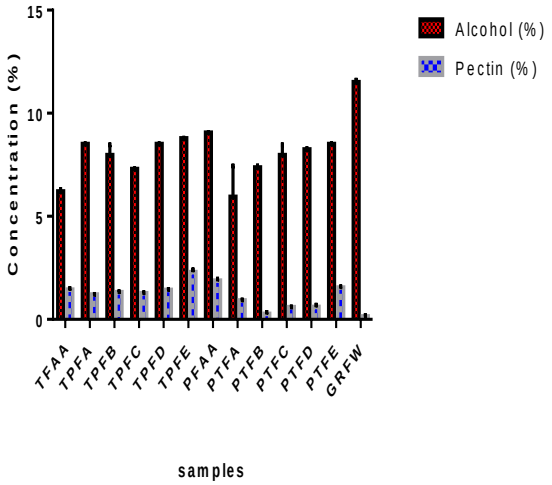

Figure 4. Alcohol and Pectin content of the formulated table wine from the blends of tamarind and passion fruit.

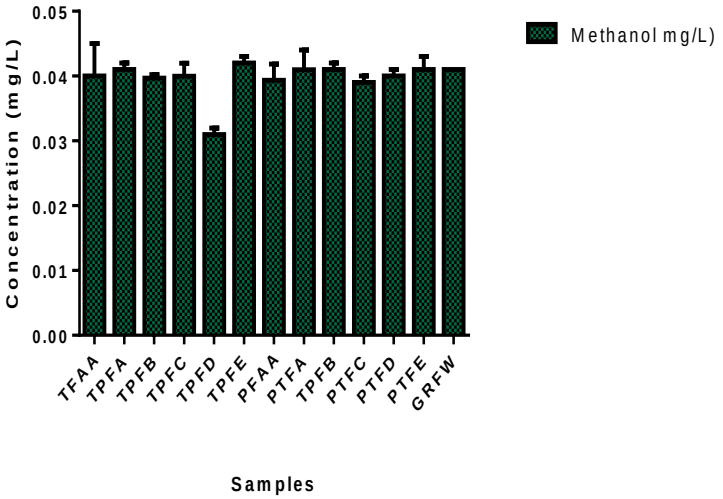

Figure 5. Methanol content of formulated table wine from the blend of tamarind and passion fruit

NUTRITIONAL ALTERATIONS OCCASIONED BY DRYING OF *STERCULIA TRAGACANTHA* IN ITS USE AS A TRADITIONAL SOUP COMPLEMENT, *POBOLO,* IN SOUTH WESTERN NIGERIA.

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ABSTRACT

The study investigated the possible nutritional alterations that drying can have on the quality characteristics of *Sterculia tragacantha*, otherwise known as 'Pobolo' vegetable. The purchased apical shoots were washed and a part was blended, packaged and stored in its fresh form while the other part was dried at 60 °C till a constant weight was obtained, blended and stored. Both samples were analysed for proximate, minerals and vitamin compositions. It was observed that drying decreased the moisture, ash and crude fibre content of the shoots. However, the fat and protein contents increased with drying by 6% and 55.2% respectively. Calcium, Phosphorus and Zinc contents increased with drying while the Iron, Magnesium and Potassium contents reduced. This preliminary study showed that no considerable loss of nutrients was recorded by oven drying *S. tragacantha* at 60°C. The amount of nutrients retained is still valuable to the communities that enjoys the vegetable as a local cuisine.

Keywords: *Sterculia, traditional cuisine, vegetable, drying.*

1. INTRODUCTION

Vegetable can be referred to as all the parts of plant that can be used to accompany main dishes or eaten alone as snack majorly for their micronutrients values (Achigan-Dako *et al.* (2010). Leafy vegetables are good sources of nutrients with many health benefits due to the presence of some unique compounds known as phytonutrients (Okeno et al. 2003). Traditional leafy vegetables are indigenous and at times exotic species whose aerial parts or leaves have been incorporated into local food habits, customs and knowledge systems of specific communities and have been used as food over a long time. (Achigan-Dako *et al.* (2010).

Sterculia tragacantha, commonly called African tragacanth and usually described as a deciduous shrub, is a medium sized tree that grows to about 5-12 m tall. It is one of the over 300 species of the Sterculiaceae family and is found mainly in the warm areas, that is the tropical regions of the world (Dennis et al. 2002, Orisakeye et al. 2014). Traditionally, it is used for treating pain, malaria, diarrhoea, edema, gout, whitlow, diabetes, cold and infectious diseases due to its antioxidants, anti-inflammatory, neuroprotective mosquitocidal, antimicrobial activities amongst others (Olukanni et al. 2021).

The freshly growing shoots and leaves are often cooked and consumed as 'drawing' leafy vegetables in some tropical African countries like Nigeria, Benin e.t.c. (Schmelzer, 2008; Etukudo, 2003). There is limited information on its utilization as food even though in South-Western Nigeria, some towns (Imesi-Ile, Otan-Ile and Esa-Oke, all in Osun State) cook the apical shoots of the tree as vegetable soup. Preliminary investigations have revealed an encouraging proximate, minerals and vitamins compositions as well as the secondary metabolites contents of the apical shoots (Okon et al. 2018).

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Drying can be described as a process that uses heat to remove water from food material through vaporization (Cruz *et al.,* 2015). It is one of the oldest methods that have been adopted for the purpose of food preservation and this is achieved by reducing the water activity as well as the water content of the food thus extending its shelf-life, ease of storage and transportation (Guine *et al.,* 2008*;* Guine, 2010). Some of the different drying methods known are solar drying, hot air convection drying, spray drying, lyophilization, osmotic drying, microwave drying etc. (Guiné, 2018). Factors such as the thickness, vapor pressure of food, surface of food exposed to the heat, air velocity and temperature can affect the drying rate of food materials (Muliterno *et al.* 2017).
Several research studies have been published on the pharmacological, nutraceutical, phytochemical potentials of the matured leaves of *Sterculia tragacantha* (Okon et al. 2018; Onikanni et al. 2021; Mogbojuri et al 2015). In spite of the existence of this vegetable in South-Western Nigeria, there is limited information on the utilization of this plant as food. The seasonal variability has also been reported, hence there is the need for preservation during the peak season for availability when in off-season. Therefore, this study sought to establish the effect of drying on the quality parameters of this local cuisine.

2. MATERIALS AND METHODS

2.1. Materials

Apical shoots of *Sterculia tragacantha* were purchased from a local market in Imesi-Ile, Osun State, Nigeria.

2.2. Methods

2.2.1. Sample preparation

The purchased apical shoots were washed and then divided into two parts; the first part was blended, packaged and stored in a freezer for further analyses; the second part was dried in a hot air oven (Biobase BOV-T140C, China) at 60 °C until a constant dry weight was obtained. It was then blended and stored in an air tight polyethene bag and kept for further analyses.

2.2.2. Proximate analysis

The moisture, fat, crude fibre, protein and ash content of the samples were determined according AOAC (2004).

2.2.3. Mineral analysis

The Calcium, Potassium, Magnesium, Phosphorus, Zinc and Iron contents were determined using the method of AOAC (2005).

2.2.4. Vitamin analysis

Vitamins A, B-1, B-2 and Folate contents were determined using AOAC (2005).

2.2.5. Statistical Analysis

The means and standard deviations of data obtained were calculated using Microsoft Excel (Microsoft Office, 2019).

3. RESULTS AND DISCUSSION

3.1. Effect of Drying on Proximate Composition

The proximate composition values obtained for the fresh and dry apical shoots of *S. tragacantha* shoots were compared with values reported for some leafy vegetables. It was observed that drying decreased the moisture content of the shoots by 85.8%. Ash and fat contents also decreased by 11.9% and 34.2% respectively. Crude fibre and protein content increased with drying by 6% and 55.2% respectively.

The moisture content of fresh *S. tragacantha* compared favourably with values reported for *G. africanum, L. guineensis,* and *V. amygdalina* by Mih *et al.* (2017). Drying reduced moisture content by 85.8%. The low moisture resulting from drying is indicative of the ability of the vegetable to have extended storage without fear of deterioration. According to Emelike and Akusu (2020), dried leafy vegetables have better shelf stability than fresh ones.

Crude protein value increased with drying by 55.2%. The values obtained for both fresh and dried *S. tragacantha* leaves were slightly lower than the values reported by Emelike and Akusu (2020) for *Moringa oleifera* but higher than the values reported by Oni *et al.* (2015) for *Talinum spp* and *Amaranthus hybridus*. Vegetables are reportedly good sources of protein and can be effective in combatting protein-energy malnutrition particularly in low-income communities.

Fat content reduced by 34.2%. The fat content of fresh *S. tragacantha* leaves was higher than the values reported for *Talinum spp* and *A. hybridus* but lower than the values for *Moringa oleifera* as documented by Emelike and Akusu (2020). According to Ogundele *et al.* (2019), reduction in fat due to temperature may be due to oxidative reactions taking place during drying. Low fat contents are indications of the storage stability of food powders, i.e., the dried leaves have low susceptibility to spoilage during storage.

Crude fibre increased by 6% and the values obtained are higher than the values reported for dried Moringa leaves. Vegetables are rich sources of fibre which is known to confer health benefits on consumers particularly in aiding bowel movement, adding bulk to food etc. The fibre content obtained in this study was higher than the values reported for several vegetables (Kiremire *et al.*, 2010; Emelike and Akusu, 2020) because the apical shoots (peculiar to "Pobolo") had more of tender stalks than leaves in them.

3.2. Effect of drying on vitamin and mineral composition

Liman *et al.* 2014, in a study of effect of drying on mineral composition of some leafy vegetables reported that bitter leaf had greater nutrient retention ability when oven dried, in comparison with other vegetables. The values obtained in this study for calcium, magnesium, potassium, phosphorus of *S. tragacantha* were higher than values reported for Spinach, Drumstick and Bitter leaf. According to Kiremire *et al.* (2010), drying caused a reduction in the nutritional composition of foods especially vitamins as a result of oxidation that is hastened by heat, light and oxygen associated with the drying process. However, the degree of reduction is dependent on the duration of exposure to the heat treatment. Hot air drying (Oven drying) was regarded as the best probably due to the controlled nature of the drying process.

Vegetables are said to be rich in Calcium, providing about 100 – 150 mg/100g. The value obtained for calcium in this study (202 – 320 mg/100g) is significantly higher than that reported for Kale, broccoli and water cress by Cormick and Belizan (2019). According to Sunday and Hartline (2012), calcium aids in the contraction of muscles, development of bione and teeth, blood clotting and maintaining of fluid balance within the body. When compared with *Cucumis sativus* L and *Solanum nethiopicum* L. obtained from South-East Nigeria, *S. tragacantha* had high values of Ca, K and Zn.

Iron from plant sources is particularly of great importance in areas where animal protein is out of the economic reach of individuals or areas where vegetarian culture is predominant.

According to Buvka *et al.* (2019), iron content of vegetables ranged from 0.63 – 10.7 mg/100g with that of spinach being the highest and zucchini being the lowest. The value obtained for *S. tragacantha* clearly falls within this range.
The value obtained for zinc increased with drying by 76.4%. Zinc has been associated with the metabolism of macronutrients as well as energy in the body (Sunday and Hartline, 2012).
Potassium content decreased with drying by 11.7%. Potassium has been reported to be relatively stable to heat since it is a cation that is not easily susceptible to polarization rather it forms oxides when exposed to light and air (Liman *et al.*, 2014).
Magnesium is reported to be a requirement as co-enzyme in the various enzymatic reactions that take place in the body (Mih *et al.*, 2017)

Table 1. Proximate composition of fresh and dried *S. tragacantha*

Proximate (%)	**Fresh *S. tragacantha***	**Dried *S. tragacantha***
Moisture	73.14 ± 0.04	10.39 ± 0.39
Ash	15.63 ± 0.00	13.76 ± 0.02
Fibre	47.11 ± 0.11	50.10 ± 0.00
Fat	3.05 ± 0.04	2.00 ± 0.00
Protein	10.66 ± 0.05	23.81 ± 0.03
Carbohydrate	24.55 ± 1.70	10.33 ± 0.01

Table 2. Mineral composition of fresh and dried *S. tragacantha*

Minerals (mg/100g)	**Fresh *S. tragacantha***	**Dried *S. tragacantha***
Calcium (Ca)	202.52 ± 1.35	320.42 ± 1.34
Iron (Fe)	4.25 ± 0.41	2.60 ± 0.02
Magnesium (Mg)	19.25 ± 0.06	10.44 ± 0.82
Phosphorus (P)	0.99 ± 0.01	1.08 ± 0.02
Potassium	513.84 ± 4.00	453.60 ± 3.23
Zinc (Zn)	0.42 ± 0.03	1.79 ± 0.05

Table 3. Vitamin A, B-1, B-2, and folate contents of fresh and dried *S. tragacantha*

Vitamin (mg/100g)	**Fresh *S. tragacantha***	**Dried *S. tragacantha***
Vitamin A	4.85 ± 0.30	4.25 ± 0.04
Vitamin B-1	0.14 ± 0.02	0.42 ± 0.01
Vitamin B-2	0.67 ± 0.04	0.21 ± 0.03
Folate (µg/100g)	98.79 ± 0.19	71.62 ± 0.46

Figure 1. *S. tragacantha* pre-harvest

Figure 2. *S. tragacantha* post-harvest

Figure 3. *Pobolo* Soup

3. CONCLUSION

Preservation still remains a tool in driving food security. Thus, any preservation method that will ensure availability of foods during off-peak seasons without compromising the nutritional quality of the food material is worthy of exploration.

This preliminary study has revealed the potential of dried *S. tragacantha* as food as it competes favourably with other known vegetables. Its use as a local cuisine can be further explored.

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INFLUENCE OF PASTEURIZATION, SULPHITING AND ADDITION OF YEAST ISOLATE TO MUST ON THE MICROBIOLOGICAL AND BIOCHEMICAL PRODUCTION OF WINE FROM OVER RIPE PLANTAIN

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ABSTRACT

Wine is essential in every celebration but it is very expensive in countries where grape is not grown. *Agadagidi*, an effervescent wine analogue with sweet-sour taste is locally produced from overripe plantain which is abundant in the Tropics. This research produced *agadagidi* by sulphiting the must with or without inoculating with *Saccharomyces cerevisiae* isolated from spontaneous fermentation. Some of the samples were also pasteurized with a view to producing *agadagidi* with consistent quality. Microorganisms were enumerated, isolated and identified during storage, sugars, pH, TTA and sensory properties were also assessed using standard methods. The result showed that the range of TVC, LAB, and fungi count were 5.571 – 9.076 log cfu/ml, 2.717- 9.253 log cfu/ml and 4.079 - 9.418 log cfu/ml respectively. Microorganisms isolated were *Saccharomyces cerevisiae, Saccharomyces bayanus, Pichia kluyveri, Candida albicans, Bacillus pumilus, Lactobacillus plantarum, Bacillus subtilis* and *Leuconostoc oenos*. The reducing sugar was higher in unpasteurized samples than pasteurized sample at the beginning of storage. Total sugar generally decreased while the TTA increased during storage. The sensory score showed that all unpasteurized samples and pasteurized sample without isolate and sulphite were accepted by the panelists. This study therefore suggests the use of sulphite with or without starter culture in the production of *agadagidi* with consistent quality.

Keywords: *Microorganisms, sulphiting, pasteurization, agadagidi, sugar, sensory properties*.

1. INTRODUCTION

Wine is an alcoholic beverage produced from grape and fruits such as mango, pineapple, banana, plantain and other fruits that contain adequate level of fermentable sugars by spontaneous or controlled fermentation. It contains esters, sugar, aldehyde, tannin, pectin, acid (malic, tartaric and citric acid) vitamin and minerals (Amerine et al., 2012; Zubia and Dizon, 2019).

Plantain (*Musa paradisiaca*) is produced in abundance in West Africa, but due to high temperature, poor storage facilities and transportation, about 40% get spoilt before getting to market (Odemero, 2013). *Agadagidi* is West African Indigenous wine produced from overripe plantain by fermenting the must for 72 h and filtering thereafter. It has a cloudy appearance, it is effervescent and has sweet-sour taste (Omojasola et al., 2012).

Important microorganisms associated with locally fermented foods are lactic acid bacteria and yeast. They may be the natural microbial flora of the substrate or starter culture (De Vuyst and

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Leroy, 2016; Malomo and Popoola, 2020). Yeasts which are part of natural microbial flora of fruit take part in the production of wine by producing metabolic substances and intermediate products that impact the final quality of wine positively or otherwise (Cioch-Skoneczny et al., 2021). Some of the wild yeast isolated from fermentation of wine are Candida, Cryptococcus, *Debaryomyces, Kluyveromyces, Pichia, Rhodotorula, Saccharomycodes, Schizosaccharomyces, Torulaspora and Zygosaccharomyces* (Pretorius et al., 2017). Yeast metabolizes sugar present in wine through glycolysis which is the process that convert glucose to pyruvate. Pyruvate is later converted to acetaldehyde by enzyme alcohol dehydrogenase and also give off carbondioxide in the absence of oxygen (Alcamo and Warner, 2010; Zubia and Dizon, 2019). Wine is sulphited to keep out microorganisms in order to prevent them from interfering with the activity of *Saccharomyces cerevisiae* or produce undesirable substances that may have negative effect on the desired quality (Kreiger – Weiber et al., 2020). Pasteurization reduces the population of spoilage and pathogenic microorganisms in food but thermophilic microorganisms and spore of bacteria are not affected (Onaolapo and Busari, 2014).

Many works have been done (Adedeji and Abiose, 1994; Omojasola, 2012; Oriola and Boboye, 2018; Ajit et al., 2018) on *agadagidi* but there is dearth of information on pretreatment of *agadagidi* must before fermentation. This research studied the effect of pasteurization with or without addition of isolate or sodium metabisulphite on the microbiological and biochemical characteristics of *agadagidi*.

2. MATERIALS AND METHODS

2.1. Source of materials

Plantain was purchased from new market, Ile-Ife, Nigeria. Media and chemical used were of analytical grade

2.2. Preparation of plantain wine (*Agadagidi*) using natural fermentation

Overripe plantains were cleaned to remove extraneous materials and peeled. The pulps were homogenized in portable water at ratio of 1:5 (w/v) using blender, the mixture was dispensed into plastic container, covered and fermented spontaneously for 72 h. The fermented must was filtered with clean muslin cloth. (Omojasola *et al*., 2012). Yeast was isolated from the sample for further use in controlled fermentation using the scheme described by Harrigan (1998).

2.3. Isolation of yeast isolate

Agadagidi (5 ml) was homogenized in peptone water and appropriate dilution was dispensed into petridish. Molten potato dextrose agar was poured, allowed to solidify and incubated at 27 ^{o}C for three days. Colony obtained was streaked on potato dextrose agar and the pure isolate obtained was restreaked on slant agar in Macartney bottle. The isolate was viewed under the microscope, carbon assimilation and nitrite assimilation were also assessed. The pure isolate of *Saccharomyces cerevisiae* obtained was washed with 15 ml of sterile distilled water and centrifuged at 5000 rpm for 15 min. The cells pellet obtained was washed and centrifuged the second time and diluted to 10^{7} cfu/ml (Modified method of Oriola and Boboye, 2018).

2.4. Preparation of plantain wine *(Agadagidi)* using controlled fermentation

Overripe plantains were cleaned and peeled. The pulps were homogenized in portable water at the ratio of 1:5 (w/v) using blender, the must was divided into six portions of 250 ml each; AA serve as the control, 0.1% sodium metabisulphite was added to AS, 10 ml of yeast isolate and 0.1% sodium metabisulphite was added to AIS, PA was pasteurized at 70 ^{o}C for 15 min, PAI was pasteurized at 70 ^{o}C for 15 min and 10 ml of yeast isolate was added; and PAIS was

pasteurized at 70 ^{o}C for 15 min, 10 ml of yeast isolate and 0.1% sodium metabisulphite was added and each must was fermented for 24 h and filtered with sterile muslin cloth. Each filtrate was dispensed into sterile plastic bottle, covered and stored at room temperature for three weeks.

2.5. Microbiological analysis

Agadagidi (5ml) was homogenized in 45 ml of peptone water and the mixture was diluted appropriately. The representative dilution of each *agadagidi* sample was dispensed into sterile petri dish and about 20 ml of molten nutrient agar was poured for total viable count, De Man Rogosa and Sharpe agar for lactic acid bacteria and potato dextrose agar for fungi count and plates were incubated at 35 ^{o}C for 24 h, 35 ^{o}C for 48 h and 27 ^{o}C for 3-5 days respectively. The resulting colonies were counted using colony counter and pure isolates were obtained by streaking colonies on solidified agar. Each pure isolate obtained were transferred into separate Macartney bottles and stored at 4 ^{o}C (Harrigan, 1998; Malomo, 2018). Bacteria isolates were identified base on the cultural and morphological characteristic, Gram's staining reaction and biochemical tests (Harrigan, 1998). Yeast isolate were identified using colony characteristics, mode of reproduction, ability to assimilate carbon and nitrate (Barnett *et al*., 2000). Mould isolates were identified using the colour of growth on agar and microscopic (Leica DM500 13613210) characteristics such as hyphae, type of spores, mode of reproduction and special structures (Harrigan, 1998).

2.6. Determination of total reducing sugar of *agadagidi*

Agadagidi was filtered with whatman 1 filter paper and the filtrate (1 ml) was dispensed into test tube. Dinitrosalicyclic acid reagent (2 ml) was added and boiled for 5 min at 100 °C in Gallenkamp water bath (Gallenkomp, HH-S6, England). The test tube was cooled under running water and 7 ml of distilled water was added. Absorbance was read against reagent blank at 540 nm in a UV Spectrophotometer (Spectrumlab 752S, YM1206PHB2, China). Reducing sugar in each *agadagidi* sample was extrapolated from a standard curve of known concentrations of glucose (0-1000 µg/ml) (Adepoju *et al*. 2016).

2.7. Determination of total sugar of agadagidi

Total sugar was determined using anthrone reagent method of Morris (1948) described by Malomo *et al*. (2021). Each *Agadagidi* sample was filtered with Whatman 1 filter paper and the filtrate (1 ml) was dispensed into test tube. Anthrone reagent (4 ml containing 50 mg of anthrone and 1 g of thiourea in 100 ml of 66% sulphuric acid) was added and heated in a boiling water bath (Gallenkomp, HH-S6, England) for 10 min and rapidly cooled. Absorbance was read at 620 nm against blank using a spectrophotometer (Spectrumlab 752S, YM1206PHB2, China). The quantity of total sugar was obtained from the standard curve of known concentrations of glucose (10-100 mg/l).

2.8. Determination of pH

Each *agadagidi* sample (20 mL) was dispensed into a glass beaker and pH was determined by inserting the electrode of pH meter after standardization with buffer solutions with pH 4 and pH 7. Values displayed on the screen was recorded (AOAC, 2000).

2.9. Determination of Total Titratable Acidity (TTA)

Sample (10 ml) was dispensed into a conical flask, diluted with 10 ml of distilled water and 2 drops of phenolphthalein indicator was added. The mixture was titrated against 0.1 N NaCl until the colour changed to pink (AOAC, 2000). Titratable acidity values were calculated as:

$$\% \text{ Tartaric acid} = \frac{\text{Volume of NaOH} \times 0.1 \times 7.5}{Weight\ of\ sample} \quad \text{eq1}$$

2.10. Sensory evaluation

Panelist (20) who are familiar with the taste of *agadagidi* were asked to evaluate the sample for colour, aroma, taste, appearance and overall acceptability using. 9-point Hedonic scale (9 = like extremely, 8 = like very much, 7 = like moderately, 6 = like slightly, 5 = neither like nor dislike, 4 = dislike slightly, 3 = dislike moderately, 2 = dislike very much, 1 = dislike extremely) (Montgomery, 2004).

2.11. Statistical analysis

Difference in mean of data obtained was evaluated using analysis of variance (ANOVA) on EXCEL (2018) and SPSS (2010). Sensory data was analyzed using principal component analysis on XLSTAT (2014).

3. RESULTS AND DISCUSSION

3.1. Changes in microorganisms during storage of *agadagidi*

The total viable count (TVC) of *agadagidi* is shown in Table 1. TVC generally increased from 3.311 – 6.834 log cfu/ml at the beginning of storage to 5.571 – 9.076 log cfu/ml at the end of storage. Unpasteurized must fermented with sodium metabisulphite (AS) had the lowest TVC of 3.311 log cfu/ml followed by must pasteurized (PA) before fermentation with 4.135 log cfu/ml at the beginning of storage. Addition of isolate significantly increased ($P < 0.05$) the total viable count of AIS, PAI and PAIS at week zero. PA had the highest count from week one to week three while AS had the lowest from week zero to week three. This showed that sulphiting significantly reduced ($P < 0.05$) the TVC in both pasteurized and unpasteurized samples during storage. The reduction could be probably due to effect of sulphite on the microorganisms and the deactivation of microorganisms that could interfere with fermentation using high temperature. The highest count observed in PA could be due to survival of vegetative cells or germination of spores after pasteurization and the absence of chemicals or colonization with isolate that will reduce the growth of wild microorganisms. Pasteurization has been reported to inhibit spoilage microorganisms in food but not active against the spores; vegetative cell of thermophilic microorganisms can still survive pasteurization temperature (Onaolapo and Busari, 2014). Addition sulphite to wine inhibit wild yeast and selectively allow *Saccharomyces cerevisiae* to grow and ferment wine to give it its desirable quality (Costantini et al., 2009).

Lactic acid bacteria count generally increased from 2.717 – 5.272 log cfu/ml at the beginning of storage to 5.021 - 9.253 cfu/ml at the end of storage. Pasteurization and addition of sulphite generally reduced the initial lactic acid bacteria counts. There was no significant difference ($P > 0.05$) in the LAB count of samples AS and AIS from week 2 to week 3 showing that the LAB isolated from the unpasteurized samples

Table 1. Changes in microbial population (log cfu/ml) during the storage of *Agadagidi*

	Storage (weeks)			
Sample	**0**	**1**	**2**	**3**
Total viable count				
AA	$6.832^{a}\pm0.213$	$5.932^{c}\pm0.059$	$4.445^{d}\pm0.062$	$8.300^{b}\pm0.113$
AS	$3.311^{e}\pm0.159$	$3.518^{e}\pm0.071$	$4.109^{e}\pm0.124$	$7.825^{c}\pm0.049$
AIS	$6.266^{ab}\pm0.3`8$	$5.123^{d}\pm0.156$	$4.141d^{e}\pm0.098$	$7.536^{bc}\pm0.044$
PAI	$5.365^{c}\pm0.146$	$7.716^{b}\pm0.226$	$5.164^{c}\pm0.079$	$5.571^{e}\pm0.116$
PAIS	$5.375^{c}\pm0.191$	$7.678^{b}\pm0.236$	$5.485^{b}\pm0.120$	$7.345^{d}\pm0.004$
PA	$4.135^{d}\pm0.039$	$9.787^{a}\pm0.997$	$8.222^{a}\pm0.032$	$9.076^{a}\pm0.101$
Lactic acid bacteria count				
AA	$4.277^{b}\pm0.185$	$6.068^{d}\pm0.091$	$7.582^{a}\pm0.170$	$5.021^{c}\pm0.016$
AS	$2.717^{c}\pm0.033$	$6.858^{c}\pm0.122$	$7.468^{ab}\pm0.046$	$5.881^{b}\pm0.150$
AIS	$3.452^{bc}\pm0.213$	$7.599^{b}\pm0.157$	$6.997^{ab}\pm0.008$	$5.992^{b}\pm0.120$
PAI	$5.382^{a}\pm0.056$	$5.741^{d}\pm0.072$	$5.931^{c}\pm0.079$	$5.131^{c}\pm0.059$
PAIS	$5.272^{a}\pm0.054$	$6.077^{d}\pm0.103$	$6.760^{abc}\pm0.099$	$6.038^{b}\pm0.054$
PA	$3.879^{b}\pm0.460$	$8.306^{a}\pm0.052$	$6.567^{bc}\pm0.556$	$9.253^{a}\pm0.126$
Fungi count				
AA	$6.824^{a}\pm0.115$	$7.246^{a}\pm0.076$	$6.723^{a}\pm0.035$	$8.423^{b}\pm0.01$
AS	$6.779^{a}\pm0.011$	$7.411^{a}\pm0.043$	$6.016^{a}\pm0.018$	$8.024^{b}\pm0.052$
AIS	$6.795^{a}\pm0.036$	$7.382^{a}\pm0.084$	$6.089^{a}\pm0004$	$8.271^{b}\pm0.042$
PAI	$5.463^{b}\pm0.120$	$6.691^{b}\pm0.209$	$5.989^{a}\pm0.002$	$8.091^{b}\pm0.016$
PAIS	$5.480^{b}\pm0.099$	$6.825^{b}\pm0.038$	$6.368^{a}\pm0.345$	$8.150^{b}\pm0.014$
PA	$4.079^{c}\pm0.018$	$7.501^{a}\pm0.042$	$6.575^{a}\pm0.487$	$9.418^{a}\pm0.378$

AA- *Agadagidi*; AS-*Agadagidi* and sulphite, AIS- *Agadagidi*, isolate and sulphite, PAI- Pasteurized *agadagidi*, isolate, PAIS- Pasteurized *Agadagidi*, isolate and sulphite, PA- Pasteurized *agadagidi*, Values are means ± standard deviation, values in the columns with the same superscripts are not significantly different at $P > 0.05$

could withstand sulphiting (Table 1). This is very important because of malo-lactic fermentation which is usually allowed in some type of wine. LAB are important in wine production because of their ability to breakdown protein by producing proteolytic enzymes thereby reducing haziness (Virdis et al., 2021). Three genera of lactic acid bacteria namely, *Lactobacillacea, Streptococcaceae* and *Pediococcus*, has been reported to associate with grape, musts or wine (Costantini *et al*., 2009).

Fungi count ranged between 4.079 and 9.418 log cfu/ml during the period of storage (Table 1). It was lowest in PA (4.079 log cfu/ml) and highest in AA (6.824 log cfu/ml) at the beginning of storage. There was no significant difference ($P > 0.05$) between the fungi count of all the unpasteurized samples AA, AS, and AIS throughout the period of storage. PA had the lowest count (4.079 cfu/ml) at the beginning of storage and count was significantly different ($P < 0.05$) from other pasteurized samples PAI and PAIS at the beginning and the end of storage. PA had the highest count which was significantly different ($p > 0.05$) from other *agadagidi* samples at week three (9.418 log cfu/ml). This result showed that the *Saccharomyces cerevisiae* isolated from naturally fermented *agadagidi* was not significantly affected by sulphiting and the lowest fungi count recorded in PA showed that most fungi cannot withstand pasteurization temperatures. Saccharomyces which is mostly involved in natural fermentation of wine has been reported to possess ability to colonize wine environment during fermentation and it is not affected by sulphiting (Virides et al., 2021).

3.2. Microorganisms isolated from *agadagidi*

The microorganisms isolated from *agadagidi* were *Saccharomyces cerevisiae, Lactobacillus plantarum, candida albicans, Bacillus subtilis, Leuconostoc mesenteroides, Bacillus pumilus* and *Pichia kluyveri* as shown in Figures 1 and 2. It was dominated by *Saccharomyces cerevisiae* followed by *Lactobacillus plantarum*. All microorganisms isolated were present in all *agadagidi* samples from week zero to week three except Bacillus spp. *Saccharomyces* is important in wine making because of the unique characteristic it possesses. It has high sugar fermentation ability, ability to tolerate high alcoholic content, ability to compete in a medium and colonize wine during fermentation (Andorra et al., 2019). *Pichia kluyveri* has received much attention in wine making and commercially available for wine production because of its ability to improve the quality of wine by producing aromatic substances such as thiols, terpenes and fruity esters during fermentation of glucose. It also produces antimicrobial agent that inhibits spoilage yeasts (Vincente et al., 2021). *Candida s*pp has been shown to produce biofilm in wine and also causes spoilage of wine (Perpetuini, 2021).

Lactic acid bacteria are important in wine production because of the conversion of malic acid to lactic acid which increase the desired wine aroma, impact colour on wine by ability to produce hydroxycinnamic acid from tartaric ester and the ability to break down anthocyanin glucosides. They also improve mouthfeel, stability of microorganisms during fermentation and reduce the acidity of wine (Virdis et al., 2021). *Lactobacillus plantarum* has been shown to induce malolactic fermentation in wine even under the condition of high pH. Their metabolic activity also plays an important role in improving wine aroma which has led to consideration of some strains as part of the starter culture in wine production (Du Toit et al., 2011; Krieger-Weber et al., 2020).

Leuconostoc oenus is also important in malo- lactic fermentation and has been identified in palm wine (Djeni et al., 2021) and in wine produced from watermelon-banana and watermelon-pineapple mixture (Omoya and Akharayi, 2008). *Bacillus subtilis* and *Bacillus pumilus* were in PA, AA and PAI. It has been reported that Bacillus cannot survive in wine containing SO_2 (Von Cosmos et al., 2017).

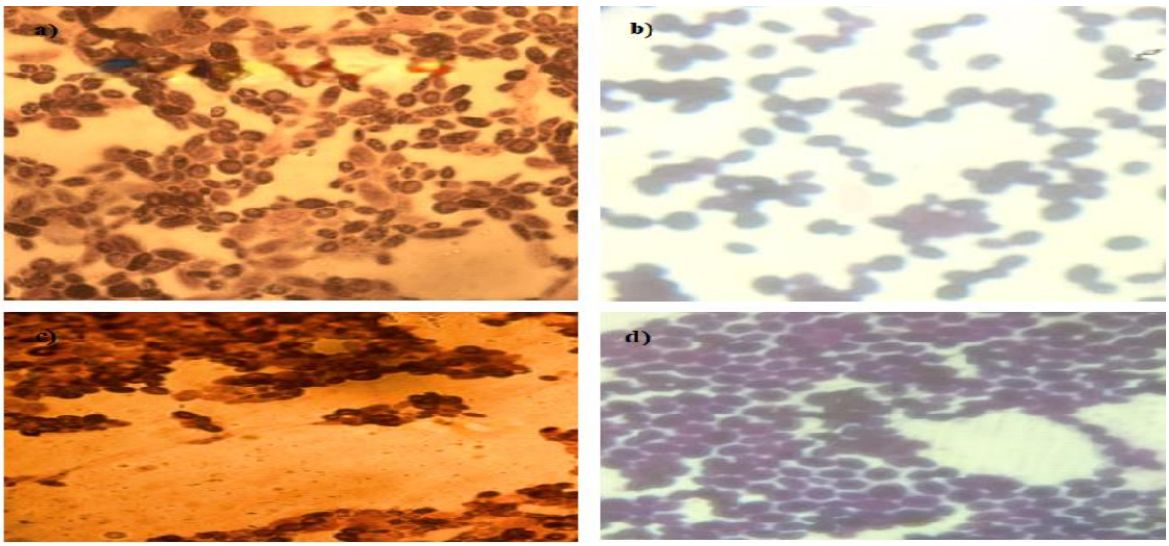

Figure 1. Yeast isolated from *agadagidi* (600 X magnification): a) *Saccharomyces cerevisiae;* b) *Saccharomyces bayanus;* c) *Pichia kluyveri*; d) *Candida albicans*

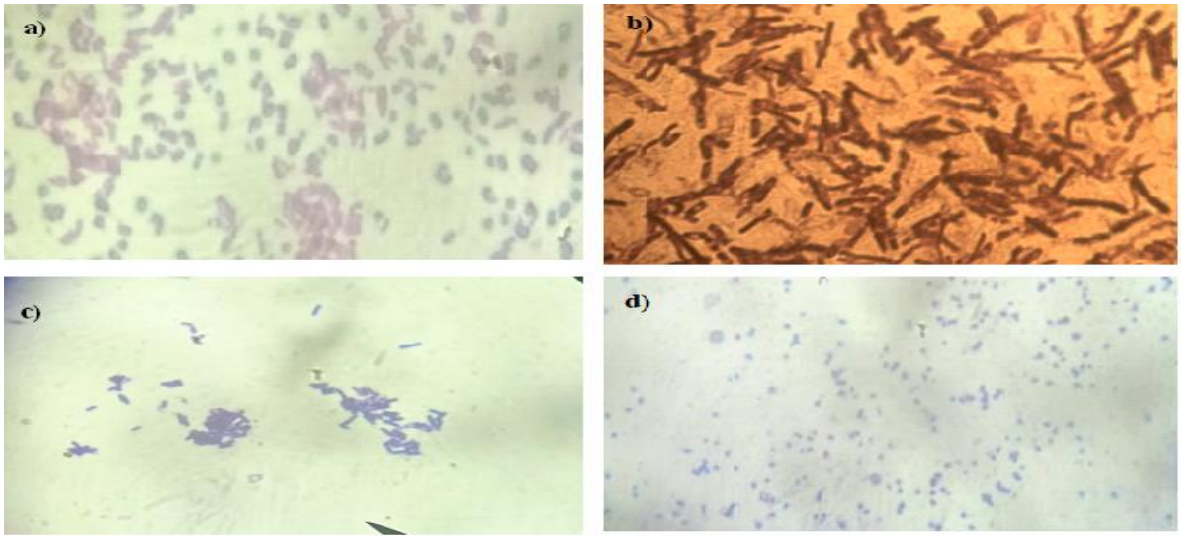

Figure 2**.** Bacteria isolated from *agadagidi* (1000 X magnification): a) *Bacillus subtilis; b) Bacillus pumilus; c) Lactobacillus Plantarum; d) Leuconostoc oenos*

3.3. Total sugar content of *agadagidi*

The total sugar (Figure 3) generally decreased with increase in storage time. Addition of isolate and sulphite affected the utilization of sugars by microorganisms in unpasteurized samples AS and AIS probably due to the lower microbial load. Addition of isolate to PAI and PAIS increased the production of sugar in freshly fermented *agadagidi*. It was highest in AA while PA had the lowest at the beginning of storage. At the end of storage, AS had the highest while PA had the lowest. Low total sugar content of PA could be due presence of pregelatinized carbohydrate that increased the rate of conversion of sugar. The fluctuation of the total sugar content during storage could be due to breakdown of carbohydrate into simple sugars that are utilized by the microorganisms as carbon source to produce metabolite such as acid and ethanol. Diaz et al. (2013) also reported decrease in total sugar with increase in days during fermentation of grape.

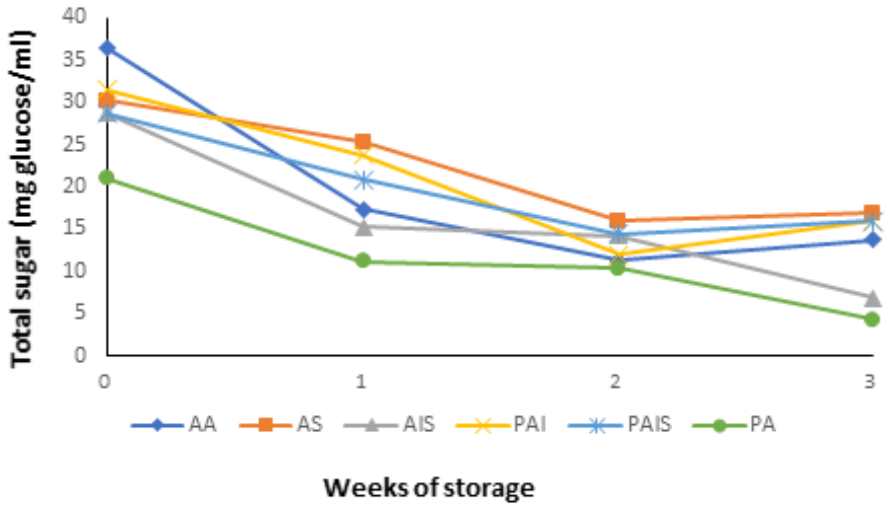

Figure 3. Effect of storage on the total sugar content of *agadagidi*. AA- *Agadagidi*; AS- *Agadagidi* and sulphite, AIS- *Agadagidi*, isolate and sulphite, PAI-Pasteurized *agadagidi*, isolate, PAIS- Pasteurized *Agadagidi*, isolate and sulphite, PA- Pasteurized *agadagidi*.

3.4. Reducing sugar content of the freshly prepared *agadagidi*

The reducing sugar (Figure 4) content of freshly prepared *agadagidi* ranged between (7.864 – 14.341 mg glucose/ml). It was highest in AS and lowest in PA. Sulphiting and addition of yeast isolate increased production of reducing sugar which could be due to hydrolysis of carbohydrate by activities of microorganisms in AS, AIS, PAI and PAIS. Pasteurized samples PA, PAI and PAIS generally had lower total reducing sugar (12.087 – 14.342 mg glucose/ml) than the unpasteurized samples (7.864 – 9.265 mg glucose/ml). This could be due to pregelatization of carbohydrate which increases rate utilization of reducing sugar. The result obtained is in agreement with reducing sugar content of 12.3 mg/ml obtained from spontaneously fermented *agadagidi* (Ajit et al., 2018).

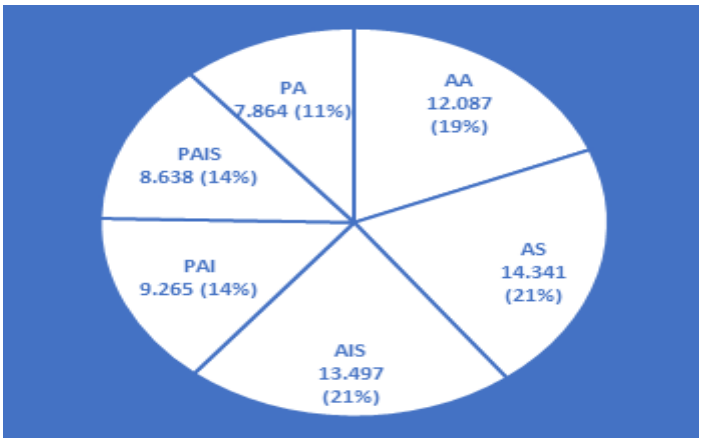

Figure 4. Effect of pasteurization, sulphiting and yeast isolate of must on the reducing sugar content (mg glucose/ml) freshly prepared *agadagidi*. AA- *Agadagidi*; AS-*Agadagidi* and sulphite, AIS- *Agadagidi*, isolate and sulphite, PAI- pasteurized *agadagidi*, isolate, PAIS- Pasteurized *Agadagidi*, isolate and sulphite, PA- Pasteurized *agadagidi*.

3.5. pH and Titratable acidity (TTA) content of *agadagidi*

The pH ranged between 5.28 and 5.39 at the beginning of storage (Figure 5). It increased in all samples at week 2 but then decreased progressively from week two to week three. AA had the lowest pH value range of 5.25 – 6.21 followed by PA with 5.28 – 6.21 during storage. Inoculation and sulphiting generally increased the pH of the samples. The TTA increased with increase in storage time as shown in Figure 6. TTA was within the range 0.59 – 0.60% at week zero. It was highest in PA (0.60%) and AS (0.60%) followed AA (0.59%) at the beginning of storage and was generally lower in inoculated samples AIS, PAI and PAIS (0.38 – 0.53%) than uninoculated samples AA, AS and PA (0.59 – 0.60%). It increased progressively in all samples and the values were higher in uninoculated samples AA, AS and PA than AIS, PAI and PAIS with AA having the highest throughout the period of storage. The values of TTA of *agadagidi* samples was within the range of 6.76 – 8.28 g/l recorded for red wine (Cioch-Skoneczny et al., 2012).

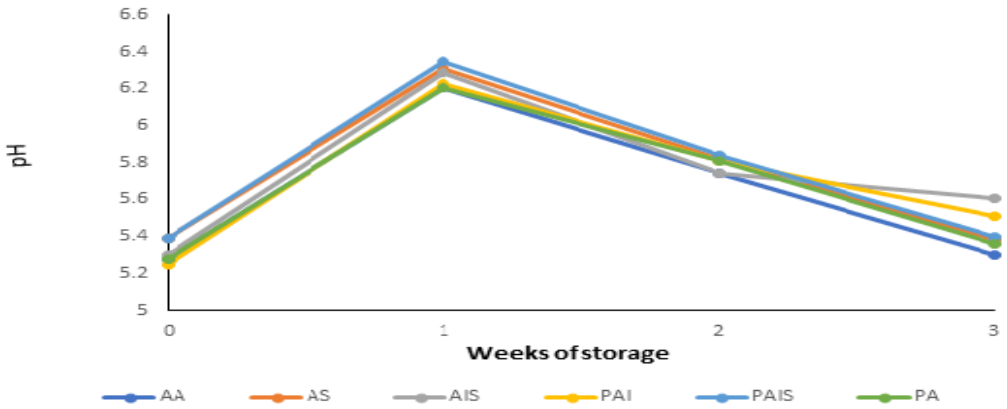

Figure 5. Changes in pH of *agadagidi* during storage. *AA- Agadagidi; AS-Agadagidi and sulphite, AIS- Agadagidi, isolate and sulphite, PAI- Pasteurized agadagidi, isolate, PAIS- Pasteurized Agadagidi, isolate and sulphite, PA- Pasteurized agadagidi.*

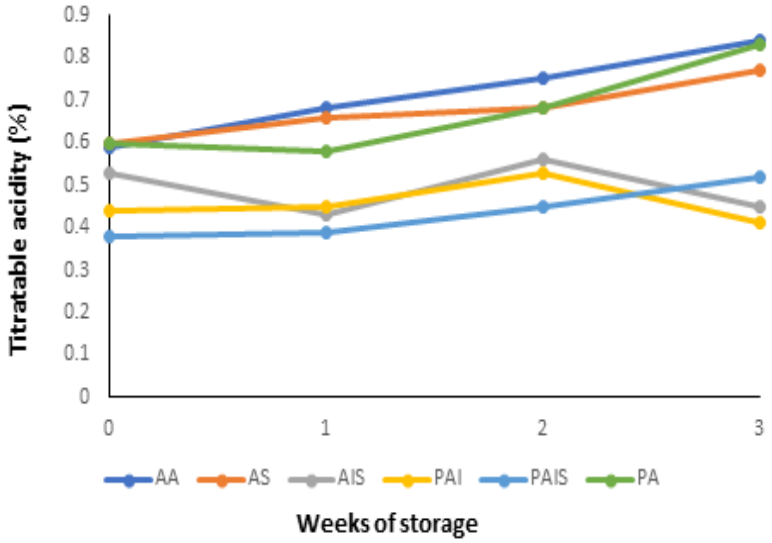

Figure 6. Titratable acidity of *agadagidi. AA- Agadagidi; AS-Agadagidi and sulphite, AIS- Agadagidi, isolate and sulphite, PAI- Pasteurized agadagidi, isolate, PAIS- Pasteurized Agadagidi, isolate and sulphite, PA- Pasteurized agadagidi.*

3.6. Principal component analysis of the sensory properties of *agadagidi*

The biplot showed the relationship between the sensory analysis of *agadagidi* samples (Figure 7). Principal component analysis divided the components into four factors with F1 accounting for 77.04% and F2 19.45%. Positive correlation exists within all unpasteurized samples AS, AIS and AA and they all had positive correlation with appearance, taste, colour, aroma and overall acceptability. PA also had positive correlation with appearance, taste, colour, aroma and overall acceptability. Addition of yeast starter culture and sulphite to pasteurized *agadagidi* PAI and PAIS had negative effect on the taste, colour, appearance, aroma and overall acceptability of *agadagidi.* This result concluded that combination of pasteurization and sulphiting with or without inoculation affected the desirable characteristics of *agadagidi*. It has been reported that wild yeast and lactic acid bacteria also produces some important metabolites that gives wine its desirable quality (Virides et al., 2017).

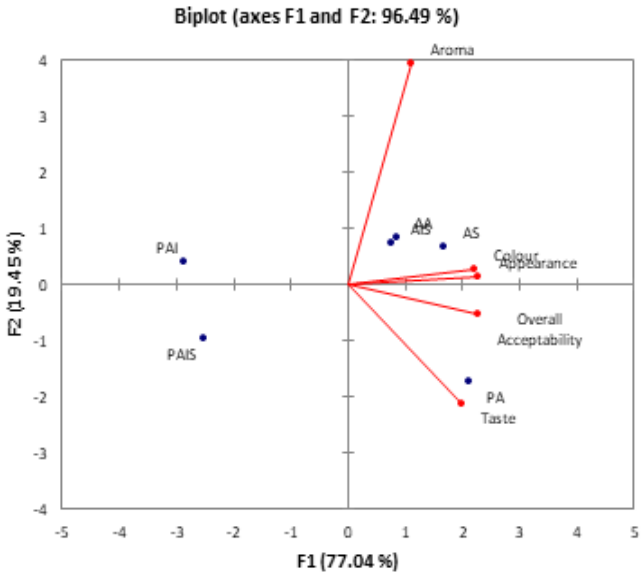

Figure 7. Biplot showing the relationship between samples and sensory parameters. AA-*Agadagidi*; AS-*Agadagidi* and sulphite, AIS- *Agadagidi*, isolate and sulphite, PAI- Pasteurized *agadagidi*, isolate, PAIS- Pasteurized *Agadagidi*, isolate and sulphite, PA- Pasteurized *agadagidi*.

4. CONCLUSION

Addition of sodium metabisulphite and yeast isolate to unpasteurized wine reduced the microbial population during fermentation and storage at room temperature. Pasteurization also reduced the microbial population but had negative effect on the organoleptic quality when inoculated and sulphited. Pasteurization had negative effect on the aroma of *agadagidi* showing that the process inhibited production of certain aromatic compound that could impact flavour on wine. This research concluded that *agadagidi* with consistent quality can be produced by sulphiting the must to inhibit microorganisms that could negatively affect the quality of wine with or without inoculating with *Saccharomyces cerevisiae*.

Further work should be done on addition of yeast food, filtration or addition of preservative to *agadagidi*.

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PERSPECTIVE ON UTILIZATION OF LEAF MEAL AS FISH FEED INGREDIENT FOR FISH IN FUTURE AQUACULTURE

Aditi BANIK[1], Abhishek KUMAR[2]

ABSTRACT

Fish feed accounts for around 60% of the operational cost of fish production, it makes sense for farmers to employ plant-based aquatic feed ingredients instead of expensive animal protein diets. The researchers have focused their efforts on developing alternatives to DORB, fish meal, soyabean meal etc. Plant based diet can partially or completely replace the high cost fish meal or stressful DORB. Leaf meal is currently the most cost-effective source of protein and energy for use as a supplement in fish feed. The leaf meals are prepared from both the terrestrial and aquatic plants depending on crude protein content and the level of inclusion as well. The disadvantage of incorporation into the fish diet lies in the anti-nutritional factors that need to be eradicated. Various processes are excavated to get rid of it. It involves using exogenous enzymes and cooking, fermentation, soaking, milling, roasting and other techniques. The effects of programming documented in fishes are based on survival, growth, brain development and nutrient metabolism. This could be brought into play as a strategy in aquaculture. In a nutshell, this paper discusses the current status of nutrition regarding feed formulation in aquaculture, their possible effective supplementation in fish diets in a sector-specific fashion with a note on some suggestive measure, if implemented, which can boost their participation in fisheries in days to come.

Keywords: *Plant-based diet, cost-effective, leaf meal, anti-nutritional factors, exogenous enzymes, fish nutrition, feed formulation.*

1. INTRODUCTION

Aquaculture basically defines the culture of economically important aquatic organisms in a controlled and semi controlled environment leading to an enhancement in economy making or intended to make a profit. Harvest stagnation in wild fisheries and overexploitation were the reasons that made to grow the demand for domestication of economically important species. As the aquaculture continues to grow commercially, the demand for the cost effective aquatic feeds get elevated so as to bag an inflated marginal profit. Since the production and proper utilization of fish feed is about 60% of the total cost of the fish production, it is highly reasonable for the farmers to use plant based aquatic feed ingredients in place of costly animal protein diets namely fish meal, bone meal, poultry meal, shrimp meal etc.

2. PRESENT RECORDS AND POTENTIAL OF AQUAFEED FORMULATION

Despite being raised in captivity for generations, the majority of fish farming has been done in impoundments, concentrating on fresh produce sources (Nash *et al*., 2011; Ghosh *et al*., and Ray *et al*., 2017). In the early era of aquaculture, to boost fish output, the fish farmers required having abilities in pond management rather than extensive understanding of the nutritional status of the fish (Mclarney *et al*., 2013). Even; much more importance was given on the growth and production of fish neglecting the feed formulation aspect with respect to economic analysis. Although there is a gap in the existing basic nutritional demands of farmed fish at various phases of their lives, there is a considerable concern in formulating feed to cope with the demand. It is critical to appreciate the importance of brood-stock or larval feed development

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in influencing reproductive development or survivorship, respectively. Whilst lipid and fatty acid nutrition appears to be the most commonly studied subject (Holt, 2011; Merrifield and Ring, 2014), there have been several publications on the influence of specific necessary amino acids, vitamins, and some trace minerals. Analogous to the land based animal production sectors, the development of diets based on fish meal and fish oils stimulated significant growth in most fish species. However, the costs associated with feed formulation have prompted efforts to develop realistic feeds that incorporate non traditional and low-cost ingredients. Aquaculture productions, especially fish, will be seen as not just an inadequate supply of nutrients, but also as neutraceuticals in the approaching years as fishes are natural providers of omega-3 fatty acids that lower the risk of cardiovascular disease since they are part of the aquatic food cycle (Mohebi-Nejad *et al*., and Bikdeli *et al*., 2014). As a result, supplementing farm-raised fish with vitamins, minerals or vital fatty acids may become a focus in the future. In this regard, a nutritionally balanced and value-added meal may hold the key to success.

3. PLANT PRODUCTS AS BASIC SOURCE OF FEED INGREDIENTS

Plants form the critical base of food chains in nearly all ecosystems and are recognized as the most simple as well as worthwhile ingredient to be used as feed for aquatic organisms. Compassioning with the same overview and thought, various scientists have used plant based diets for the aquatic organisms. Depending on the diversified ecosystem, the researchers have utilized diversified native plants as a source of aquatic feed that varied from one place to another. Among them quite a few are Berseem (*Trifolium alexandrinum*), Jatropa, Pea, Moringa, Basil, sweet potato, *Leucaena leucocephala*, Baobab (*Adansonia digitata*), *Houttuynia cordata*, rice bran, *Hydroglina spinosa*, Potato, Papaya, Cabbage, Mulberry, Turi, Cucumber, Squash, Broad beans, Black gram, Banana, Jackfruit, pumpkin, green mung beans, cow pea etc. Even the plant ingredients are utilized fore and aft leaving no bits unturned.

It is expected that aquaculture will expand in the near future due to the rapid advancements in the technology. This can only be accomplished through intensive form of aquaculture and formulated feed. The most frequently used basal diets include fish meal, deoiled rice bran, Soyabean meal, mustard oilcake, groundnut oilcake etc. But, fish meal is highly unsustainable to be used as fish feed affecting the food chain by virtue of the natural ecosystem. Rather, the formulated feed mechanically produced in farms incorporates about 85% or more DORB that may eventually cause stress to the fish thereby deteriorating the productivity. Furthermore, the use of DORB in diversified livestock feeds and human food products incites an undersupply of the above mentioned requiring to meet the demand of fish feed preparation. In a recent study Kumar *et al*., demonstrated that if DORB is substituted to around 33-40% in the diet of carp, no such effective growth is observed in the fingerlings of rohu. However some farmers are susceptible to incorporate higher levels of DORB to lower the feed cost making it easily available. Consequently, to make the food sustainable, cost effective, easily available, meeting the nutritional demands as well as bringing about no stress to the fish , the researchers have thrust their energy to develop alternatives to DORB, fish meal, soyabean meal etc and the alternative sources are mostly comprised of the plant based ingredients with reference to sustainability. In addition to these, the benefit of using plant based ingredient in aquatic feed is that it contains lower amount of nitrogen and phosphorus as compared to the animal source henceforth reducing the phenomenon of eutrophication in water body. From the report of Vhanalakar, (2009) it is evident that pods, leaves, seeds, fruits, kernel, stem, shoot are the principal sources of plant to be used in aquatic feed.

4. LEAF MEAL AS AN ALTERNATIVE REPLACEMENT IN FISH FEED

Recently, the most buzzed out plant part to be used in aquatic feed is the leaf.

Advantages over using leaf meal rather than other plant feedstuff:

i. The availability and economic supply of animal protein (fish meal, shrimp meal, bone meal, blood meal) is limited due to the increase in human population and overexploitation.

ii. Cost effective and availability is comparably easy.

iii. It is a renewable plant based alternative.

iv. Cheapest source of protein and energy that favours the growth performance in fish.

v. Possesses less amount of phosphorus and nitrogen as compared to animals thus reducing the occurrence of eutrophication.

The respective native terrestrial and aquatic plant leaves are:

Table 1. Plant leaves studied using fish models at different inclusion levels

Plants	**Nature of the plant**	**Used as**	**Fishes being experimented**	**Level of inclusion in the fish feed**	**Themost convincing inclusion level**	**Reference**
Berseem leaf meal (C.P 24%)	Terrestrial	De oiled rice bran replacement	*Labeo rohita*	25%, 50%, 75%, 100%	50%	Singh *et al*., Gupta *et al*., Sahu *et al*., Sardar *et al*., Deo *et al*.,
Moringa leaf meal (C.P=26%)	Terrestrial	Replacer of basal diet containing fish meal and soyabean meal	Grass carp	5%, 10%, 15%	15%	Faheem *et al*., Saba *et al*., Mustafa *et al*., Rani *et al*.,Khalid *et al*.,(2020)
Moringa leaf meal (Fermented)[C.P=33%]	Terrestrial	Dietary fish meal replacement	Juvenile gibel carp	20%, 40%, 60%	40%	Zhang *et al*.,Sun *et al*.,Jinfeng *et al*.,(2020)
Basil leaf meal(C.P=13%)	Terrestrial	Feeding attractant	Hybrid tilapia(*Oreochromis niloticus* × *Oreochromis aureus)*	0.5%, 1%, 2%	2%	Dakar *et al*.,Hassanien *et al*.,Gad *et al*.,Sakr *et al*.,(2008)
Hygrophila spinosa(C.P.31%)	Terrestrial	Replacer of DORB	*Labeo rohita*	10%, 20%, 30%	30%	Maiti *et al*.,Sahu *et al*.,Sardar *et al*.,(2019)
Houttuynia cordata leaf meal(C.P 35%)	Terrestrial	To evaluate the effects on the growth performance, nutrient utilization and gene expression	*Labeo rohita*	0.25% 0.5% 1%	1%	Garg *et al*.,(2018)

Houttuynia cordata leaf extract(CP 35%)	Terrestrial	Same as above	*Labeo rohita*	0.25% 0.5% 1%	1%	Garg *et al*.,(2018)
Baobab leaf meal(C.P 35%)	Deciduous	To evaluate the floating and stability of fish feed pellets		4%, 8%, 12%,16 %	16%	Felix *et al*.,(2018)
Leucaena leucocephala leaf meal(C.P 30%)	Legumino us and terrestrial	Replacer of fish meal	*Clarias gariepinus*	0%, 10%, 20% and 30%	20%	Amisah *et al*.,(2009)
Moringa leaf meal (aqueous extracted)[CP 30%]	Terrestrial	Replacer of fish meal	Nile tilapia juveniles	15% 30% 45% 60%	No such effective dose evaluate	Madalla *et al*.,(2013)
Sweet potato leaf meal[CP 35%]	Terrestrial	Replacer of DORB	*Labeo rohita*	0% 25% 50% 75% 100%	100%	Adewolu *et al*., (2008)
Sweet potato leaf meal (fermented)	Terrestrial	Replacer of DORB	*L. rohita*	0% 33.33% 66.67% 100%	100%	Jayant *et al*., (2020)
Green pea leaf meal (CP 31%)	Legumino us	Replacer of DORB	*L. rohita*	0% 15% 30%	30% with supplementati on of cellulase and xylanase @1g/kg	Hussain *et al*., (2021)
Cassava leaf meal(CP 20-35%)	Terrestrial	Replacer of DORB	Rohu fingerlings	0% 13% 26% 39%	26%	Sutriana *et al*., (2009)
Guava leaf extract	Terrestrial and deciduous	To evaluate the effect on growth, antioxidant and metabolic enzyme activities	*Labeo rohita* fingerlings	0.5% 1%	0.5% and 1%	
Mango leaf extract	Terrestrial	Same as above	Rohu fingerlings	0.5% 1%	0.5% and 1%	Dorothy *et al*.,(2018)
Alfa-alfa leaf meal (15-35%)	Perennial legume	Fish meal	*Oreochromis mossambicus*	15% 25% 35% 45% 55%	5% and 10%	Olvera-Novoa *et al*.,(1990)
Chickweed leaf meal(CP 24.23%)	Terrestrial		*Oreochromis mossambicus*	0% 2.5%	10%	Yilmaz *et al*., and

				5% 10% 20%		Ergun *et al*.,(2013)
Mulberry leaf meal(30%)	Deciduous and terrestrial	Fish meal replacement	*Labeo bata*	0% 65% 75% 80%	65%	Mondal *et al*.,(2012)
Mulberry leaf meal (fermented)[CP 26.25%]	Same as above	Replacer of fish meal	*Labeo rohita* and Singhi	0% 25% 50% 75%	25 and 50%	Ali *et al*.,(2019)
Peanut(Arachis hypogaea)		Fish meal	Nile tilapia	0% 10% 20% 30%	All	Lugo *et al*., and Novoa *et al*.,(2008)
Sesame meal	Terrestrial	Soyabean meal	Nile tilapia	0% 8% 16% 24% 32% 40% 48%	16%	Guo et el., (2011)
Azolla	Aquatic	Replacer of fish meal	*Oreochromis mossambicus*	5% 10% 20% 30% 100%	5% and 10%	Abou et el.,(2012)
Water hyacinth	Aquatic	Replacer of fish meal	*Cyprinus carpio*	0% 10% 20% 30% 40%	40%	Mohapatra *et al*.,(2015)
Water hyacinth(fermented)	Aquatic	Replacer of fish meal	*Labeo rohita*	20% 30% 40%	40%	Sadique *et al*.,(2018)
Duckweed leaf meal(*Lemna polyrhiza*)	Aquatic		*Labeo rohita*	10% 20% 30% 40%	30%	Bairagi *et al*.,(2002)
Pistia stratiotes	Aquatic	Fish meal replacement	*Labeo rohita*	10% 20% 30% 40% 50%	30%	Nazerath *et al*., and Balu *et al*.,(2017)
Ipomoea aquatica	Aquatic	Replacer of fish meal	*Labeo rohita*	0,25,50 and 75%	25%	Ali *et al*.,(2018)
Spirulina platensis	Aquatic	Fish meal replacement	Rohu and Catla	25% 50% 75% 100%	>25%	Rosenau *et al*.,(2021)

The leaf meals are prepared from both the terrestrial and aquatic plants depending on their respective crude protein content and the level of inclusion as well. Mondal *et al*., and Das *et al*., investigated concerning the potency of the leaves of various terrestrial and aquatic plants for partial or complete replacement of fish meal, DORB, Soyabean meal etc. According to Ray

and Das (1994), it is evident that the aquatic weeds contain worthwhile portion of minerals and protein. Bulk of researches has been done on implementation of water hyacinth in fish feed (Ray and Das, 1994).

5. TERRESTRIAL PLANT-BASED LEAF MEALS

Borlogan *et al*.,(2003) thoroughly studied about *Pisum sativum* leaf meal on *Chanos chanos* unveiled that this green pea leaf meal is an appropriate source of protein in the feed with substitution of 20%. Besides, the sweet potato leaf can also serve as a potent source of protein with a crude protein content of 23to 33% in the aquafeed. Zhang *et al*., analyzed that the use of moringa leaf in feed possesses properties of anti inflammation, antibacterial, hepatoprotection and antioxidant property as well. It was reported to have a crude protein content of 26% with 87% of true protein in it. Also, it contains several biologically active compounds counting the flavonoids, ascorbic acid, α tocopherol, carotenoides, isothiocyanates, isoquercetin, glucosinolates and minerals like Ca, Mg, Fe, K etc.(Zhang and Sun, 2020).

The partial replacement of conventional diets by Moringa leaf meal has achieved success deprived of striking a balance with the performance of growth on Nile tilapia (Afuang, 2003), Thai magur (Nsofor, 2012) and common carp (Yuangsoi and Masumoto, 2012). Afuang unveiled that the Moringa leaf extract has the ability to oust 30% of the fish meal in nile tilapia diets. In contrast to these statement, Hlophe and Moyo in 2014 reported that by addition of moringa leaf meal to the diets of *Tilapia rendalli* at an inclusion level of 25% had led to ineffective growth and poor health status of the fish which may be due to the presence of anti nutritional factors like tannins, oxalates, polyphenols etc. According to Tagwireei (2012) steam heated moringa leaf meal can be substituted at a rate of 10% to the basal diet for an effective growth performance in fry of Nile tilapia.

Kaitho *et al* stated that turi leaves contain 22-30% crude protein henceforth nutritionally sound to be used in fish feed. Conforming to Francis *et al*. the turi leaf has a higher protein content in contrast with mungbean, chickpeas and cowpeas. Devi *et al*. (1997) reported to have enhanced growth on *Labeo rohita* fingerlings when fed with turi leaf meal.

Other than moringa, turi and water hyacinth, subabul leaves also stands in the forefront with a considerable crude protein content of 20% based on dry weight(Kale, 1987). In the year 1979, Pantastico and Baldia outlined that on inclusion of subabul or leucaena leaf meal had shown an improvement in the growth activity in tilapia. The incorporation of Leucaena leaf meal ranging from 33 to 100% showed an enhanced growth rate in the fingerlings of Nile tilapia reared in cages(Cruz *et al*., Laudencia *et al*.,1977).Instead, Santiago *et al*., informed that the incorporation @ 12.5% in the same fish hardly showed any change in the growth performance whereas the inclusion level of ≥25% showed deterioration in growth performance.

Coming to a flowering plant, alfa alfa, with a crude protein content of 15 to 35% has been reported to have used in feeds of tilapia at an inclusion level of 35% with hardly any adverse effect on the fish's growth and survivability (Olvera-Novoa *et al*.,1990). The growth parameters of common carp and mrigal are found to be activated followed by a proliferation of protein and lipid content during the inclusion of alfalfa leaf meal incorporated at 40% and 30% respectively as mentioned by Vhanalakar *et al*., and Muley *et al*., (2015).The replacement level of alfalfa leaf meal in fish diet need to be 5% maximally(Ali *et al*., 2003) and if completely replaced i.e 100% replacement may affect drastically in the growth and health of fish(Sklan *et al*., 2004).

Another noteworthy leaf used in preparation of fish feed is the mulberry leaf having a crude protein content of 30% (Mondal *et al*., 2012). But its use in the fish feed industry is limited as it possesses deficient amount of essential amino acids and other prohibitors most likely the anti nutritional factors and the complexity being created by the inherited carbohydrates within the leaves of mulberry plant. According to a report of Mondal *et al*., it was stated that the mulberry

leaf meal can be a good protein source to be used in the feed for *Labeo bata*. The use of mulberry leaf meal in Nile tilapia at an inclusion level of 60% resulted in elevated growth performance and low FCR(Cruz *et al*., and Laudencia *et al*.,1978). The amalgamation of these leaf meal in stinging catfish as reported by Bag *et al*.,(2012) showed a luminary effect on growth and survivability and highly accepted by the fish with the improvement in immune system as well.

The sweet potato leaves with a crude protein content of 26-33% is rich in amino acid, essential vitamins and minerals. Adewolu *et al*.,(2008) exemplified that the credit of using this sweet potato leaf meal is that it can be picked severally hence easily available in a cheap price. An experiment conducted by Adewolu *et al*.,(2008) illustrated that the most effective dosage to be implicated with hardly any change on the growth performance of Tilapia zilli is 15%. Also, Manish *et al*.,(2020) reported that by fermenting the sweet potato leaf meal using fungus Chaetomium globosum has the ability to replace 100% DORB in the rohu fingerling diet.

The leaf meal of cassava with a crude protein content of 16.7 to 39.9% reported by Ravindran *et al*., was utilized effectively in the feed of Nile tilapia for superior growth performance and survivability which was a success(Ng *et al*., and Wee *et al*.,1989). The report of Hassan *et al*., in 2017 conveyed that the inclusion of leaf meal in case of 20% replenishment of fish meal in African catfish diet will have no significant negative impact on the fish's growth.

The other noteworthy terrestrial plants used as a replacer of fish meal, DORB or Soyabean meal are squash, broad bean and cucumber with a crude proteincontent of 21.11%, 27.45% and 26.87% respectively being reported by Magouz *et al*.,(2008) and co-workers. The incorporation of duckweed @ 30% in the feed of nile tilapia has found to enhance growth(Fasakin *et al*.,1999). The use of papaya leaf meal in the diet of nile tilapia has completely replace fish meal by 100%(Obwanga *et al*.,2010).

6. AQUATIC PLANT-BASED LEAF MEALS

Additionally, the usage of aquatic plants other than terrestrial plants in the fish diet has also been reported. It was Shino and Sahu in 2006 who utilized the aquatic macrophytes replacing partially or completely in the fish diet. For example Azolla was potent to be used in the fish feed industry as a source of protein(Micha *et al*., 1988) with a protein content of 19-31% as stated by Sheeno and Sahu. El sayeed *et al*., (1992) cited that the powder formed by drying Azolla can replace fish meal by around 25% in *Oreochromis mossambicus* followed by 42% replacement in nile tilapia(Sandtiago *et al*., 1988) and that of 45% replacement in Mrigal fry (Gangdhar *et al*.,2014).

Besides azolla, the role of water hyacinth in the fish feed industry is significant and a lot of studies are executed on the basis of its reasonable crude protein content of 30%(approximately) as informed by Saha *et al*., (2011).So the use of this nasty aquatic weed in fish feed making is somewhat using the bad in good terms.Even the fresh and fertilized form of water hyacinth can be used as feed(Loreo *et al*., and Bressani *et al*.,1982).The leaves of water hyacinth (C.P 38% and mineral content of 17-26%) were not allowed by any reasearchers until and unless the leaves are degenerated and fermented due to the presence of non digestible cellulose material which is why microbial degeneration of the leaves is required for its use in aquatic feed. A report by El sayed *et al*., (2003) said that the leaves of water hyacinth can be included in the diet of Nile tilapia @ 25% after undergoing fermentation. The fermentation not only enhances the digestibility but also the palatability meeting the acceptance requirements of the fish(El sayed *et al*., 2003). The fermented form of water hyacinth, as articulated by Edward *et al*., and his co workers, can be added in the diet of Nile tilapia at an inclusion level of 75% replacing the fish meal from the basal diet. Furthermore, the inclusion of water hyacinth meal incorporated @ 18.9% barely affecting the growth of Matrincha fish(Saint Paul *et al*.,1981) but an level of implication in the fish feed may affect the fish in terms of growth and survivability.

Coming to duckweeds we can come out with the fact that this floating aquatic macrophyte is proximately composed of 15-43% crude protein,5-30%fibre and 5% lipid(Leng *et al*.,1995;Mahapatra *et al*., and Patra *et al*., 2013). According to Mahapatra and Patra's experiment in 2013, it was inferred that duckweed(lemna leaf meal) cannot be a complete replacer of fish meal but it can be substituted @ 15% unbiased of the change in growth performance. The recommendation of Yilmaz *et al*.,(2005) to ferment the duckweed and using in fish feed substituting fish meal upto 20% was a success observed in common carp. In case of incorporating sundried *Spirodela polyrrhiza* with replacement of fish meal upto 30% in the feed of Nile tilapia, showed a better growth performance and worthy of cost as well.
In addition, various submerged aquatic weeds for example chara, water velvet, water milfoil, hornwort, *Elodia* sp.etc were also supplemented in fish diet either fresh or in powdered form (Stott *et al*., and Orr *et al*.,1970).Nonetheless, the unicellular microscopic algae likely the *Chlorella, Spirulina, Scenedesmus, Spirogyra* were also in practice for usage in diet formulation of fish(Sheeno *et al*.,Sahu *et al*., 2006).
However, the use of medicinal herbs in human is an age old practice quite significant in ancient India, China and Egypt but its usage in fish feed is not entirely popular. Within some of its rare utilization, the leaves of Marjoram implemented as a feed attractant in diet of hybrid tilapia, led to an improved growth performance, protein utilization, upgraded digestibility and low FCR(El-Dakar *et al*.,2004).Mendoza *et al*.,(1997) cited that the inclusion of these leaves upto 2-3% in fish feed may result in uplifting success in the economy.

7. ANTI NUTRITIONAL FACTORS IN LEAF MEAL

One of the major constraints to the consumption of plant based ingredients as compared to animal based product is the presence of anti nutritional factors in the plant based feedstuffs. If these plant based diet can partially or completely replace the high cost fish meal or stressful DORB the cost of feed can help reducing the overall production and maintainance cost. Despite having a less expensive and more sustainable feed stuff this anti nutritional factors provide an hindrance by interfering with the nutrient uptake by the fish reducing its digestibility as a whole (fao.org).

Table 2. Plant ingredient with anti-nutritional factors

Plant based ingredient	**Residing antinutritional factors**	**Anti-nutrient content (mg/100g)**	**References**
Pisum sativum leaf meal	Total tannin(g/kg)	0.4	Husain *et al*.,(2021)
	Phytic acid(g/kg)	5	
	Total oxalate(g/kg)	0.03	
Hydrophila spinosa leaf meal	Alkaloid(g/100g)	1.84	Maiti *et al*.,(2019)
	Total tannin(g/100g)	0.48	
	Total oxalate(g/100g)	0.43	
	Phytic acid(mg/100g)	5.51	
Water hyacinth leaf meal	Cellulose	11.4	Saha *et al*., and Ray *et al*.,(2011)
	Hemicellulose	0.15	
	Tannin	0.98	
	Phytic acid	0.42	

Moringa leaves	Saponins		Potter *et al*.,(1993)
	Tannins		Egwui *et al*., (2013)
Subabul leaf meal	Mimosine	1.66	Amisah *et al*., (2009)
	Saponin	1.43	
	Tannin	1.03	
Sweet potato leaves(*Ipomoea batatus*)	Total oxalate	308	Antia *et al*.,(2006)
	Cyanide	30.24	
	Phytic acid	1.44	
	Tannin	0.21	
Soyabean meal	Protease inhibitor	45-60	Adeyemo at al., (2013)
	Saponin	0.5-0.6	
	Phytic acid	0.6	
Sesame seeds(*Sesamum indicum*)	Phytic acid	31.59	Mukhopadhyay *et al*., and Ray *et al*., (1999)
	Phytin phosphorus	8.89	
	Oxalate	1.05	
Maize leaves	Saponin	44.1	Samtiya *et al*., (2020)
	Total phenolics	20	
	Tannic acid	12.3	
	Phytic acid	6.5	
Cassava leaves	Cyanide	31.48-35.77	Oresegun *et al*., (2016)
	Oxalate	29.32-35.77	
	Phytate	1.95-2.17	
	Trypsin inhibitör	0.48-0.72	
Banana peel	Phytic acid	0.79	Azza *et al*.,(2018)
	Tannic acid	0.083	
Mulberry leaves	Phytic acid	0.335	Adeduntan *et al*., (2010)
	Tannic acid	2.492	
Ipomoea aquatica	Tannic acid	3.138	Verma *et al*.,(2016)
	Phytic acid	0.249	
Castilla rose leaf(*Purshia plicata*)	Ellagitannins	119.22mg/g	Carlos *et al*.,(2020)
	Gallotannins		
	Condensed tannins		
	Complex tannins		
Aloevera gel powder	Phytic acid	0.08	Monika *et al*., (2012)

	Saponin	0.01	
	Tannins	0.01	
Berseem leaf protein concentrate	Tannin(%)	0.20	Singh *et al*.,
	Phytate(mg%)	3.62	
	Oxalate(mg/g)	1.01	
	Alkaloid(%)	5.55	
	Trypsin inhibitor(mg%)	4.74	
	Saponin(%)	0.71	
Berseem leaf meal	Tannin(%)	0.34	Singh *et al*.,
	Phytate(mg%)	4.29	
	Oxalate(mg/g)	3.94	
	Alkaloid(%)	3.46	
	Trypsin inhibitor(mg%)	48.84	
	Saponin(%)	0.91	

8. STRATEGIES TO INCLUDE LEAF MEAL IN FISH FEED

Plant protein sources are reported to be the cheapest among the other protein feedstuffs. But the disadvantage of incorporation into the fish diet lies in the anti-nutritional factors that need to be eradicated. Various processes are excavated to get rid of or somewhat reduce these antinutritional factors likely Dehulling, Aqueous heat treatment, Aqueous extraction, Germination, Fermentation, Autoclaving, Extrusion, Micronization, Microwaving, Alkali treatment, Oil extraction, Heat treatment and use of exogenous enzymes. But in case of leaf meals, the removal of antinutritional factors is performed throught the processes of cooking, fermentation, soaking, milling, roasting and addition of exogenous enzymes as cited by Samtiya et el., (2019).

i. Cooking : It is an eradication process that enhances the protein digestibility and palatability of the food ingredient by decreasing its non conventional content(Nergiz *et al*., and Gokgoz *et al*., 2007).The process of cooking is carried out in extracting the antinutritional factors of groundnuts(Omoikhoje *et al*., 2009). Also, Maunri *et al*., reported that by undergoing the process of cooking, the trypsin inhibitor gets lowered by 78-100% in alfa alfa leaves. According to Mbah *et al*., (2012), the antinutritional factors like oxalate, phytate and saponin are increased by boiling and roasting whereas it lessens the level of tannin in the moringa leaves. The levels of oxalate and tannin was dropped by 16-78% and 28-61% respectively with a reduction in phytate composition by 17-41% rarely when the Colocasia esculanta leaves are boiled continuously for 5 mins(Lewu *et al*., 2009). Cooking under pressure can effectively reduce polyphenols and saponins(Kataria *et al*., 1988). Additionally, when the immature soyabean seeds are steam cooked for about one third of an hour, the trypsin inhibitors can be completely removed(Keshun *et al*., and Markakis *et al*., 1987).

ii. Soaking: It is performed to improve the nutritional status as well as palatability of the feedstuff. It is a tool that efficiently disintegrates the content of carbohydrate present in raw foods and elevating its digestibility(Preet *et al*., and Punit *et al*.,2000). There was a reduction in the tannin levels by 31.4% when the leaves of alfa alfa are soaked. Also, the phytate level can be decreased by 25-30% due to soaking of soyabean. The soaking followed by boiling method was performed by Onwuka in 2006 that involved reducing the Trypsin inhibitor by 10 folds and complete reduction in tannin when the pegion pea beans are soaked for half a day and then boiled for a consecutive 40, 60 and 80 mins. It happened the same with faba beans of colour

green and white. But it doesnot hold the same for dehulling followed by soaking as investigated by Luo *et al*., and Xu *et al*.,(2012). The soaking for 6 hrs at 60oC is supposed to reduce the antinutritional content of major soyabean based feedstuffs(Nowshim *et al*., 2018).

iii. Milling: Refers to the pulverization of grains into fine powder terminating the anti nutrient factors from the feedstuffs. Milling is carried out with diversified processes like cooking, roasting, fermentation, soaking, germination and so on that appreciably turns down the non conventional factors as found in ragi and wheat(Gunashree *et al*.,2014). Even though the saponins, alkaloids,phytates,cyanogens are removed, the distinguished parts of the dietary fibres and minerals are drifted away as well(Gupta *et al*.,2015). The process of milling can distinctly lower the content of antinutritional factors like phytate and oxalates in semi refined pearl millet flour(Suma *et al*., and Surooj *et al*.,2011).Anuonye *et al*.,(2009) reported that extrusion cooked soyabean flour can wipe out the residing antinutrient factors but if the same is blended, the non conventional factors gets diluted making the latter process unworthy. Besides, the phytic acid content in the cereal grains can be lessened by a whole of 65% when it is dehulled(Ertop *et al*.,2020). The milling process of pulses reduces the antinutrient contents like phytate, protease inhibitor, tannins.saponins etc as cited by Patterson *et al*.,(2016).

iv. Fermentation: It is a phenomenon that employs enzymes to manipulate chemical changes in naturally derived organic substances. In food industry, it is a process involving a desirable change in the compound by microbial action according to Sokrab *et al*.,(2012). An experiment was done in maize flour by raising the period of fermentation to study whether there was a decrease in anti nutrient factors. This experiment came out quite well as the phytate, tannin, trypsin inhibitor and polyphenols got distinctly reduced (Ogodo *et al*.,2018). Similarly, fermentation of Jatropa kernel meal using fungus Aspergillus niger could successfully replace soyabean meal as the former process was able to mitigate the restricted nutritional factors like phytate trypsin inhibitor and tannins (Vikas *et al*.,2016). A recent study on fermented sweet potato leaf meal as a replacer of deoiled rice bran in the rohu fingerlings diet, reported that by fermentation of the former using Chaetomium globosum, the tannins got reduced by 64.95% followed by reduction in the others likely Phytates by 57.51%, Trypsin inhibitor by 15.31%, Alkaloids by 50%, HCN by 61.7% and oxalates by 37.32%(Manish *et al*.,2019). Zhang *et al*., and Sun *et al*.,performed a study on fermented Moringa leaf meal where the flavonoid aglycones were easily and promptly absorbed in the intestine after fermentation. The solid state fermentation of Deoiled rice bran using fungus Rhizopus oryzae showed a reduction in the phytate activity by 3.2% and that in the trypsin inhibitor activity by 24.8% as the microbes utilize and reduce the undesirable antinutrients to prevent from chelation with di and trivalent mineral ions such as Ca2+, Mg2+, Zn2+, Cu3+ and Fe3+ leading to its easy availability to fishes(Ranjan *et al*.,2019). The fermentation of soyabean meal raised the adequacy and the biological value of the striped bass diet replacing the content of fish meal from the basal diet(Rombenso *et al*.,2013). In case of sesame seeds, the antinutrient factors such as phenols were reduced by fermentation for 7 days as reported by Ibuku *et al*., and Anyasi *et al*.,(2013). The fermentation of black gram seed meal using Bacillus sp. isolated from adult common carp intestine lessened the anti nutritional factors like Tannins and phytase in compound diets for the fingerlings of Labeo rohita (Ramachandran *et al*., and Ray *et al*., 2005).

Table 3. Fermentation of plant ingredient using fish models

Plant ingredient used	**Fermentation using**	**Fish studied**	**Effects**	**Inference**	**References**
Water hyacinth leaf meal	Two bacterial stains: *a) Bacillus subtilis* b) *Bacillus megaterium*	*Labeo rohita*	Better growth performance, low FCR and better performance in protein efficiency ratio and net protein utilization. The apparent protein digestibility in fish fed diets was better as well.	The fermented Eichhornia leaf meal can be substituted in the fish diets replacing fish meal up to 40%.	Sangbrita *et al*., and Ray *et al*., (2011)
Fermented moringa leaf meal	One fungus: Aspergillus niger	Juvenile gibel carp (Carassius auratus gibelio)	Concentration of flavonoids raised by 11.18%. Concentration of polysaccharides increased by 17.39%. Flavonoid aglycones are easily and rapidly absorbed in the inteatine after fermentation	40% of the fish meal in the baal diet can be replaced by fermented moringa leaf meal. The fungus Aspergillus niger is more suitable for the fermentation of leaf material than bacteria due to its higher levels of lignocellulose secretion.	Zhang *et al*., and Sun *et al*.,(2020)
Fermented Sweet potato leaf meal	Fungus : Chaetomium globosum	Rohu fingerlings	Significantly higher growth rate. Crude protein content increased from 21,47 to 31,2% in feed. Reduction in the crude fibre content from 19.43 to 7.22%. Decrease in the anti nutrient content in feed:	The fermented sweet potato leaf meal can completely replace DORB in the fish diet.	Manish *et al*., Sahu *et al*., Deo *et al*.,Subodh *et al*.,(2020)

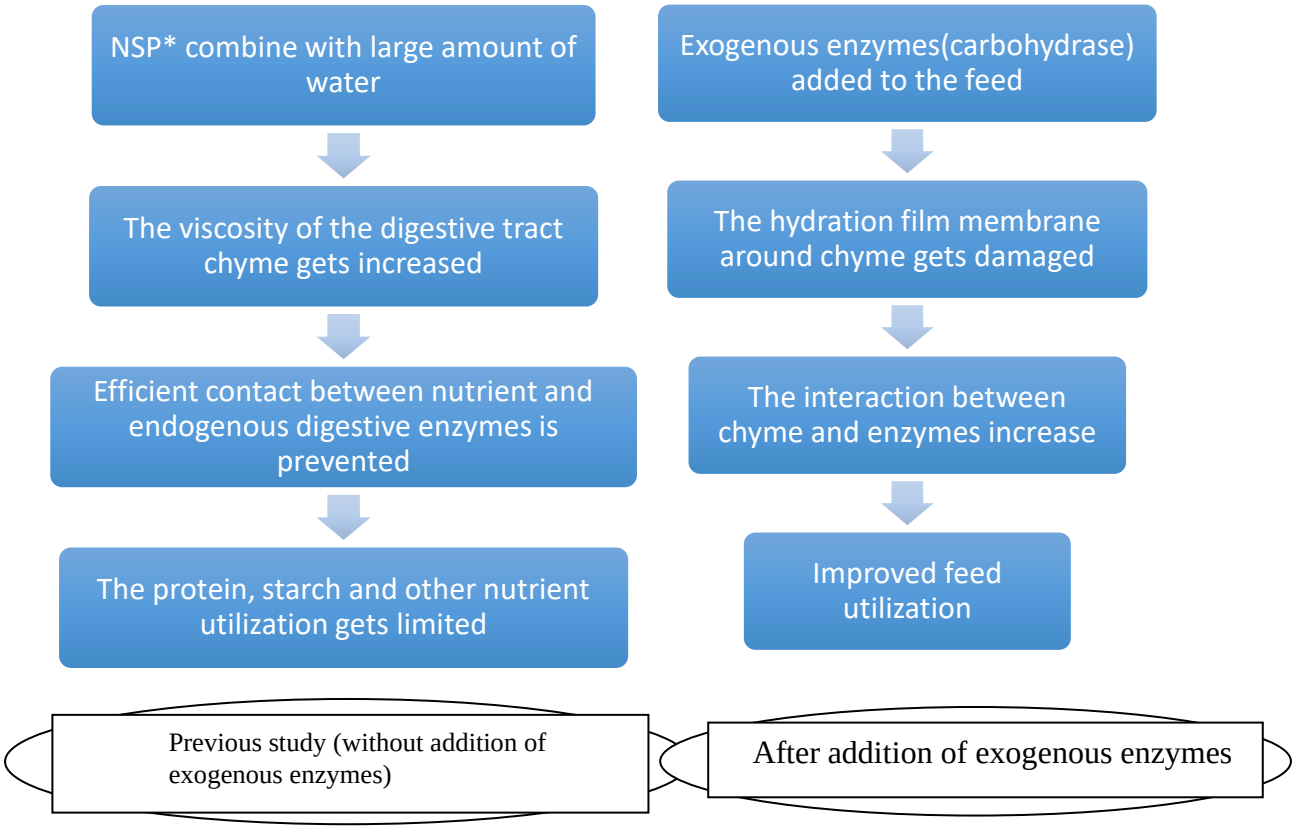
			a) Tannin (↓64.95%) b) Phytic acid (↓ to 57.51%) c) Trypsin inhibitor (↓ to 15.31%) d) Oxalate (↓ to 37.32%) e) Alkaloids (↓ to 50%) f) HCN(↓ to 61.70%)		
Fermented Ipomoea aquatica leaf meal	Phytase producing bacteria Stenotrophomonas maltophilia	Labeo rohita	Decrease in phytic acid content from 0.223 to 0%. Decrease in tannic acid content from 3.1 to 2.242%. Considerable increase in iron content in the feed. Elevation of crude protein and crude lipid levels.	This bacterial strain is efficient enough to ferment Ipomoea leaf hardly affecting the growth performance of the fish.	Ali *et al*., and Kaviraj *et al*.,(2018)
Fermented mulberry leaf meal	Phytase producing bacteria Stenotrophomonas maltophilia	Labeo rohita and Heteropneustes fossilis	Decrease in the phytic acid content from 0.33 to 0%. Decrease in the tannic acid content from 2,456 to 1.56%. The essential minerals like copper, manganese and zinc are substantially increased.	The Indian major carp and the catfish thrive well on the feed supplemented by Fermented Mulberry Leaf Meal.	(Kaviraj1, 2019)
Fermented moringa leaf meal		Red tilapia	Antinutrient substances like phenol, tannin,phytic acid and hydrogen cyanide were considerably	Suitable to be done for moringa leaves replacing fish meal by 30% without	Helmiata *et al*.,(2020)

			reduced by means of fermentation.	compromising growth.	
Fermented Lemna leaf meal	Liquid probiotic's brand Akuasimba-d	Nile tilapia and Catfish (Pangasius hypophthalmus)	Increase in protein content and decrease in crude fibre in feed. Better growth performance that artificial fish diets.	30% administration of fermented Lemna sp. in artificial diets give the best growth performance.	Yuli *et al*.,(2019)
Fermented duckweed meal(Lemna minor +Spirodela polyrhiza)	Lactobacillus plantarum DSM 8862 and DSM 8866	Nile tilapia	Trypsin inhibitor, Phytates, soluble and condensed tannins and oxalates are found to be distinctly reduced(Cruz *et al*.,2011).	The fermented duckweed and water fern can be successfully implicated upto 15% inclusion level in low fish meal diets	Cruz *et al*., Kijora *et al*.,(2015)
Fermented water fern meal	Lactobacillus plantarum DSM 8862 and DSM 8866	Nile tilapia	Trypsin inhibitor, Phytates, soluble and condensed tannins and oxalates are found to be distinctly reduced (Cruz *et al*.,2011).	The fermented duckweed and water fern can be successfully implicated upto 15% inclusion level in low fish meal diets	Cruz *et al*., Kijora *et al*.,(2015)

v. Inclusion of exogenous enzymes in fish feed: These are one kind of enzymes added externally being incorporated in the fish feed implemented globally.Despite knowing the chemical effects of the respective exogenous enzymes its use and impact on the fishes consuming the fish feed is still unknown (Zheng *et al*., 2019).

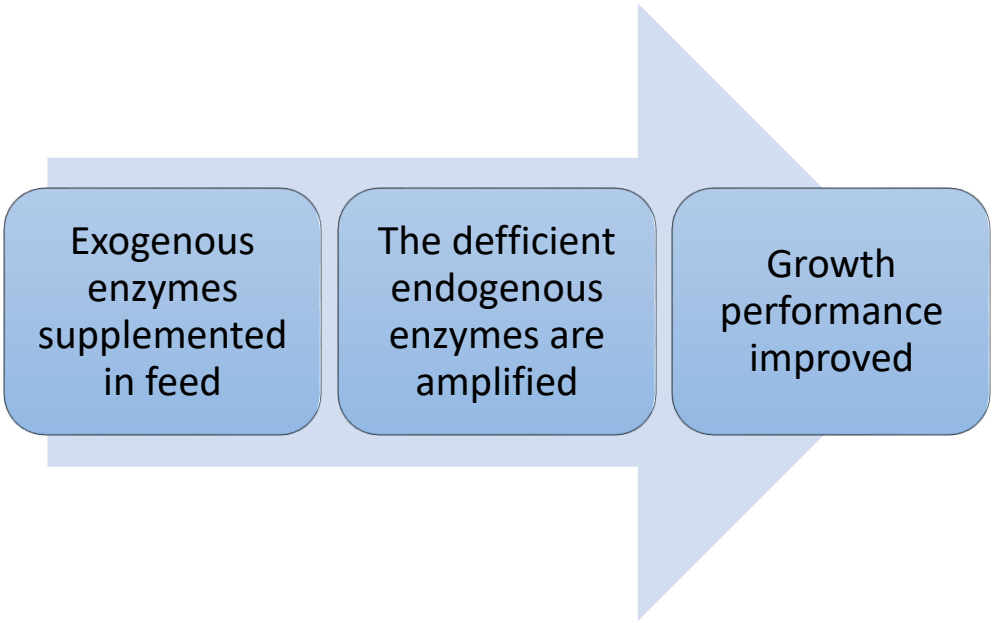
The most possible reasons for the exogenous enzymes to be used in fish diet are:

- Improvement in digestibility and utilization of feed: Scientists have worked a lot to excavate the beneficial activities of the enzymes when implemented into the fish diet(Ali *et al*., 2007).



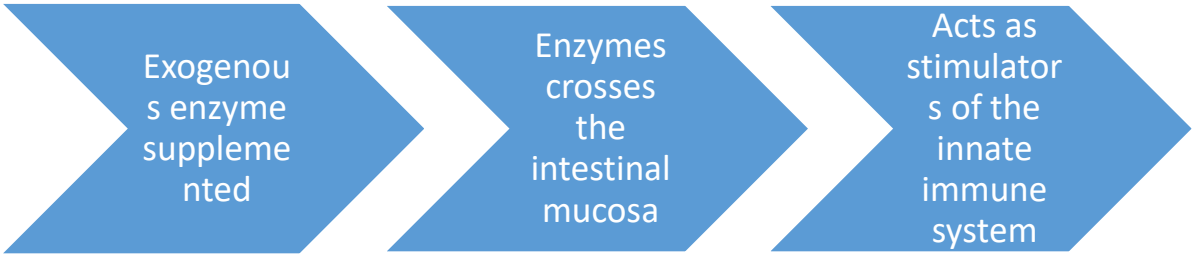
Additionally, the cereals and plant based feedstuffs possesses about 60-80% phosphorus(i.e 600-800g/kg) as phytate phosphorus form. As the enzyme hydrolyzing the phytate phosphorus is absent in the fishes, henceforth, the phytate in combination with the phosphorus cannot be absorbed and utilized by the fish which in turn may pollute the water by releasing phosphorus. The administration of the respective exogenous enzymes(for ex. Phytase for phytic acid) may cleave the phytic acid combined phosphorus to available phosphorus of fish thereby inducing phosphorus utilization in the body of fish.

- Influencing better growth performance and optimizing composition of the whole body.When formulated feeds are supplemented to the fish the lack of significant enzymatic activity due to partial development in the digestive tract lead to deteriorated growth performance as observed subsequently by Kolkovsi *et al*.,(1993). Therefore the digestive tract needs to be developed for better enzymatic activity in order to improve the digestibility in the fish. One of a promising strategy is the incorporation of exogenous enzymes. The inclusion of exogenous enzymes appropriately can augment the deficient endogenous enzymes to improve the growth performance.



Immunity enhancement and resisting pathogens: The factors affecting the immune system in fish include pollution, pathogens, disease outbreak, stress and feed(Doan *et al*.,2019).In a recent report, it was cited that high WBC count had been observed in the enzyme incorporated DORB based diet with inclusion level of xylanase being 16000U/kg and that of phytase being 500U/kg(Ranjan *et al*., and Kumar *et al*.,2020).Concerning with the same, Zamini *et al*.,(2014) reported that the supplementation of exogenous multienzyme in *Salmo trutta caspius* stimulated the innate immune system.

In lipid based low protein diets when lipase is supplemented in diet the fish
immune response was observed to be improved due to partial optimization of the acid phosphatise activity and complement protein followed by reduced pro-inflammatory cytokine gene expression by enhancing antibacterial peptides and anti-inflammatory cytokine gene expression thereby partially regulating nuclear factor kBp65 protein inhibitors, kBa, intestinal kinase and rapamycin target signalling in fish(Liu *et al*.,2016).



- Additionally, The changes in the composition of the di*et al*so affects the gut microflora and fishes cannot respond to most of the plant based diets due to the anti nutritional factors and their inability to produce adequate enzymes required for the digestion of respective feedstuffs.The implementation of exogenous enzymes in the diet hydrolyzes the enzyme activity thereby enhancing its digestibility.A study on grasscarp fed with cellulase supplemented duckweed diet showed a significant change in the intestinal microbiota(Zhou *et al*.,2013).

Table 4. Exogenous enzymes currently used in fish

Sl. No	**Exogenous enzymes**	**Features**	**Effects**	**References**
1.	Protease	Supplement the deficiency of endogenous proteases to break down macromolecular protein to smaller unit of peptides and amino acids that can feadily be digested and absorbed.	• Promotes growth by reducing muscle layer thickness(Liu *et al*., 2018). • Reduce the stimulation of the feed to the digestive tract. • Improves feed utilization. • Reduced the dietary protein requirement, FCR and improved digestibility of crude protein and lipid. • efficient feed and nutrient utilization. • Reduces dependence on fish meal in aquafeeds. • Ability to eliminate anti-nutritional factors.	
2	Carbohydrase	Includes amylate, β glucanase,β xylanase, cellulase, pectinase. The most abundantly used are xylanase and glucanase. It synthesizes the carbohydrate polymers to break down into low molecular weight oligosaccharides or polysaccharides. It improves Non starch polysaccharide utilization where NSP acts as a barrier to the substrate to act with the digestive enzymes.	• Increased activity of intestinal amylase and protease. • Improved growth. • Improved protein utilization. • The muscle protein, liver glycogen content, HSI were significantly increased. • Enhanced blood glucose and G6P dehydrogenase activity in liver. • The apparent digestibility coefficient of protein and lipid. • The digestive enzyme activity of lipase, protease and amylase augmented. • Increases intestinal digestive enzyme activities.	
3	Lipase	Influences fish intestinal health by accelerating lipid digestion. It activates Poly unsaturated fat to Poly unsaturated fatty acids like EPA and DHA.	• Bears a protein sparing potential. • Maintainance of water quality and reduction of disease outbreak in fish. • Enhanced by 3 folds in spontaneity of tissue lipids indicating that it modifies the process of lipid metabolism. • Increased acid phosphatase activity and complement component 3 contents followed by upregulation in the relative mRNA levels of antimicrobial peptides, anti-inflammatory cytokines and signalling molecule inhibitor protein such as	

			κBa, target of rapamycin(TOR) and glutathione content.	
4	Phytase	Enhances the phytate (salt of phytic acid) availability in plant based diet. • The exogenous enzyme enables the animals to access the majority of plant based feed stuffs.	• Increased body weight and whole body composition. • Utilization of nutrient efficiently.	

Table 5. Summary of exogenous enzyme studies using fish models

S. N.	**Exoenzyme stimuli**	**Species**	**Effects**	**References**
1	Low protein diet supplemented with protease	Juvenile gibel carp	✓ Reduction in the dietary protein requirement ✓ Reduced FCR ✓ The digestibility of crude protein and lipid got significantly improved ✓ The muscle layer thickness got reduced. ✓ Promotes the growth of fish	Liu *et al*., (2018)
2	Exogenous protease added into extruded canola: pea based diet	Rainbow trout	✓ Increase in feed efficiency ✓ Better nutrient utilization.	Drew *et al*., (2005)
3	Exogenous protease supplementation to flax: oea based diet	Rainbow trout	No significant effect on nutrient digestibility is observed.	Drew et al., (2005)
4	α-amylase (50mg/kg) supplemented gelatinized and non-gelatinized corn diets	Labeo rohita fingerlings	✓ Performance was best in non-gelatinized corn fed fish. ✓ Increased activity in intestinal amylase and protease.	Kumar *et al*., (2006); Kumar *et al*.,(2009)

			✓ Improved growth and protein utilization. ✓ Increase blood glucose and Glucose 6 phosphate dehydrogenase activity in liver. ✓ Activities of Glucose 6 phosphate and fructose-1,6-bisphosphate, alanine aminotransferase and aspertate aminotransferase deteriorated.	
5	Exoenzyme complex of highly purified NSP (endo-1,4-beta-xylanase and endo-1,4-beta-glucanase)	Turbot (*Scopthalmus maximus*)	✓ Increased apparent digestibility coefficient of protein and lipid. ✓ Promotion in the activity of the digestive enzyme in the posterior intestine.	Diogenes *et al*., (2018)
6	Supplementation of exogenous enzyme cocktail(Pentosanase+Cellulase+ Xylanase)	*Lateolabrax japonicus*	✓ Effectively reduces the antinutritional factors. ✓ Increase in phosphorus retention and protein utilization leads to better growth performance.	Ai *et al*., (2007)
7	Supplementing β glucanase into diet containing 344 g/kg soyabean meal	Rainbow trout	✓ Improvement in apparent digestibility of all dietary nutrients.	Dalsgaard *et al*., (2012)
8	B glucanase added to 250g/kg sunflower meal based diet	Rainbow trout	✓ Improved apparent digestibility of lipids	Dalsgaard *et al*., (2012)
9	Xylanase supplemented to rapeseed meal(260 g/kg) based diet	Rainbow trout	✓ Positively affecting apparent lipid digestibility	Dalsgaard *et al*., (2012)
10	Exogenous xylanase and phytase in DORB based diet	Rohu	✓ Improvement in	Ranjan *et al*., Kumar

			physiological status and growth performance.	*et al*., Sahu *et al*., (2020)
11	Cellulase supplemented diet	Carassius auratus	✓ Improved growth performance, digestive activity and nutrient digestibility	Shi *et al*., Luo *et al*., Chen *et al*., Huang., (2017)
12	Cellulase(3g/kg) supplemented duckweed based diet	Grass carp	✓ Increased intestinal digestive enzyme activities.	Zhou *et al*., (2013)
13	Multienzyme complex(Phytase+Xylanase+β glucanase+β amylase+cellulase+pectinase) supplanted	African catfish Great sturgeon Caspian salmon	✓ Positive growth performance and feed efficiency	Yildirim and Turan (2010), Ghomi *et al*. (2012) and Zamini, Kanani, azam Esmaeili, Ramezani, and *Zoriezahra* (2014)
14	500mg/kg multienzyme complex supplemented	Sturgeon fingerlins(Huso huso)	✓ Elevation in content of higher n3 essential fatty acids. ✓ n-3/n-6 fatty acid ratio lowered	Ghomi *et al*., (2012)
15	Cellulase enzyme (1-5g/kg)product on canola meal based diet	Oreochromis niloticus	✓ No impact on growth performance, body composition and nutrient digestibility.	Yigit *et al*., Olmez *et al*., (2015)
16	Exogenous lipase supplementation	Young grass carp	✓ Increased acid phosphatase activity. ✓ Upregulation in the relative mRNA levels of antimicrobial peptides, antiinflammatory cytokines as well as signalling molecule inhibitor protein.	Liu *et al*., (2016)
17	Dietary lipase supplementation	Rainbow trout	✓ No influence on	Samuelsena *et al*., (2001)

			growth, fillet composition, hepatosomatic and carcass percentage. ✓ Affected the monounsaturated fatty acid profile of the fillet.	
18	Phytase(500or 1000 units/kg) supplemented in diet with 50% phosphorus content	Nile tilapia	✓ Increased body weight and whole body composition. ✓ Efficient in nutrient utilization.	Abo *et al*., (2018)
19	Dietary phytase supplementation	Japanese sea bass	✓ Enhanced carcass phosphorus, carcass zinc and carcass calcium. ✓ Reduced total phosphorus effluent.	Ai *et al*., (2007)
20	Exogenous phytase and xylanase supplementation of fermented DORB(fermented by Rhizopus oryzae) based diet	Rohu	✓ Growth performance in fish was less significant as compared to the only enzyme supplemented DORB based diets.	Ranjan *et al*., Kumar *et al*., Sahu *et al*., Jain *et al*., Deo *et al*., (2020)

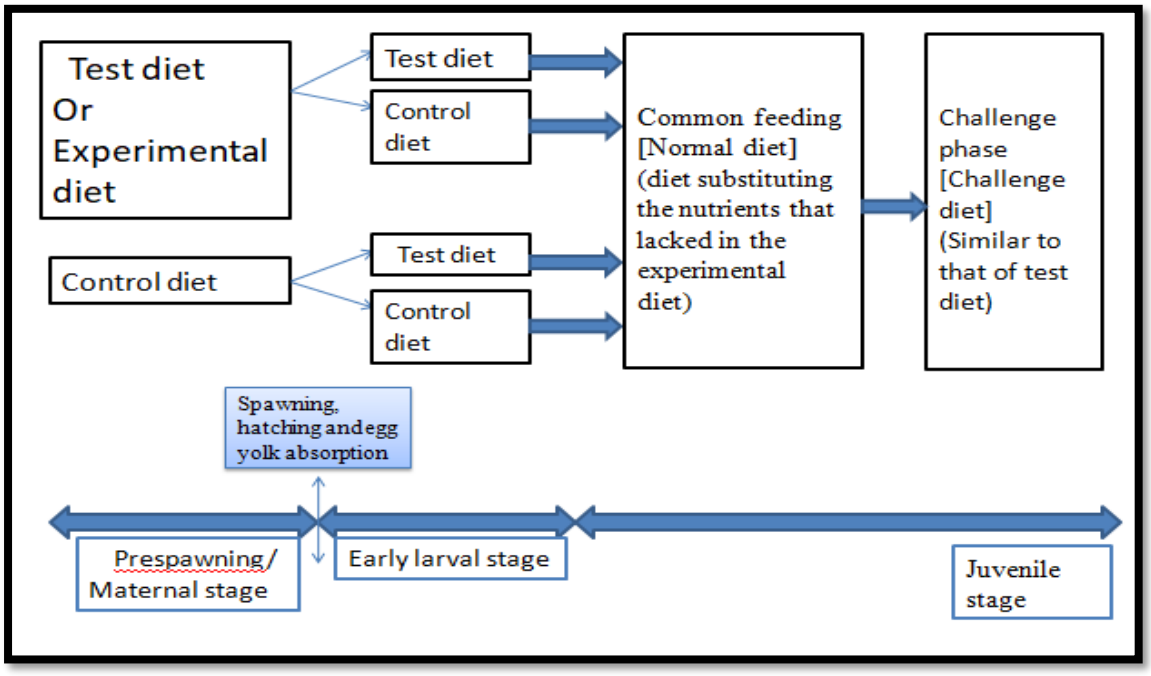
9. FUTURE PROSPECTS

The recognised benefits of Fish meal on human health, as well as its use, even if in tiny amounts, in other livestock production systems, have resulted in an increase in demand for this basic material, resulting in higher pricing. The plant based aquatic feedstuffs had proved to be cheaper but the antinutritional factors hinder the management of economy. The exogenous enzyme supplementation in the diet, fermentation using beneficial microorganisms including use of probiotics despite being advantageous, the application cost turns out as the drawback. However, the prospective application lies in nutritional programming. Earlier, studies related to nutritional programming were carried out using models of mammals which showed that there is a strong interdependence between the nutrition gained during early stages of life and its susceptabilty to metabolic infirmities likely deterioration in growth permanently including nervous dysfunction and pathways associated with metabolism. This nutritional programming, evidently an innovative concept has set its foot in the domain of fisheries studies as well. Though the maternal metabolic programming and its generative processes between fishes and mammals is highly contrasting, yet early nutrition of fishes from both endogenous (maternally derived) and exogenous (larval feeding) sources, could induce similar programming effects on development and metabolism. The effects of programming documented in fishes are based on survival, growth, brain development and nutrient metabolism. Intervention of these effects can be brought out by utilizaing varied byways of metabolism succeded by inherited gene

expression and its regulation during its flexible stages of development. Thus, nutritional programming could be brought into play as a strategy in aquaculture thereby promoting sustainability in feeding trials.

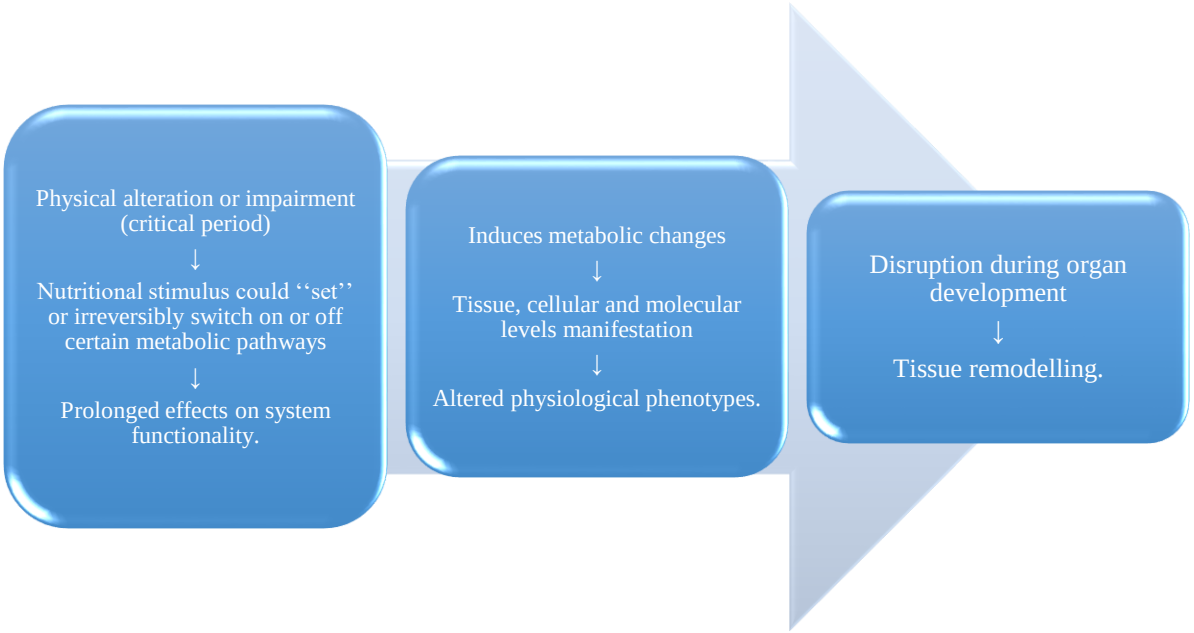
10. CONCEPT OF NUTRITIONAL PROGRAMMING

Nutritional programming also called as metabolic programming are mostly studied for getting the successful outcome ignoring the cause of the study. Other relevant terms for nutritional programming include fetal programming, focusing on vertical transmission between mother and daughter/ son or developmental programming associated with regenerative processes. The concept of nutritional programming involves two different types of maternal diets likely the control diet and the low protein diet during prespawning and early larval stages. The shoal of fishes were crossfostered at the time of spawning thus producing two pairs of nutritional treatment groups for the offspring i.e. control, low protein diet during prespawning and early larval stages, postspawning low protein(only during postspawning phase) and prespawning low protein. By crossfostering, one can investigate whether programming works for the prespawning or larval period or both, and whether the programming effect is reversible. Thereafter a challenge experiment was conducted at the end of some cross-fostering studies, to test whether nutritional programming gives out greater adaptability to nutritionally suboptimal conditions. Subsequently, the fishes fed on experimental diet is transferred to a ‘‘normal’’ diet for several weeks to months (which implies an optimal diet, high quality food, or a diet substituting the nutrients that lacked in the experimental diet, being referred to as ‘‘common feeding’’). Then the experimental or a similar diet is given (referred to as the ‘‘challenge diet’’) and is retaliated at the end of this ‘‘challenge phase’’. Here, after the early nutritional stimuli being removed, a common feeding period portrayed a standard for determining whether a study measured the effects of nutritional programming. Hardly had an early nutritional stimulus(without a common feeding period) not rated to be programming when studies showed a response. A crossover feeding paradigm (equivalent of cross-fostering) is not required.



Procedure followed in nutritional programming of fishes

Mechanism of action



The above flowchart conveys the idea that this concept of nutritional programming involves physically altering or impairing somatic structures during a critical period and alternatively, the nutritional stimulus could set or irreversibly switch on or off certain pathways of metabolism leading to prolonged consequences on system functionality.

In general, nutritional programming brings out changes in metabolic activities that can perceptionalize at the tissue, cellular and molecular levels leading to alteration in the physiological phenotypes i.e. change in metabolism, growth rate, locomotory performances, phenotypic plasticity and selective mortality including energy requirement, aerobic and anaerobic capacity, tolerance to environmental stress followed by effects on foraging requirements and hunger. The perceptible tissue manifestation affects immunology and defence mechanism when something affects fish body.

The disruption of either differentiation or proliferation processes under adverse conditions during organ development could yield tissue remodelling.

Table 6. Nutritional programming studies using fish models

Species	**Programming window**	**Effects**	**Nutritional stimulus**	**References**
Atlantic cod	Larval feding	Growth	Copepod	Imsland *et al.* (2006); Koedijk *et al.* (2010); Øie *et al.* (2015)
	Larval feding	Stress tolerance	Copepod	Øie *et al.* (2015
Rainbow trout	Larval feding	Growth, muscle growth	High fat	Alami-Durante *et al.* (2014)
	Larval feding	Carbohydrate metabolism	Hyperglucidic+hypoxia	Liu *et al.* (2017); Hu *et al.* (2018)
	Larval feding	Carbohydrate metabolism	Hyperglucidic	Geurden *et al.* (2007, 2014)

	Prior to spawning	Growth, survival; ingestion	Methyl group donor	Fontagne´-Dicharry *et al*. (2017
	Prior to spawning	Lipid metabolism; carbohydrate metabolism	Methyl group donor	Seiliez *et al*. (2017)
	Adult life cycle	Lipid metabolism; carbohydrate metabolism; muscle growth	Plant-based diet	Lazzarotto *et al*. (2016)
	Larval feding	Ingestion	Plant based diet	Geurden *et al*. (2013)
	Larval feding	Growth	Plant based diet	Geurden *et al*. (2013); Clarkson *et al*. (2017)
	Larval feding	Lipid metabolism; muscle metabolism	Vitamin supplementation	Panserat *et al*. (2017
European seabass	Larval feding	Lipid metabolism	HUFA deficiency	Vagner *et al*. (2007, 2009
	Larval feding	Growth	Hyperglucidic	Zambonino-Infante *et al*. (2019)
	Larval feding	Stress tolerance	Hyperglucidic	Zambonino-Infante *et al*. (2019)
	Larval feding	Hypoxia tolerance	Hyperglucidic	Zambonino-Infante *et al*. (2019)
	Larval feding	Carbohydrate metabolism	Hyperglucidic	Zambonino-Infante *et al*. (2019)
Gilthead seabream	Larval feding	Carbohydrate metabolism	Hyperglucidic	Gong *et al*. (2015)
	Spawning	Growth; lipid metabolism	Plant based diet	Izquierdo *et al*. (2015); Turkmen *et al*. (2017)
	Larval feding	Growth; digestion	Plant based diet	Perera and Yufera (2016a)
	Larval feeding;	Inflammation	Plant based diet	Perera and Yufera (2016a, b)
	Juvenile	Lipid metabolism,Growth	Plant based diet	Turkmen *et al*. (2017)
Zebrafish	Embryonic stage	Carbohydrate metabolism	Hyperglucidic	Rocha *et al*. (2014, 2015)
	Larval feding	Carbohydrate metabolism	Hyperglucidic	Rocha *et al*. (2016a, b)

	Adult life cycle	Lipid metabolism	Maternal one-carbon micronutrient deficiency	Skjærven *et al*. (2016, 2018)
	Adult life cycle	Lipid metabolism	Maternal high ARA	Adam *et al*. (2018, 2019)
	Larval feding	Inflammation	Plant based diet	Perera and Yufera (2016a, b)
Senegalese sole	Larval feding	Growth	Intact protein (vs hydrolysate with polypeptides)	Canada *et al*. (2018)
	Spawning	Growth, development(deformity); lipid metabolism	Maternal PUFA and vitamin supplementation	Morais *et al*. (2014)

11. PHYSIOLOGICAL MECHANISM

11.1.Ingestion

The hypothalamus is responsible for appetite regulation and induces energy homeostasis influencing structural and functional modifications of hypothalamus as a result of early nutritional stimulation. This may further lead to modification in structure and function. A very few studies have been conducted on feed intake of fishes with reference to programming. A table is given showing variation in effect on the same species with respect to different programming window and diff nutritional stimuli (Table 7).

Table 7. Variation in effect on the same species

Species	**Stage at which the nutritional stimuli is given**	**Nutritional stimuli**	**Effects**	**Justification**	**References**
Rainbow trout	Broodstock	Different levels of methionine	Offspring survival and growth	Alteration in the expression of an anorexigenic peptide (proopiomelanocortin A, POMCa) and an orexigenic peptide (NPY) in offspring after hatching, and the effect on POMCa expression remained three weeks after initiation of exogenous feeding.	(Fontagné´-Dicharry *et al*. 2017)
	Juvenile	Hyperglucidic diet	No effects on feed intake		Geurden *et al*. (2007) and Gong *et al*. (2015)

It is to be noted that the regulation of appetite in fishes is not fully known. It has still not been clarified that when during the developmental stage, the internal appetite regulating mechanism becomes functional in the larval stages of fishes.

Also it has been observed that fish larva feed constantly if prey or feed supply is abundant thereby suggesting that the signal of feeding satisfaction regulated by the anorexigenic factors are not yet functional.

11.2.Digestion and absorption

For most fish species, digestive enzymes in striking amount are present immediately after the commencement of external feeding or at hatching (Oozeki and Bailey 1995; Lazo *et al*. 2011), though the digestive system is not completely developed then. This is a nutrient sensitive process as the digestive enzymes are specific to their activity at different stages.

Table 8. Digestion and absorption effects

Species	**Programming window**	**Nutritional stimuli**	**Effects**	**References**
Juvenile rainbow trout	Larval feeding	Hyperglucidic diet	Upregulated expression of pancreatic a-amylase and intestinal maltase	(Geurden *et al.* 2007)
Adult zebrafish	First feding	High glucose stimulus	Enhanced expression and activity of a-amylase	(Fang *et al.* 2014)
Gilthead seabream	Larval feeding	Soyabean meal(for 2 weeks)	Decreased pancreatic enzyme activities (trypsin, chymotrypsin, amylase) and reduced growth	(Perera and Yu´fera 2016b).
		Removal of soyabean meal after 2 weeks	Resumed chymotrypsin and amylase activities, but trypsin activity and growth did not recover	(Perera and Yu´fera 2016b).
	After 3 weeks of common feeding	Normal diet	enhanced fatty acid transport and suppressed peptide absorption, marked by upregulation of intestinal fatty acid binding protein 2 gene related to fatty acid transport and uptake and downregulation of solue carrier family 15 oligopeptide transported member related to dipeptide and tripeptide absorption and gwoth development	(Perera and Yu´fera 2016b)

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ROLE OF SUSTAINABLE PACKAGING IN CONSERVING THE ENVIRONMENT AND FOOD CONTAMINATION

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ABSTRACT

Packaging plays an important role in preserving the food quality where it is an important aspect in controlling the food borne diseases and chemical contamination through food. Packaging material is said to be sustainable if it is recyclable, compostable or bio-based form which is safe for consumers and environmental friendly. Food packaging is a representative of multifaceted nature of sustainability, FP has multiple pro-social functions were it determines how supply chain performer and consumers can distribute and handle food products. FP is a major social impact which enhances food security, where all people, all time have the access to sufficient nutritious food to lead a healthy life. The micro biodegradable polymers from agro-food waste residues is the bright route for the packaging industry where it helps to reduce the wastage, food loss and nutrients can be retained by the soil which helps to restore the environment. Biodegradable packaging development is hampered its technical, social, and environmental benefit. Modified atmospheric packaging (MAP) in which active MAP where active compounds are emitted for instance from packaging material towards headspace where modified atmosphere is created that limits microbial spoilage which is an eco-packaging solution.

Keywords: *Food packaging, biodegradable packaging, modified atmospheric packaging, food quality.*

1. INTRODUCTION

The huge losses of the food is due to the less shelf-life of the food materials which leads to million tons of food waste which causes environmental pollution. The huge losses effects the food security where the availability of food is low (Vermeulen et al., 2012). Food packaging plays an important role in food supply chain and society in protecting the quality of food from microbial and physical damage (Aguirre -Joya et al., 2018).

Conventional packaging is the one where it is of one time use and is discarded after the use of the packed content which generally leads to environmental burden where lots of the materials used were non-recyclable (Jeevahan and Chandrasekaran, 2019). Most commonly used materials include plastics, glass, steel, paper, aluminium and others, nature of plastics which is non degradable and recyclable leads to the land and oceans fills which is not environmental friendly which leads to the emission of toxins during its disposal (Salkani et al., 2019).

2. BRIEF HISTORY OF FINDINGS

Modified atmospheric packaging (MAP) is the one which reduces the oxygen which surrounds the food, it includes others like vacuum packaging, controlled atmospheric packaging and true modified atmospheric packaging. MAP was 1st used on apples to extend its shelf-life during the 1927 (Davies, 1995). In every food type it does not improve the shelf life but helps to restore the colour and other properties for the prepacked foods e.g. smoked and cured foods (Philips, 1996).

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MAP is of two types active and passive packaging, where in active type there is optimum temperature in the packaging is maintain by flushing gases into it. It involves an interaction between the packaging material and the food product (Soroka, 2008b). The major types of active packaging includes Oxygen scavengers which scavenges oxygen molecules in the package headspace, which prevents oxidative damage of oil, flavors, vitamins, color, etc. can be prevented, it also retards the growth of aerobic bacteria and mold. It is the mostly commercially applied technique in food industry, the most commonly used ones include iron powder sachets, which reduces the oxygen concentration in headspace to 0.01% (Robertson, 2007).

Moisture absorbers sachets (silica gel, calcium oxide, and activated clays and minerals) are used in food packaging for humidity control where moisture is a major concern in the food industry which causes the deterioration which causes microbial growth (Shin and Selke, 2014).

Antimicrobial agent releasers are the one used to decrease the surface contamination of the products which are caused during the handling and transportation of the materials. Addition of them in less quantity helps to reduce the growth. The most commonly used is silver ion-based film which is most effective and has no toxic effect on human, others include nisin, pediocin, organic acids, grapefruit seed extract, cinnamon, and horseradish (Han, 2003).

Ethylene scavengers are the which helps to remove the ethylene which accelerates the respiration process, the most commonly used includes potassium permanganate ($KMnO_4$), activated carbon scavengers with many metals were also effective (Rooney, 2005).

Flavor and odor absorbers which helps to absorb the undesirable flavor from the packaging material which destroys the original flavor of the product. The most commonly used is cyclodextrin which helps to absorb the odor gases which are released (Wood, 2011).

The passive type of MAP changes optimum gaseous atmosphere in a package by combining food's respiration and metabolism of microorganisms within food along with permeability of the packaging. With the optimized gaseous environment, degradation reactions such as oxidation, enzyme activity, moisture loss, and postharvest metabolic activities as well as the growth of microorganisms are delayed. The major gases used are nitrogen (N_2), oxygen (O_2), carbon dioxide (CO_2) and other minorly used includes argon (Ar) and carbon monoxide (CO) (Shin and Selke, 2014).

Essential oils (EOs) are secondary metabolic products which were isolated from plant parts like leaves, bark, flowers, bud, seed, root, stem, and fruits. The common method of extraction which is used to isolate oils from plant parts is Hydrodistillaton (Silvestre et al., 2019). EOs acts as an novel alternative to synthetic preservatives in food preservation which has less residual toxicity and adverse effects on humans. Even though, the usage of EOs as preservatives has few limitations such as negative effect on sensory properties, volatility, low stability, and low water solubility, which prevents them in largescale practical usage. Different strategies like nanoencapsulation, active packaging and polymer-based coating involving EOs are alternative solutions for effectiveness in food systems without effecting nutritional qualities (Maurya et al., 2021).

Biodegradable packaging is an alternative source which helps to maintain quality of food compared to conventional method where it helps to extend shelf life, reduces the waste and lowers the environmental burden. The versatility of them which has made from different materials which are natural polymers and has no harm when consumed made to use them in different fields of food science (Restrepo et al., 2018).

Degradation means destruction of the polymer by the action of microbes, macroorganisms, photo/ chemical degradation. The main aim of the packaging is to improve shelf life and maintain quality of the end product. Selection of biobased materials for packaging is based on the characteristics of the product applicable, storage and distribution factors (Petersen, 1999).

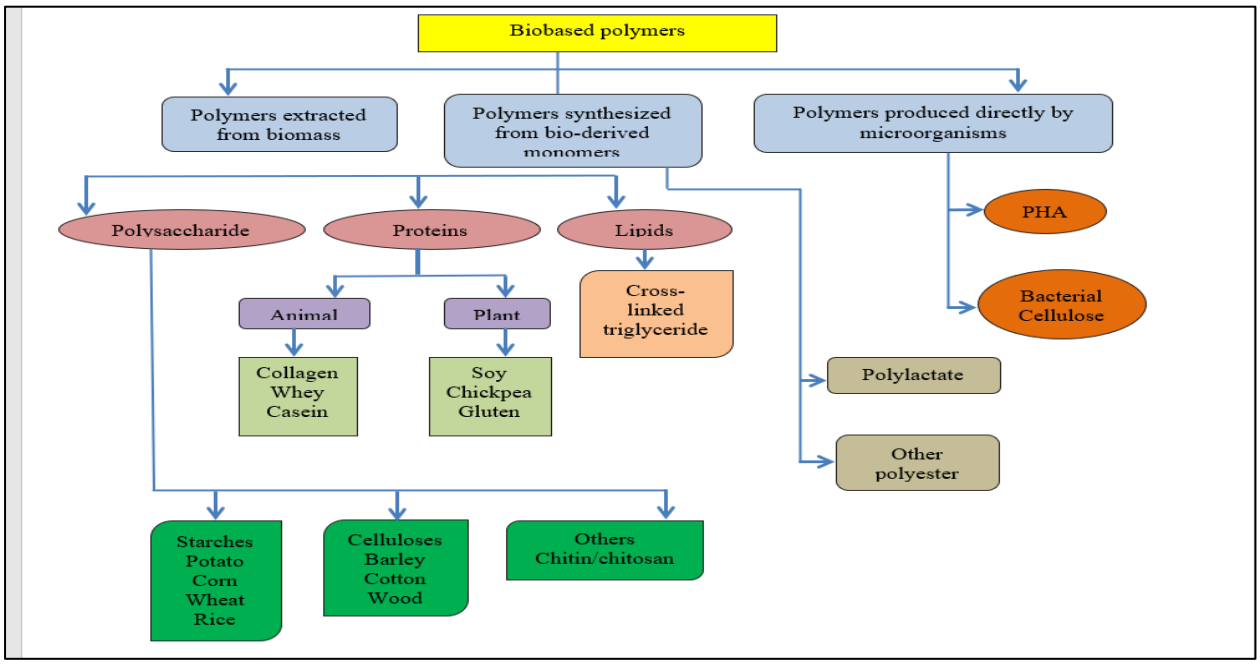

Figure 1. Biodegradable materials classification **(**Van Tuil et al., 2000**).**

Polysaccharides were abundant in nature and has good foaming and filming properties which has high accessibility, low cost, biodegradable all these features makes them to use in sustainable food packaging systems (Nilsen-Nygaard et al., 2020). Cellulose which is crystalline in its structure and insoluble in most of the solvents is used in most of the paper based packaging materials. Film like hydroxypropyl cellulose and methyllcellulose has good gas barrier properties, good fat resistance. The clear films derived from cellulose is mostly used in dry foods and fresh produce, where its application areas are restricted (Cazon et al., 2017).
Starch films has the network of amylose and amylopectin which oxygen barrier and water sensitive properties which can be improved more by increasing their crystallinity which makes it elastic properties poor. Blending with plasticizers (polyvinyl alcohol) helps to reduce the brittleness to some extent (Thakur et al., 2019). In natural biopolymers alginates has good tensile strength, flexibility, mechanical strength and O_2 barrier properties along with fat resistant (Shahabi-Ghahfarrokhi, 2020).
Chitosan are structural polysaccharide of the exoskeleton of crustaceans and insects, chitosan-based films has low gas permeability along with good mechanical properties. In comparison with other natural biopolymers, due to its highwater vapor permeability (WVP) nature limitations were there in the usage (Elsabee and Abdou, 2013).
Protein based films has gained much importance due to their good film forming properties, biodegradability and economically affordable nature e.g., wheat gluten protein and soy protein (Zubair and Ullah, 2020).
The use of natural plasticizer is gaining interest in the sustainable food packaging industries were Polylactic acid (PLA) plays major role which is synthesized from simple sugars of lactic acid. It is costly but due to its ease of processing, transparency and environmental friendliness it is used in packaging industries. Polyhydroxyalcanoates are synthesized by bacterial fermentation, where polyhydroxy butyrate is mostly used where, it has very low resistance to thermal degradation (Bucci et al., 2007). Melt blending is easy, cost-effective and readily available processing technology at industrial level were PHB and PLA has similar melting

temperature and high crystallinity which makes them perfect blends which acts as replacements for the petrochemical based packaging materials (Arrieta et al., 2017).
A biosensor is basically an analytical device used to quantify target in a sample. In food production Global land degradation is one of the biggest challenges due to rapid urbanization, industrialization, pollution, and unsustainable land use. While, bioremediation is the better technology which helps to restore the degraded land has its potential field limitations. Nanomaterial such as gold nanoparticles, quantum dots, carbon nanotubes and nanowires has been applied to food contamination which helps to assess, monitor, and control food environments. This technology provides tools in food security to identify and prioritize environmental risks and reduce food contaminants while balancing the ecosystem (Neethirajan, 2018).

3. ADVANTAGES

It plays an important role in fortifying the outer layers of the product and prevents the loss of moisture, aroma and helps in the normal exchange of gases which plays key role in respiration of food (Otoni et al., 2017), improves sensory properties, acts as carrier of functional components. Addition of antioxidants aids in delay of oxidation reactions which improves food quality and safety (Galus and Kadzinska, 2015).

4. LIMITATIONS

Edible packaging sector has the potential to become an everyday part of consumers due to its new inventories in the field life. However, it will not solve the problem of plastic waste burden but, has a meaningful contribution (Petkoska et al., 2021).

5. CONCLUSION

Packaging plays a major role in the food industry to lower the food wastage losses during handling and transportation. The usage of conventional packaging which is one time use has created huge environmental pollution which can be recycled and causes land filings. As an alternative solution biodegradable packaging and MAP helps to reduce the petrochemical based pollution where the packaging material is produced from agricultural wastes which helps to reduce the environmental pollution and helps to maintain the quality of food by extending its shelf-life. Selection of proper packaging material based on the products that has to be packed plays a major role in reducing the pollution and maintaining the quality of foods.

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CARAMBOLA A VALUABLE SOURCE OF ANTIOXIDANT NUTRACEUTICALS

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ABSTRACT

Starfruit or carambola is the fruit of the Averrhoa carambola tree in the family of Oxalidaceae native to Southeast Asian countries, mainly the Philippines, Indonesia, Malaysia, Vietnam, Nepal, Bangladesh, and India and widely distributed around the world. In Manipur, it is called Heinoujom. The fruit has a star-like segment of five, giving it a star shape. The entire fruit is edible and consumed raw and frequently used in fruit salad and fruit platters, as a garnish in cocktail drinks and beverages, or squeezed into juice and served as a beverage. It is a crunchy, juicy fruit with a light flavour. The skin is waxy yellow or green and edible and the fruit has a tiny dark seed in the centre. The odour of the fruits resembles oxalic acid and their taste varies from very sour to mildly sourish or sweetish.

Traditionally, it is used for treating diabetes, diabetic nephropathy, arthralgia, vomiting, lithangiuria, coughing, hangovers and chronic paroxysmal headache for thousands of years. Fresh star fruit (per 100g) showed: an energy of 31 Kcal, carbohydrates 6.73g, protein 1.04g, and total fat 0.33g. The nutritional value of Starfruit includes; that they are low in calories and a great source of vitamins and other nutrients as well as antioxidants including fibre, protein, vitamin C, vitamin B5, calcium, sodium, folate, copper, potassium, and magnesium. The star fruit is known to have high antioxidant properties that efficiently scavenge free radicals as well as help in hypoglycaemic and hypoglycaemic treatments. Due to the presence of the above nutritional values, the fruit had different health benefits that include anticancer potential, anti-inflammatory ability, weight loss promotion, and immunity boosting ability, improved heart health, and improved digestion. Phytochemical analysis of Starfruit showed the presence of saponins, alkaloids, flavonoids and tannins. Starfruit contains caramboxin and oxalic acid which is harmful to individuals suffering from kidney failure, kidney stones and it also contains toxic substances called neurotoxins that can affect and the brain and causes neurological disorders. Starfruit is as delicious low calorie food except with kidney problems and who take prescription drugs but for most people starfruit is a healthy and tasty addition to diet

Keywords: *Averrhoa carambola, benefits, antioxidant, nutrition, medical properties.*

1. INTRODUCTION

The star-fruit plant, *Averrhoa carambola* L. (family: Oxalidaceae), is widespread around the world, but is particularly common in tropical nations like India, Malaysia, Indonesia, and the Philippines. This starfruit plant is a member of the genus Averrhoa, which also includes the species A. carambola, A. bilimbi, A. dolichocarpa, A. leucopetala, and A. microphylla. A. carambola, however, is commonly grown for commercial purposes. In Manipur, it is called Heinoujom. The most significant species, Averrhoa carambola, is widely farmed in Malaysia and South-east Asia. Additionally, it is a well-liked fruit in the markets of the South Pacific Islands, Australia, and the United States (Muthu et al., 2016). The taste of starfruits is fleshy, crisp, juicy, and somewhat tangy, acidic, and sweet. The entire fruit is edible and consumed raw and frequently used in fruit salad and fruit platters, as a garnish in cocktail drinks and beverages, or squeezed into juice and served as a beverage. It is a crunchy, juicy fruit with a

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light flavour. The skin is waxy yellow or green and edible and the fruit has a tiny dark seed in the centre. The odour of the fruits resembles oxalic acid and their taste varies from very sour to mildly sourish or sweetish (Saghir et al., 2013). This fruit aids in the treatment of hypoglycemia and low cholesterol because of its high antioxidant content, which effectively scavenges free radicals. Additionally, starfruits are frequently used to make juice, pickles, and salads. However, because it aids in reducing the rust brought on by iron oxidation, it can be consumed raw and used to clean utensils. The oxalic acid found in starfruits is widely known for having a negative impact when taken by uremic sufferers (Dasgupta et al., 2013). The present review brings insight towards botanical description of star fruit, nutritional attributes and its medicinal importance.

2. BOTANICAL DESCRIPTION

2.1. Tree

The carambola tree can grow up to 12 metres in height. It has numerous branches, which results in numerous water shoots. While the older plant has a spherical shape, the younger plant has a pyramidal shape.

2.2. Leaves

The leaf is tiny and shaped like an oval. The leaf's flat, golden green upper surface is smooth. It has a dark green lower surface. The length and width of the leaf are 2–9 cm.

2.3. Flowers

The blossom is tiny and has a burgundy hue. It has five petals, five sepals, and five stamens. Under the style is where the ovary is placed. The trunk, branches, and twigs are all where the flowers are generated (Dasgupta et al., 2013).

2.4. Fruit

The fruits have 5.6 angles and ribs and are oval. When cut across, it will take the shape of a star. When young, the fruit is green; when ripe, it becomes yellow or orange. Smooth, juicy, crunchy, sweet but sourish-tasting describe the flesh (Nayak et al., 2018).

3. NUTRITIONAL ATTRIBUTES OF STAR-FRUIT

The starfruit is a good source of a number of vitamins and minerals. The natural antioxidants L-ascorbic acid (Vitamin C) and gallic acid, which help scavenge reactive oxidative species, are abundant in starfruits as well (ROS). According to the research, starfruits are an excellent source of magnesium, potassium, and phosphorus as well as -carotene and vitamin C, two typical antioxidants (Lakmal et al., 2021). Iron, zinc, and manganese, three antioxidants included in the fruits, help to boost the immune system. Table 1. defined the minerals found in star fruit. Furthermore, the high fibre content of fruits helps to absorb glucose while delaying its absorption into the bloodstream, so assisting in the regulation of blood glucose concentration. As it facilitates the removal of cholesterol, lipid, and bile acid through excretion, starfruit consumption also has a hypocholesterolemic and hypolipidemic effect. Fresh star fruit (per 100g) showed: an energy of 31 Kcal, carbohydrates 6.73g, protein 1.04g, and total fat 0.33g (Lakmal et al., 2021; Nayak et al., 2018). Table 2. described the carotene, vitamins and acids found in mature star fruit.

Table 1. Minerals composition of starfruit

Minerals	**Amount [mg/100g fruit]***	**References**
Sodium (Na)	3.8 - 3.85	Bhaskar and Shantaram, 2013; Ruvini et al., 2017; Pang et al., 2016
Potassium (K)	167.13 -168.0	
Calcium (Ca)	6.37 - 6.40	
Phosphorous (P)	17.87 - 17.88	
Magnesium (Mg)	11.85 - 12.05	
Iron (Fe)	0.34 - 0.45	
Copper (Cu)	0.19 - 0.45	
Zinc (Zn)	0.29 - 0.51	
Manganese (Mn)	0.04 – 0.52	
Selenium (Se)	Not detectable	

*On a dry weight basis

Table 2. Carotene, vitamin and acids composition in mature starfruit

Components	**Amount [mg/100g Starfruit weight]***	**References**
Carotene	0.003 – 0.55	Ruvini et al., 2017; Pang et al., 2016; Bhaskar and Shantaram, 2013; Narain et al., 2001
Tartaric acid	4.37	
Oxalic acid	9.6	
Ketoglutaric acid	2.2	
Citric acid	1.32	
Vitamin B1 and B2	0.12	
Vitamin C	25.8	

*On a dry weight basis

4. MEDICINAL PROPERTIES

Herbal remedies are currently gaining popularity as an alternative to drug therapy on a global scale. In addition to serving as a food source, starfruits are also widely used in Ayurvedic and traditional Chinese medicine preparations as a treatment for fever, sore throat, cough, asthma, chronic headaches, and skin inflammations (Manda et al., 2012). They are also regarded as herbs in many regions of Brazil, China, India, Malaysia, and Taiwan. According to phytochemical and pharmaceutical studies, the leaves, fruits, and roots of the star fruit plant contain extracts that are known to have antioxidant and particular therapeutic characteristics such as saponins, flavonoids, alkaloids, and tannins (Gunasekara et al., 2011). The different medicinal properties of star fruit are discussed below:

4.1. Antioxidant property

According to studies, proanthocyanins, in addition to vitamin C and gallic acid, are an antioxidant found in starfruits. Scavenging ROS like peroxides is the primary function of antioxidants. Fatty acids are typically vulnerable to oxidative harm from peroxides and hyperperoxides. Consuming starfruits helps the body remove toxins and supports the immune system's defences against cancer, ROS damage, and lipoperoxidation (Thomas et al., 2008).

4.2. A source of water insoluble fibres

When drinking star fruit juice, the fiber-containing leftovers of the fruits are frequently not included. Despite this, the starfruit has a cellulose content of about 60%, hemicelluloses of 27%, and pectin of 13%. It suggests that insoluble fibre components are definitely abundant in starfruit (IFF). Water-insoluble fibre fractions, or WIFFs, are insoluble fibres that can hold

onto water better than cellulose (Yasawardene et al., 2021). WIFFs actually facilitate regular bowel movements and have the power to reduce blood sugar by delaying the body's absorption of carbohydrates. The fibres also assist in decreasing the body's total cholesterol level by generating a hypoglycemic effect. Consuming fruit juice and fibres in a smoothie lowers the risk of cardiovascular disease by assisting in the removal of lipids through excretion. Additionally, it has been found that starfruit extracts exhibit specific anti-tumour action (Saha et al., 2018).

4.3. Anti- inflammatory and anti-microbial property

According to research by *Cabrini et al*., star fruit extracts' anti-inflammatory properties aid in reducing skin inflammation. On a mouse model, researchers used croton oil to create an eczema-like skin inflammation. Mice's eczema was gradually reduced and inflammation was lessened when ethanolic extracts of star-fruit plant leaves were applied to the skin. Additionally, the extracts were reported to inhibit the growth of Klebsiella spp. (MBC of 125mg/ml) and Staphylococcus aureus (MBC of 15.62mg/ml) in varied concentrations. Extracts were also effective against *Escherichia coli*, *Pseudomonas aeruginosa* and *Bacillus cereus* (Saha et al., 2018).

4.4. Anti-Ulcer Property

Starfruits have long been used to treat ulcer-like conditions and stomach discomfort. According to *Cabrini et al* study results, star-fruit plant leaf extracts contain anti-ulcerogenic characteristics. Terpenoids (diterpenes and triterpenes), flavonoids, and mucilage, which are known to have the anti-ulcer activity, are present in the extracts. The mucilage serves as a lining for the mucosa in the gastro-intestinal tract, preventing damage from gastritis (Yasawardene et al., 2021).

5. CONCLUSION

The starfruit is a good source of essential natural compounds for human health, both nutritionally and medicinally. However, those with renal issues should avoid eating the fruits because of their high oxalate and caramboxin levels. The Star-transcriptomics fruit's study will help us understand the genes that are expressed in it, and the identification of novel genes may aid in the design of an innovative plan for the genetic engineering of this plant to specifically target the oxalate and caramboxin biosynthesis pathways to improve the nutritional quality of the fruit.

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STONE APPLE FRUIT AS A BIOACTIVE SOURCE AND HEALTH BENEFITS

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ABSTRACT

Stone apple scientifically known as *Aegle marmelos* belongs to the family *Rutaceae*. The bael is the large fruit and the color is pale yellow to golden orange when ripe. Its leaves are offered in prayers of lord shiv. It is one of the most important medicinal plants in India. Bael has been used in the Ayurveda as a part of various formulations since ancient times to help with many diseases like dysentery, earaches, and discharge from the ears, fever, and cold. The nutritional benefits of Bael fruit are composed of fat 0.8%, protein as 1.8%, fiber 2.9%, carbohydrate 31.6%, calcium 0.09% and phosphorus as 0.05%.

Purpose: The present study is to evaluate the bioactive constituents and health potentials of Bael fruit in the previous studies done. The plants contribute a variety of bioactive compounds in fruit, bark, leaves, seeds, and roots such as coumarin, xanthotoxol, imperatorin, aegeline, and marmeline. These compounds can provide antidiabetic, anticancerous, antifertility, antimicrobial, immunogenic, and insecticidal activities.

Methodology: Different review and research papers are collected for the present study evaluation to know about bioactive and health status of the plant. Findings done on Bael plant was identified and the present study highlights the nutritional, bioactive and health benefits of plant among consumers.

Findings: Bael has bundle of bioactive compounds which highlight the health status of the plant. Utilization of bael fruit in day-to-day life has a great nutritional, environmental as well as commercial importance and all the parts of tree including stem, leaves, seed, bark, flower and fruit are utilized for various purposes. The presence of bioactive compounds helps to reduce the swelling and help in the treatment various diseases like asthma and diarrhoea, provide various benefits to the body like it boost the immunity, provide good digestion, reduce the cholesterol level, prevent the skin infections and also act as a blood purifier.

Keywords: *Bael, bioactive constituents, health benefits, nutritional profile, food products.*

1. INTRODUCTION

The subtropical fruit *Aegle marmelos* or commonly known as Bawl belong to the Rutaceae family. There are several plant which have tremendous therapeutic applications in Indian medicine system from ancient times and bael is one of them. It also possesses great mythological importance in Hindu religion (Gurjar et al., 2015; Gopal, 2020). Leaf of this sacred tree which is vernacularly known as Tripatra has been essential in offering to Lord Shiva. Every part of this tree such as root, bark, leaves, flower and fruit can be utilized in different fields. The wild variety of fruit is similar in size than cultivated type and also not popular for commercial purpose (Neeraj and Johar, 2017). A wide range of cultivar variety included Kagzi Gonda, Gonda no 2, Kagzi Etawah, Mirzapur. In different languages bael is named different as Bilwa, Shiva phal, Sanskrit. A different medicinal system like Siddha, Unani, and Ayurvedic system provide information about the potential effects of bael. Various studies on bael reveal that it acquires a variety of nutraceutical elements like a large group of phytochemicals which include phenolic acid, flavonoids, alkaloids, tannins and coumarins

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(Gopal, 2020). Other than these amino acid, fatty acids, a wide range of organic acid, minerals, carbohydrates, vitamins, fibres make bael a highly nutrition fruit with immense health benefits. The peel of the fruit is very hard shell and green to brown in colour depends on the ripening stage. The appearance of yellow or orange edible pulp is like a boiled pumpkin. Seeds are surrounded by the transparent mucilage. The uses of bael fruit in aspect of food have many forms in each country. For example, the ripe fruit is consumed fresh and also in form of nectar, squash, sharbat, jam, marmalade, and cream in India (Singh et al., 2019). Various bioactive compounds are present in the bael fruit like beta-carotene, marmelosin, luvangetin, riboflavin, flavonols, flavonoids, glycosides, leucoanthocyanins, umbelliferon and anthocyanins. These compounds cannot be available easily in any other fruit and have particular importance in the pharmacy for preparing food additives and medicines. The polyphenols which are characterized as phenolic acids, stilbenes, flavonoids and liganins exhibits the antioxidants activity and can be useful for heart diseases. The flavonoids include flavanols, anthocyanins, flavones etc. which prevent coronary heart diseases, oxidation and cancer of membrane lipids (Lakht-e-Zehra et al., 2015). The present review represents the botanical description, nutritional composition, medicinal uses and value added products of stone fruit.

2. BOTANICAL DESCRIPTION

This growing tree is found to have a medium height of nearly about 762 cm and plant parts includes bark, leaf, flower, fruit and seed. Spiny branches of stem are observed in bael tree. The leaves are in an alternated fashion, generally trifoliate contains leaflets of 3-5 number, having a length of 4-10cm with 2-5cm width (Chhetri et al., 2021). A comparatively lighter green in colour on maturation bark of tree is thick and flaking often spiny branches. From the wounded bark gum secretion is observed, which turns thick when comes in contact with air. The flower of bael is a greenish white colour. The pulp of fruit is yellow in colour and mucilaginous. It contains some dots on the outer surface and also contain numerous seed, which are hard and having a threads like hairs over their outer surface which is white (Baliga et al., 2012).

3. TRADITIONAL USES

Extensive use of bael has been found in Ayurveda and traditional medicine system. Each part of bael is found to have the potential for curing various disease. Following are the traditional uses of bael fruit

3.1. Leaf

In the treatment of jaundice, asthma, it is found to very useful. Bael leaves are good aid in removing mucilage secretion from bronchial tubes. Applications is found in conjunctivitis treatment and even in curing constipations, deafness and leuccorrhoea. Bael leaf are essential oil is reported to show various therapeutic actions (Singh et al., 2019).

3.2. Fruit

It is very helpful in curing vomiting during pregnancy when take with rice water in boiling condition. The pulp, of the unripe fruit is very helpful. Starch present in unripe fruit convert to sugar with heat treatment, then the fruit extract is added with hot water and anise and stained the extract found in useful in dysentery Ripe fruit juice extract help in lowering blood sugar levels owing to its bitter flavour. Powdered fruit and mustard oil in ratio of 1:2 is used in burn treatment (Singh and Chaurasiya, 2014).

3.3. Flower

The flower has astringent as well as an antiseptic properties used in epilepsy. Bael flowers found helpful in wound healing properties.

3.4. Root and bark

The decoction of root and bark is useful in heart palpitation and intermittent fever. In preparation for a popular ayurvedic medicine dashmula bael tree root is used as one of the ingredient. It is also one of the most Important ingredient of Chyavanprash (Chhetri et al., 2021).

4. NUTRITIONAL COMPOSITION

It is clear from numerous research on the nutritional makeup of bael that the fruit is rich in a variety of elements that are very good for human health. The fruit reportedly includes several types of carbohydrate, vitamins, a lot of minerals, different fatty acids, and amino acids acid. It contains a lot of sugar, glucose, and fibre (Singh and Chaurasiya, 2014). Bael is abundant in vitamins such as vitamin A, vitamin B group, and vitamin C. Bael discovered to have antioxidant properties, reducing rancidity and colour fading. The stated minerals from the fruit's edible section are phosphorus, potassium, calcium, iron, and their salts. It contains moisture, mineral, phosphorus, potassium, calcium, fiber, protein and carotene in fruit juice possesses a higher amount of fat content (Pathirana et al., 2020). Fruit pulp and leaves are very low in the fat content. Some important nutritional value is shown in Table 1.

Table 1. Nutritional composition of Bael fruit

Nutrients	**Quantity**	**References**
Calories	88g	Chuadhary et al., 2020; Dhakar et al., 2019; Ankita et al., 2018
Fat	0.3g	
Carbohydrate	32g	
Fiber	2.9g	
Protein	1.8g	
Vitamin C	8.7g	
Riboflavin	1.19g	

5. PHYTOCHEMICALS IN BAEL

Bael contains a good number of polyphenols as well as flavonoids. Bael fruit juice have been reported to be rich in numerous health-boosting compounds. Alkaloids, flavonoids, phenolic compounds, terpenoids have been accumulated in bael pulp (Singh and Chaurasiya, 2014). The most important polyphenols and flavonoids include alkaloids, coumarins, polysaccharides, and carotenoids. Polyphenols present in bael depends on the maturity stage of bael. From showing anti-oxidant activities to lipid cholesterol absorption these phytochemicals possess immense health benefits. Phenolic compounds in bael fruit juice include caffeic acid, arbutin, chlorogenic acid, p-coumaric acid, p-coumaroyl, quinin acid, and protocatechuic acid. Terpenoids, flavonoids, saponins, tannins, glycosides have been isolated from bael fruit (Murthy et al., 2020). Bael leaves also retains phytochemicals in a good amount, the reported compound includes γ-sitosterol, rutin, β-sitosterol, glycosides, marmeline, aegelin, marmesinin, halfordiol, phenyl ethyl cinnamamides and lupeol. Catechin, flavanols, flavones, lignin, tannins, and iso-flavones fall under the polyphenol group (Singh and Chaurasiya, 2014).

5.1. Antimicrobial activity

The antibacterial activity of present in the leaves, bark and fruit of *A. marmelos*. The *Aegle marmelos* in the traditional system of medicine to treat various infectious diseases. The leaves contain the antimicrobial property (Singh and Chaurasiya, 2014).

5.2. Antifungal activity

The bael contain the essential oil in their leaves which act as the antifungal compounds. The root of the fruit is also used for treating various fungal disease. It inhibits the spore germination and kill the bacteria (Murthy et al., 2020.

6. VALUE-ADDED PRODUCT OF BAEL

Different bael items have been created from various bael tree sections. Being a seasonal fruit, bael is extremely rich in nutrients, but because it must be used to manufacture a variety of bael products, those nutrients may not always be available.

6.1. Bael juice

Bael pulp extracted with water and mixed with different ingredient like sugar + lime + jaggery + lime flavoring component cardamom powder.

6.2. Bael jam

Bael fruit pulp is extracted with water and cooked with adding different combination of sugar (75%, 100%, 150%) for 20 min. Lime juice is added to set pectin. After 20 min cooking the jam is tested for the jam consistency.

6.3. Bael toffee

Bael fruit pulp is extracted with water and cooked for 20 min with adding different combination of sugar (75%,100%&200). After 2o min in to cooking ghee is poured f in thick bottom pan with cooked pulp, corn flour, milk powder and citric acid is added by dissolving in water. After adding the mixture for 20 min and consistency is tested (Pal et al., 2017).

6.4. Bael preserve

Green fruit are used to make murraba or preserved. The fruit is peeled using knife and slice crosswise into the pieces of all about 2 cm thickness and then washed with water. The slices are picked from both sides and place on the boiler. Treat fruit until it become soft. The treated fruits are placed in stainless steel container and sugar syrup is poured in it. On successive days the syrup of higher concentration up to 70% and afterwards the preserved is stored in glass (Pal et al., 2017).

6.5. Bael fruit powder

A thin sheet of bael powder having a moisture content of below 4% was prepared by drying the pulp and was the grounded to powder. Other method is dried fruit slices in a grinder which was then packed into the polythene bags and stored in a dry place.

7. MEDICINAL PROPERTIES OF BAEL

7.1. Diarrhoea and dysentery

Chronic diarrhoea can be treated with the use of bael fruit especially half ripe or unripe fruit. Dried bael fruit powder is the best one for this purpose (Gopal, 2020). The astringency of unripe fruit is the key tom treat chronic diarrhoea and dysentery compounds extracted from bael fruit demonstrate powerful effects in fighting off dangerous bacteria. The bacteria Shigella

dysenteries binds to cells in the colon, causing diarrhoea, fever, and stomach pain (Gurjar et al., 2015).

7.2. Diabetes

Diabetes occur in the human body due to lack of insulin so in the treatment of diabetes it is required to get insulin extremely in similar fashion bael can replace insulin by enhancing the extremely glucose the clotting which in a way affects the blood circulation (Singh et al., 2019).

8. CONCLUSION AND FUTURE PROSPECT

Aegles marmelos, also known as the brilliant apple, stone apple, wood apple, Bengal quince, and bael, has remarkable health benefits and restorative properties. It is used as a home remedy for a variety of medical conditions, including obstruction, peptic ulcer, acid reflux, respiratory problems, loose stools, and respiratory problems. A. marmelos is very protective against infections caused by bacteria, viruses, and parasites. Its relevance is increased by its commendable flavor and function as a revitalizing refreshment for beverages containing A. marmelos. Large-scale fruit production has not yet taken place; the only processing and product industries based on A. marmelos are still unorganized development, but its commercial aspects, such as value-added products, impressive. Effectively engaged research is necessary to uncover undiscovered truths and unique goods**.** However, this plant's cultivation is still in little supply, and it grows slowly. Consuming bael is harmless and has no adverse effects on any bodily organ, according to studies. It is necessary to standardize the bael extract's bioavailability and its doze.

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QUALITY EVALUATION OF FORMULATED INSTANT NOODLES FROM WHEAT, RICE (*Oryza sativa*) AND MUSHROOM (*Agaricus bisporus*) FLOUR BLENDS

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ABSTRACT

This study evaluated the quality of instant noodles from wheat, rice and mushroom flour blends. A composite flour of wheat and rice flours (90:10) was obtained as the best blends after a preliminary sensory evaluation and substituted with 10, 20, 30, 40 and 50 % mushroom flour coded as WRM1 (90:10), WRM2 (80:20), WRM3 (70:30), WRM4 (60:40), WRM5 (50:50) and commercial noodles (Indomie) served as the control. The formulated blends were used to produce instant noodles. The instant noodles were analysed for proximate composition, micronutrients (vitamin B_1, B_2 and B_3, iron, potassium, and phosphorus) microbial quality, cooking characteristics, sensory qualities and functional properties of the flour blends using standard procedures. Results showed that mushroom flour increased the crude protein (9.49-15.39 %), ash (1.39-5.31 %), crude fiber (1.50-5.40 %), moisture content (7.92-14.48 %). It, however, decreased the fat (0.5-1.50 %) and carbohydrate content (58.42-77.45 %). Potassium and Vitamin B_3 were identified as the predominant micronutrients in the instant noodles samples and increased with level of mushroom addition. Sample WRM1 (90:10) with 10% mushroom flour had the highest mean for all sensory attributes (taste, colour, appearance, texture, and overall acceptability) compared to other samples. The total viable count ranged from 4.3×10^2 (control) to 1.78×10^3 cfu/g in sample WRM4 (60:40). Thus, mushroom flour could be incorporated into instant noodles to obtain an acceptable product rich in dietary fiber, protein, ash, vitamin B_3 and potassium but low in fat and carbohydrate.

Keywords: *Noodles, Rice flours, Wheat flour, mushroom flour, composite flour blends.*

1. INTRODUCTION

Noodles are narrow strip of unleavened dough which is stretched, extruded or rolled flat and cut into one of a variety of shapes (Anon, 2019). Noodle has been increasingly an important food commodity worldwide, with annual production of 101,420 million packs in 2012, and a steady increase of 3% annually since 2010 (World Instant Noodle Association, 2019).

There are many types of noodles, but the "instant" types continue to show increasing popularity globally as these products offer ease in preparation while being economical and tasty(Akanbi *et al.*, 2011). Noodles are produced basically from wheat flour. However, wheat production in Nigeria has been unpredictable. Reports indicated that up to 1985, domestic wheat production in Nigeria was about 66,000 tons (Olugbemi, 1991). In 1988/89 crop production season about 600,000 tons of wheat was produced from a total of 214,000 hectares with an average yield of 2 tons per hectare (Olugbemi, 1991). In 2011 the production was 165,000 metric tonnes which drastically dropped to 60,000 metric tonnes in 2016 (Olugbemi, 1991), thus noodle production depended on wheat importation mostly from the United States since wheat cannot perform well under tropical climate. This wheat importation has resulted to an immerse drain on the economy, suppressing and

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displacing of indigenous cereals, with a resultant detrimental effect on the agricultural and technological development, and cause of poverty in Nigeria (Kumara, 2015). In order to reduce the impact of wheat importation on the economy, the Federal Government released a policy mandating flour mills to partially or wholly substitute wheat flour (Ammar *et al.,* 2009). This resulted in the adoption of alternative solutions by using flours gotten from other raw materials in combination with wheat flour. In addition to wheat importation, noodles prepared from wheat flour cannot be consumed by the entire population, because some individuals are intolerant to gluten present in this flour. The increasing demands for gluten free products is due to their beneficial health aspects as they induce a low-glycemic index for diabetic patients, reduced risks of celiac diseases and allergic reactions, as caused by eating wheat-based products (Torbica *et al.,* 2010). Celiac disease is a lifelong autoimmune disorder that is passed on genetically, triggered by the ingestion of proteins of wheat, rye, and barley in genetically susceptible individuals which comprises approximately 1% of the worldwide population (Renzetti *et al.,* 2012). The only satisfactory solution treatment for gluten intolerance is complete avoidance of wheat, rye, barley, oatmeal and their derivatives in the diet (Raymond *et al.,* 2006). The substitution of these cereals can be done with soy, rice, corn, potatoes, cassava and yams, and among these, rice is the least allergic.

Rice is regarded as one of the most appropriate cereal grains for producing gluten-free products owing to its benefits of high digestibility, hypoallergenic properties among others (Marco and Rosell, 2008). Rice-based noodles are prepared from rice cultivars containing high-amylose content, low-gelatinization temperature and high-gel consistency (Yoenyongbuddhagal *et al.*, 2002). Textural and cooking properties of rice-based noodles are dependent upon flour swelling power, pasting properties and gel hardness (Bhattacharya *et al.,* 1999) which directly affects consumer acceptance (Hormdok and Noomhorm, 2007).

In general, products made from cereals are low in sodium, amino acids and total fat. Noodles produced from wheat flour contain 11-15 % protein dry basis but deficient in lysine and threonine (the first and second limiting amino acid), common to most cereal products (Tongpun, 2006). Cereals are rich in minerals but the bioavailability of these minerals is usually low due to the presence of anti-nutritional factors such as phytate, trypsin inhibitor and polyphenols. Phytic acid is most important anti-nutrient because it is found in most of the cereals and has strong ability to complex multi-charged metal ions, especially zinc, calcium and iron and makes them unavailable for human body utilization. The absence of lysine makes it difficult for the body to synthesize protein, hormones, enzymes and antibodies which are needed for growth and other functions (Flodin, 1997). Food fortification is adopted to improve the nutritive value of noodles made from cereals.

Mushroom is a macro fungus with a distinctive fruiting body, which can be either epigeous or hypogenous and large enough to be seen with naked eye and to be picked by hand (Chang and Miles, 1992). These mushrooms have a wide range of health benefits, like antiviral, antioxidative, antitumor and hypocholesterolaemic effects (Kim *et al*., 2014). Mushrooms also present high nutritional value, having some bioactive components, like dietary fibre, antioxidants, minerals, folates, essential amino acids (such as lysine) as well as vitamins B_1, B_2, B_3 and C (Li *et al*., 2015), and a wide spectrum of mineral substances, it represents a good source of biologically valuable substances for human nutrition

2. MATERIALS and METHODS

2.1. Materials

Wheat (Crown flour mill) flour and vegetable oil (Power oil) were purchased from Ogige market, Nsukka Enugu State, Nigeria. Parboiled seeds of Rice (*Oryza sativa*) were obtained from Adani Rice Mill in Uzo Uwani Local Government Area, Enugu State, Nigeria. Mushroom (*Agaricus bisporu*) was procured from Afor Enyiogugu market, Mbaise, Imo State, Nigeria.

2.2. Methods

The mushroom (*Agaricus bisporu*) was processed by modifying the method described by Bello et al. (2017). Fresh mushrooms were cleaned, cut into slices (about 3 mm thickness) and sundried. Dried mushroom sample were milled and sifted through an 80 mesh screen to obtain fine powders. The obtained powder were cooled and hygienically packed and stored in air tight container for further use.

The Rice flour was processed by modifying the method described by Iwe et al., (2016). Parboiled rice grains were cleaned, sorted and washed, then steeped in water for 12 h, drained and dried in a hot air laboratory oven (LABE 1201, Divine International, Delhi). Milling of the dried rice grains was done using a rice milling machine (Angel bergs, miller Germany) and the milled grains was sieved using a 300 μm mesh size sieve to obtain fine flour which is designated as DM/PRF (Dried or Milled Parboiled Rice Flour)

2.2.1. Formulation of blends

The flours obtained from rice and wheat was blended in different percentage as shown in Table 1 to produce noodles. The noodles produced from the blended flour were subjected to sensory evaluation in order to obtain the best blend. Based on the sensory evaluation of the noodles, the blend of wheat and rice flour (90:10) was chosen as the best blend. The best blend was then blended with mushroom flour as shown in Table 2 to produce the final product.

Table 1. Blending ratios of wheat and rice flour

Sample code	**Wheat/ local rice flour blend (90:10 best blend) (%)**	**Mushroom flour (%)**
WF + RF_0 (100:0)	100	0
WF + RF00 (0:100)	0	100
WF + RF1 (90:10)	90	10
WF + RF_2 (80:20)	80	20
WR/MF_3 (70:30)	70	30
WR/MF_4 (60:40)	60	40
WR/MF_5 (50:50)	50	50

Key:

WR = wheat flour + rice flour blend; WF + RF_0 = 100% wheat flour and 0% rice flour; WF + RF_{00} = 0% wheat flour and 100% rice flour; WF + RF_1 = 90% of wheat flour and 10% rice flour; WF +RF_2 = 80% wheat flour and 20% rice flour; WF + RF_3 = 70% wheat flour and 30% rice flour; WF + RF_4= 60% wheat flour and 40% rice flour**;** WF + RF_5 = 50% wheat flour and 50% rice flour

Table 2. Blending ratios of wheat/ rice flour and mushroom flour

Sample code	**Wheat/ local rice flour blend (90:10 best blend) (%)**	**Mushroom flour (%)**
WR/MF_0 (100:0)	100	0
WR/MF_1 (90:10)	90	10
WR/MF_2 (80:20)	80	20
WR/MF_3 (70:30)	70	30
WR/MF_4 (60:40)	60	40
WR/MF_5 (50:50)	50	50

Key:
WR = wheat flour + rice flour blend; MF = mushroom flour; WR/MF_0 = 100 % of the best blend flour and 0% of mushroom flour; WR/MF_1 = 90 % of the best blend flour and 10 % of mushroom flour; WR/MF_2 = 80 % of the best blend flour and 20 % of mushroom flour; WR/MF_3 (70:30) =70 % of the best blend flour and 30 % of mushroom flour; WR/MF_4= 60 % of the best blend and 40 % of mushroom flour; WR/MF_5= 50 % of the best blend and 50 % of mushroom flour

2.2.2. Production of Instant Noodles

The noodles were produced using the method described by Hou (2001). One hundred grams (100 g) of the blended flour were mixed with 38 ml of water and 1 g of salt and kneaded until the flour forms dough sheets of about 3 mm thickness. The crumbly dough obtained was rested for 30 minutes to mature and then kneaded to uniformly distribute the ingredients and hydrate all the flour particles. The dough was then passed through rotating rollers of a hand operating extruder (LAMI LM-20, China) to produce a noodle sheet. The sheet was repeatedly folded and passed through the rollers to facilitate gluten development, which gives the noodles its stringy and chewy texture. The gap between the finishing rolls was adjusted to produce the desired thickness of the noodle belt that was then immediately cut in the cutting section of the same machine. The noodles were steamed at 98-100 ^oC for 1-5 minutes, which gelatinizes the starch and improves the texture of the noodles, after which the noodles were dried by frying in oil at 135-145 ^oC for 2 minutes.

2.2.3. Analysis of raw materials and noodles produced from wheat, local rice and mushroom

The flours were analyzed for their proximate, functional properties and micro-nutrients while the noodles were analyzed for their proximate composition, cooking characteristics, microbial analysis for one month at seven (7) days interval, sensory attribute and micronutrients.

2.2.4. Determination of proximate composition

Moisture content, crude fibre, ash, protein, fat were determined using AOAC (2010) method while carbohydrate content was determined by difference.

2.2.5. Determination of selected functional properties of flour blends

The methods described by Onwuka (2018) were used in the determination of the functional properties of the flour blends. The functional properties determined included the water and oil absorption capacities, bulk density and swelling capacity.

2.2.6. Determination of water and oil absorption capacities

The water absorption capacity of the flours was determined as follows. One (1) gram of sample was mixed with 10 mL of distilled water using a waring whirl mixer. The sample was allowed to stand at ambient temperature (30±2 °C) for 30 seconds and then centrifuged for 30 minutes at

5,000 rpm × g. Water absorption was examined as per cent water bound per gram flour. For oil absorption capacity one gram of sample was mixed with 10 mL soybean oil (Sp. Gravity: 0.9092) and allow to stand at ambient temperature (30±2 °C) for 30 minutes and then centrifuged for 30 min at 5,000 rpm × g. Oil absorption was examined as percent oil bound per gram flour.
Absorbed water/ oil = total water/oil – free water/oil x density of water/oil.

2.2.7. Determination of bulk density

The bulk density was determined as follows. A graduated measuring cylinder of 10 ml capacity was weighed and gently filled with the sample, followed by gently tapping the bottom until there was no further diminution of the sample level after filling to the 10ml mark.
The bulk density was calculated as:
Bulk density (g / ml) = Weight of sample (g)/ Volume of sample (ml)

2.2.8. Determination of swelling capacity

The swelling capacity was determined by modifying the method of Prescott *et al., (*2005). The flour sample (0.1 g) was weighed into a test tube and 10 ml of distilled water added. The mixture was heated in a water bath at a temperature of 50°C for 30 minutes with continuous shaking. In the end, the test tube was centrifuged at 1500 rpm for 20 minutes in order to facilitate the removal of the supernatant which was carefully decanted and the weight of the starch paste taken. This was carried out over a temperature range of 50 – 100 °C. The swelling power was calculated as follows:

$$\text{Swelling power} = \frac{\text{weight of starch paste}}{\text{weight of dry starch sample}}$$

2.2.9. Determination of micronutrient

2.2.9.1. Determination of vitamins

2.2.9.1.1. Determination of vitamin B_1 (Thiamine)

Thiamin was determined using AOAC (2010) procedure. Seventy five milliliter (75 ml) of 0.2 N HCl was added to 2 g of sample and the mixture boiled over a water bath (Stuart; RE300B, UK). After cooling, 5 ml of phosphatase enzyme solution was then added and the mixture incubated at 37 ^{o}C overnight. The solution was placed in 100 ml volumetric flask and the volume made up with distilled H_2O. The solution was filtered and the filtrate purified by passing through silicate column. To 25 ml of the filtrate in a conical flask was added 5 ml acidic KCl eludate, 3 ml of alkaline ferricyanide solution, and 15 ml isobutanol, and shaken for 2 mins. The solution was then allowed to separate and the alcohol layer taken. About 3 g of anhydrous sodium sulphate was added to the alcohol layer. A 5 ml of thiamine solution was accurately measured into another 50 ml stoppered flask. The oxidation and extraction of thiochrome as already carried out with the sample was repeated using thiamine solution. A 3 ml of 15 % NaOH was added to the blank instead of alkaline ferricyanide. The blank sample solution was poured into fluorescence reading tube and reading taken: Thiamine was calculated as follows:

$$\% \text{ thiamine} = \frac{X}{Y} \times \frac{1}{5} \times \frac{25}{V} \times \frac{100}{W}$$

Where W= weight of sample; X = reading of sample- reading of blank; Y = reading of thiamine standard – reading of blank standard; V = volume of solution used for test on the column.

2.2.9.1.2. Determination of vitamin B_2 (Riboflavin)

The method of AOAC (2010) was used. Two grams (2 g) food material was taken in a conical flask. Fifty millimeters (50 ml) of 0.2N HCl was added and boiled in a water bath (Stuart; RE300B, UK) for 1h. The solution was cooled and the pH adjusted to 6.0 using NaOH. About I N HCl was added to lower pH (METER TOLED. Seven-Multi. pH MV/ORP-MTW 1.49/01.38. Schwerzenback) to 4.5, then filtered in a 100 ml measuring flask and used to make volume up to mark. To remove interference, two tubes was taken and labeled 1 and 2 for tube 1 and 10 ml of filteration, and 1 ml of water for tube 2 respectively. Then, 10 ml of filtrate was added to 1ml of riboflavin standard. One milliliter (1 ml) of acetic acid (glacial) was added to each test tube, mixed and then 0.5 ml of 3 % $KMnO_4$ solution was added. The solution was kept away for 2 min and then 0.5 ml of 0.3 % H_2O_2 added and mixed well. The flourimeter was adjusted to exicitation wavelength of 470 nm and emission wavelength of 525 nm. Also, the flourimeter was adjusted to zero deflection against 0.1 N H_2SO_4 and 100 against tube 2. The fluorescence tube was measured. Twenty milligram (20 g) of sodium hydrogen sulphate was added to both tubes and fluorescence measured within 10 seconds and recorded as blank readings.

Calculation:

Wt = weight sample

X = (reading of sample 1) – (reading of sample blank)

Y = (reading of sample + standard tube 2) – (reading of sample + standard blank)

Riboflavin (mg per sample) = X/Y-X x 1/wt

2.2.9.1.3. Determination of vitamin B_3 (Niacin)

Five grams (5 g) of the sample was treated with 50 ml of 1 N sulphuric acid for 30 minutes. 0.5 ml ammonia solution was added to it and it was then filtered. To 10 ml of the filtrate, 5 ml of 0.5 % potassium cyanide was added. This was further acidified with 5 ml of 0.02 N sulphuric acid. The absorbance of the resultant solution was recorded at 420 nm. The absorbance obtained from the sample extract was converted to Niacin concentration by means of a calibration curve generated using different standard concentrations

2.2.9.2. Determination of minerals

Mineral analysis was determined using the method described by AOAC (2010). Two grams (2g) of the sample were weighed and subjected to dry ashing for 5 hours in a well cleaned porcelain crucible at 550 ^oC. The resultant ash was dissolved in 5ml of $HNO_3/HCl/H_2O$ (1:2:3) and heated gently on a hot plate until brown fume disappears, remaining the mineral. Deionized water of 5ml was added and heated until colourless solution is obtained. The solution in each crucible was filtered into 100ml volumetric flask and the volume made up to 100ml with the deionized water. The solution was then used to analyse for magnesium, potassium and phosphorus. This was done using Atomic Absorption Spectrophotometer and the absorbance was read at maximum wavelength of absorbance of the respective minerals. The results were expressed as mg/100g.

2.2.10. Cooking characteristics of noodles

Cooking quality of noodles is the most important aspect from the consumer's point of view, including optimal cooking time, swelling or water uptake during cooking, the texture of the cooked

product, stickiness, aroma and taste. These cooking factors of noodles were related to the gelatinization rates and chemical composition of the noodles used. Cooking time, cooking quality, solid loss and water absorption were studied as per the methods described by American Association of Cereal Chemists (AACC, 2000).

2.2.10.1. Optimum cooking time

The optimum cooking time of the noodles was evaluated according to the modified method of Schoenlechner et al., (2010). One hundred grams of noodles was put into a beaker containing 1 L of boiling water (without salt addition). Every minute, some pieces were taken out and pressed between two glass plates (2.5 cm × 2.5 cm). The optimal cooking time (OCT) corresponded to the disappearance of the white center core.

2.2.10.2. Determination of cooking yield

Cooking yield was determined according to the method of American Association of Cereal Chemists (AACC, 2000). Ten grams (10 g) 0f the noodles was added to a beaker containing about 10 ml boiling water. The beaker was covered and the noodles cooked for 10 minutes. The cooked noodles were drained and then weighed. The cooking yield was calculated using the equation:

$$\text{Cooking yield (\%)} = \frac{\text{weight of noodles after cooking- weight of noodles before cooking}}{\text{weight of noodles before cooking}} \times 100$$

2.2.10.3. Determination of cooking loss

The cooking loss was determined according to the method of American Association of Cereal Chemists (AACC, 2000). The gruel obtained after cooking the noodles was poured into a 200 ml volumetric flask and adjusted to volume with distilled water. Ten milliliter of the solution was pipetted into an aluminum dish and dried to a constant weight at 105 ^{o}C. The cooking loss was calculated as follows:

$$\text{Cooking loss (\%)} = \frac{\text{weight of gruel and dish- weight after drying}}{\text{Constant weight after drying}} \times 100$$

2.2.11. Microbial analysis

The microbial analysis was determined using the method of Prescott et al., (2005).

2.2.11.1. Media preparation

Nutrient Agar powder (7 g) was dissolved in distilled water (250 ml). Thirteen grams (13 g) of sabourand Dextrose Agar (SDA) was dissolved in water (250 ml). The mixtures were stabilized by bringing them to boiling while homogenizing by shaking in whirl motion. The mixtures were sterilized by autoclaving for 15minutes at the temperature of 121 ^{o}C. The ringer solution was allowed to cool after sterilization to about 40 – 47 ^{o}C.

2.2.11.2. Ringer solution preparation

One ringer tablet was dissolved in distilled water (500 ml) .The clear solution formed was sterilized by autoclaving for 15 minutes at the temperature of 121 ^{o}C. The ringer solution was allowed to cool completely to a temperature of 28 ^{o}C.

2.2.11.3. Determination of total viable count

The total viable count was determined by the method of Pour Plate Count. The method involved weighing the sample (1 g) into a sterile test tube. A $^{1}/_{4}$ strength Ringers solution (9 ml) was poured into it and also into other test tube arranged for serial dilution. The sample with the solution was homogenized by shaking. The sample with solution was pipetted (1 ml) into test tube containing Ringers solution (9 ml). Then, 1 ml of different dilution factor was transferred into the sterile petri dishes and sterile nutrient agar was poured into the same petri dish and was mixed by rocking. When they solidified, they were turned upside down and cultured by incubation for 24 h at temperature of 37 ^{o}C. At the end of the incubation period, the colonies were counted using the colony counter (Gallenkamp colony counter, CWN 330- 010X) and the number of colonies recorded appropriately.

2.2.11.4. Determination of mold count

The mold count was determined using Sabouraud Dextrose Agar (SDA) as the plating medium. The sample (1 g) was weighed and put in a test tube prepared for serial dilution. The ringer solution (9 ml) was aseptically transferred serially into other test tubes. Serial dilution of 10^{-1} was used for mould count determination. Appropriate diluent (1 ml) was transferred into the sterile petri dishes. Sabouraud Dextrose Agar was used for culturing the organism for 48 hours at room temperature. The mold colonies were enumerated and calculated as colony forming units (cfu)/g of the sample. Cfu/g = Number of colonies × reciprocal of dilution factor

2.2.12. Sensory evaluation

The noodles were cooked and assessed by a 20 – man untrained panel selected randomly from among students of the Department of Food Science and Technology, University of Nigeria, Nsukka. The samples were evaluated for colour, appearance, mouthfeel, aroma, taste, texture and general acceptability on a 9 - point Hedonic scale as described by Ihekoronye and Ngoddy (1985). The samples were presented in coded plates. The order of presentation of samples was randomized. Water was served to the panelist to rinse their mouths in-between sample evaluation.

2.2.13. Data analysis and Experimental design

The experimental design that was used is Completely Randomized Design and the mean values were subjected to analysis of variance (ANOVA) using Duncan's Multiple Range Test (DMRT) and SPSS (Statistical Product for Service Solution) version 20 computer was used. Significance was accepted at $p < 0.05$ (Steel and Torrie, 1980).

3. RESULTS and DISCUSSION

3.1. Proximate composition of wheat, rice and mushroom flours

The proximate composition (%) of wheat, rice and mushroom flours, used in the instant noodles production is as shown in Table 3.

The protein content of the mushroom flour had the highest protein content (20.88 %) followed by the rice flour (8.53%) and wheat flour the least protein content (8.17 %). This makes mushroom flour a good protein supplement. The protein content compared well with 11.91-22.60 % obtained by (Nwagu and Obiakor-okeke, 2014) in the analysis of nutritional profile of three different mushroom varieties A (white button mushroom), B (oyster mushroom) and C (crimini mushroom) consumed in Amaifeke, Orlu LGA, Imo State. It was reported that, with the exception of green peas and pulses, fresh mushrooms had higher protein content than most vegetables (Bora and Kawatra, 2014).

The high ash content of mushroom flour suggests that incorporation of mushroom flour will increase the mineral content of the blends. The rice flour had the lowest ash content (0.5 %). The fat content of rice flour had the highest (1.79 %) and the wheat flour the least value (1.15 %). The fat content of mushroom flour is low (1.25 %) compared to (2.0 %) obtained by Shah *et al.,* (1997). Crude fat content of mushrooms is usually low, and was from 1.0 % to 6.7 % for certain species collected in China (Xue-mei *et al.,* 2013). According to Liu et al. (2010), the % of total fatty acids for stearic, palmitic, linoleic and oleic acid in *Tricholoma matsutake* was 2 %, 9 %, 27 % and 58 %, respectively. Ratio of unsaturated to saturated (UFA/SFA) fatty acids is an important measure to judge stand or fall of fatty acid in mushrooms (Zhang and Ran, 2005).

The mushroom flour ranked highest in the fibre content 9.97 % and the rice flour with the least value 0.6%. The fibre contents of the mushrooms are reasonably high, suggesting that the mushrooms would be valuable in improving human health by quickening the excretion of wastes and toxins from the body. Crude fibre is a group of indigestible carbohydrates. It can improve the function of the alimentary tract and also lower blood glucose and cholesterol levels. The values obtained are similar to those obtained by (Nwagu and Obiakor-okeke, 2014). They ranged from 7.94 to 18.63 % in the analysis of nutritional profile of three different mushroom varieties consumed in Amaifeke, Orlu LGA, Imo State.

Cereals are usually high in carbohydrate. From the findings, rice flour had the highest value (85.90 %) followed by the wheat flour (77.03 %) and mushroom flour had the least carbohydrate value (47.15 %). The moisture content of the flours varied from wheat flour (11.92 %), rice flour (2.70 %) and mushroom flour (10.58%), respectively. The moisture content of the wheat flour was below the maximum moisture content limit of 15.5 % stipulated by FAO, (2006). The moisture content of the rice flour 2.70 % was below the 10 % stipulated standard for dry food products (SON, 1988).

Table 3. Proximate composition of wheat, rice and mushroom flour

Sample	**Protein (%)**	**Ash (%)**	**Fat (%)**	**Fiber (%)**	**Moisture (%)**	**Carbohydrate(%)**
WF	8.17^{a} ±0.02	1.29^{a} ±0.73	1.15^{a}± 0.03	$0.96b^{a}$±0.02	11.92^{c}±0.02	77.03^{c}±0.04
RF	8.53^{b} ±0.01	0.50^{a}±0.14	1.79^{b}±0.01	0.60^{a}±0.28	2.70^{a}±0.02	85.90^{b}±0.03
MF	20.88^{c}±0.03	10.15^{b}±0.01	1.25^{c}±0.01	9.97^{b}±0.02	10.58^{b}±0.02	47.15^{a}±0.01

Values are means ± standard deviation of duplicate replications. Means within a column with the same superscript were not significantly ($p < 0.05$) different

Key: WF= Wheat flour; RF= Rice flour; MF= Mushroom flour

3.2. Micronutrient composition of wheat, rice and mushroom flours

3.2.1. Vitamins

Table 4 shows the vitamin content of instant noodles formulated from wheat, rice and mushroom flour blends.

Mushrooms contain several primary vitamins including thiamine, riboflavin, niacin, tocopherol and vitamin D (Kalac, 2013). For other researchers using several species, the content of thiamine, riboflavin, niacin and ascorbic varied from 0.02–1.6, 0.3–4.5, 1.2–6.6 and 1.3– 2.7 mg 100 g_1 dm, respectively (Quan *et al*., 2007; Wu *et al.,* 2005; Xu *et al.,* 2012; Zhou and Yin, 2008; Zhu *et al.,* 2007).The values for vitamin B_1 (0.25 mg/100g), B_2 (0.07 mg/100g) and B_3 (1.26 mg/100g) obtained from this study were in line with the report. The B-complex vitamins, especially thiamin,

riboflavin and niacin offered by natural brown rice promote youthful energy and nourishment to skin and blood vessels (Lloyd *et al.,* 2000). According to Juliano, (1985), the vitamin B content of rough rice were as shown vitamin B_1 (0.26-0.33 mg/100g), vitamin B_2 (0.06-0.11 mg/100/g) and vitamin B_3 (2.95.6 mg/100g).The findings was similar to those obtained in this study as shown in Table 4.

Table 4. Vitamin content (mg/100g) of wheat, rice and mushroom flours

Sample	**Vitamin B_1 (mg/100 g)**	**Vitamin B_2 (mg/100 g)**	**Vitamin B_3 (mg/100 g)**
WF	0.25^{a}± 0.04	0.07^{a} ±0.02	1.26^{a} ±0.02
RF	0.36^{b}±0.02	0.05^{a}±0.02	2.50^{b}± 0.14
MF	0.28^{ab} ±0.02	0.25^{b} ±0.02	3.00^{b} ±0.28

Values are means ± standard deviation of duplicate replications. Means within a column with the same superscript were not significantly ($p< 0.05$) different.
Key: WF= Wheat flour; RF= Rice flour; MF= Mushroom flour

3.2.2. Mineral content of wheat, rice and mushroom flour

Table 5 shows the mineral content of the wheat, rice and mushroom flours
The mostly occurring microelements in mushroom are iron and potassium with phosphorus in significant quantity. Potassium is very important in the maintenance of osmotic balance between cells and the interstitial fluid in animal systems. The potassium content for the different flour samples was highest in mushroom flour (22.90 mg/100g). This value was higher than the values obtained for the specie *C. ventricosum* (2.7 mg/100g) by Liu *et al.* (2012) [48]although it was lower than that for the range of values reported by Afiukwa *et al*. (2013), which was 221.13 mg/100g. Iron, which is essential for the biosynthesis of the oxygen-carrying pigment of red blood cells and the cytochromes that function in cellular respiration, is also present in good amounts in the mushrooms (Wani *et al.,* 2010). The iron content in the mushroom flour is higher than those in rice and wheat flour (4.77 mg/100g). The mushroom flour iron content was lower than that obtained for the specie *C. ventricosum* (6.73 mg/100g) as reported by Liu *et al.* (2012). The lower value obtained could be as a result of the differences in species. Low levels of phosphorus were observed in three flour samples. The mushroom flour had the highest value (0.18 mg/100g) and wheat flour (0.05 mg/100g) with the least value.

Table 5. Mineral content of wheat, rice and mushroom flours

Sample	**Iron (mg/100g)**	**Potassium (mg/100g)**	**Phosphorus (mg/100g)**
WF	1.10^{a}± 0.01	1.78^{a} ±0.02	0.05^{a} ±0.02
RF	1.10^{a} ±0.04	4.18^{a} ±0.01	0.11^{ab}±0.02
MF	4.77^{b} ±0.02	22.90^{b} ±0.02	0.18^{b}±0.02

Values are means ± SD of duplicate replications. Means within a column with the same superscript were not significantly ($p< 0.05$) different.
Key: WF= Wheat flour; RF= Rice flour; MF= Mushroom flour

3.3. Functional properties of flour blends from wheat, rice and mushroom

The functional properties of flour blends of wheat, rice and mushroom flour are as shown in Table 6.

Table 6. Functional Properties of Flour Blends from Wheat, Rice and Mushroom Flours

Sample	**Bulk density (g/cm^3)**	**Water absorption (%)**	**Oil absorption (%)**	**Swelling capacity (ml)**
A (100:0)	0.71^{e} ±0.02	100^{a} ±0.28	372^{e}± 0.00	15.0^{a} ± 0.14
B (90:10)	0.69^{cd}± 0.01	120^{b} ±0.00	195.3^{a} ±0.28	20.0^{b}± 1.44
C (80:20)	0.67^{cd} ±0.02	150^{c}± 0.14	260^{b}± 0.28	22.0^{c} ± 0.00
D (70:30)	0.63^{bc}± 0.02	200^{d} ±0.00	269^{c} ±0.28	25.0^{d}± 0.28
E (60:40)	0.59^{b} ±0.01	210^{e}± 0.14	279^{d}± 0.00	26.0^{d}± 0.00
F (50:50)	0.53^{a}± 0.02	250^{f}± 1.97	279 ^{d}±0.56	28.0^{e}± 0.14

Values are means ± standard deviation of duplicate replications. Means within a column with the same superscript were not significantly ($p< 0.05$) different.

Key: A (100:0): 90% wheat and 10 % rice flour +0 % mushroom flour; B (90:10):90% wheat and rice flour + 10 % mushroom flour; C (80: 20):80% wheat and rice flour +20 % mushroom flour; D (70:30):70% wheat and local rice flour +30 % mushroom flour; E (60:40): 60% wheat and local rice flour +40 % mushroom flour; F (50:50): 50% wheat and local rice flour +50 % mushroom flour.

Water absorption capacity represents the ability of a product to associate with water under conditions where water is limited (Singh, 2001). Percent water absorption varied from 100 % to 250 % with the blend with no mushroom flour (100:0) having the least value and blend with 50% mushroom powder having the highest value. Water absorption capacity is a critical function of protein in various food products like soups, dough and baked products (Adeyeye and Aye, 1998). Water absorption capacity increased with increasing levels of mushroom flour. This could probably be due to the high protein and fiber content of mushroom flour. Kaur *et al.*, (2013) also observed significant increase in water absorption on addition of more than 8 % mushroom powder to semolina for pasta extrusion.

The highest value of oil absorption capacity was observed for flour blend of wheat and rice flour without mushroom flour (100:0) was 372 % and the lowest value (195.3 %) for the 90 % composite wheat-rice flour and 10 % mushroom flour. The water and oil binding capacity of food protein depend upon the intrinsic factors like amino acid composition, protein conformation and surface polarity or hydrophobicity (Kaushal, *et al.,* 2012). The wheat and rice flour without mushroom flour (100:0) blend which had the highest oil absorption capacity could be, therefore, be a better flavor retainer. The ability of the proteins of these flours to bind with oil makes it useful in food system where optimum oil absorption is desired. This makes flour to have potential functional uses in foods such as sausage production. The oil absorption capacity also makes the flour suitable in facilitating enhancement in flavor and mouth feel when used in food preparation. Due to these properties, the protein probably could be used as functional ingredient in foods such as whipped toppings, sausages, chiffon dessert, angel and sponge cakes among other products.

The swelling capacity was found highest for 50 % composite wheat-rice flour with 50 % mushroom flour blend (28.0 ml) and lowest for 100 % composite wheat-rice flour blend without mushroom flour (100:0) (15.0 ml). The swelling capacity of flours depends on size of particles, types of variety and types of processing methods or unit operations.

According to Gustavo et al. (2005), the bulk density of food powders depends on the combined effect of interrelated factors such as the intensity of attractive inter-particles forces, particle size, and number of contact points. It is clear that a change in any of the powder characteristics might result in a significant ($p< 0.05$) change in the powder bulk density. Bulk density is an indication of

the porosity of a product which influences package design and could be used to determine the type of packaging material required. Low bulk density is desirable and required for infant foods (Omerie *et al.,* 2015).

3.4. Proximate composition (%) of Instant Noodles formulated from wheat, rice and mushroom flour blends

Table 7 shows the proximate composition of the formulated instant noodles from wheat, rice and mushroom flour blends.

Table 7. Proximate composition (%) of Instant noodles from wheat, rice and mushroom flour blends

Sample	Protein (%)	Ash (%)	Fat (%)	Fiber (%)	Moisture (%)	Carbohydrate (%)
CTRL	$10.84^{a} \pm 0.01$	$1.39^{a} \pm 0.04$	$0.90^{b} \pm 0.01$	$1.50^{a} \pm 0.05$	$7.92^{a} \pm 0.02$	$77.45^{g} \pm 0.02$
WR0	$9.49^{b} \pm 0.01$	$1.66^{b} \pm 0.02$	$1.50^{f} \pm 0.01$	$1.79^{b} \pm 0.28$	$12.21^{e} \pm 0.02$	$73.35^{f} \pm 0.00$
WRM1	$10.96^{c} \pm 0.01$	$2.19^{c} \pm 0.01$	$1.40^{ef} \pm 0.01$	$2.30^{c} \pm 0.14$	$8.28^{b} \pm 0.02$	$74.87^{e} \pm 0.00$
WRM2	$12.77^{d} \pm 0.02$	$3.34^{d} \pm 0.02$	$1.30^{de} \pm 0.00$	$3.38^{d} \pm 0.28$	$9.73^{c} \pm 0.00$	$69.48^{d} \pm 0.02$
WRM3	$13.21^{e} \pm 0.01$	$4.47^{e} \pm 0.01$	$1.20^{cd} \pm 0.01$	$4.57^{e} \pm 0.28$	$11.45^{d} \pm 0.00$	$65.09^{c} \pm 0.01$
WRM4	$13.59^{f} \pm 0.01$	$5.30^{f} \pm 0.01$	$1.10^{c} \pm 0.15$	$5.39^{f} \pm 0.01$	$12.18^{e} \pm 0.05$	$62.49^{b} \pm 0.01$
WRM5	$15.39^{g} \pm 0.01$	$5.31^{f} \pm 0.01$	$0.5^{a} \pm 0.28$	$5.40^{f} \pm 0.22$	$14.48^{f} \pm 0.05$	$58.42^{a} \pm 0.05$

Values are means ± standard deviation of duplicate replications. Means within a column with the same superscript were not significantly ($p < 0.05$) different.

Key: CTRL=Control commercial sample; WR0 = 90 % wheat flour +10 % rice flour; WRM1= 90 % wheat/rice flour +10 % mushroom flour; WRM2 = 80 % wheat/rice flour +20 % mushroom flour; WRM3 = 70 % wheat/rice flour +30 % mushroom flour; WRM4 = 60 % wheat/rice flour + 40 % mushroom flour; WRM5 = 50 % wheat/rice flour + 50 % mushroom flour

The protein content of the samples ranged from 9.49-15.39%. Sample WRM5 (50:50) had the highest protein content and sample WR0 (100:0) had the least protein value. There was a progressive increase in the protein value with increase in mushroom addition. Mushroom protein includes all nine essential amino acids required by man, although it can be limiting in sulphur-containing amino acids, such as cystine and methionine. In terms of the essential amino acid index, amino acid score and nutritional index, mushrooms are between low grade vegetable and high grade meats with values that are close to that of milk, some species even well above milk which is an animal product (Bora and Kawatra, 2014). As a result of this, FAO has recommended mushrooms as a supplementary food item in the context of the world protein shortage for the growing populations of the developing countries. The protein content was within the range (10.54-14.34 %) obtained by Bindvi *et al.* (2017) in instant noodles supplemented with oyster mushroom (*P. ostreatus*).

The ash content ranged from 1.39 to 5.31 % with sample WRM5 (50:50) having the highest ash content while the CTRL (commercial sample) having the least ash content. The high ash content of the instant noodles might be attributed to the fact that mushroom has been reported to be a good source of minerals as there was a notable increase in the ash content with addition of mushroom. The ash content of a food material could be used as an index of minerals constituents of the food. The values obtained were higher than those reported by Bindvi *et al.* (2017) which ranged from 1.84 to 176 %. This may be attributed to the nutritional varieties in the different species.

The crude fibre content of the samples ranged from 1.50 to 5.40 %. Sample WRM5 (50:50) ranked highest and CRTL (commercial product) the lowest value. There was no significant ($p< 0.05$) difference between samples WRM4 (60:40) and WRM5 (50:50). Increase in the incorporation of mushroom flour brought about increase in the crude fibre content of the instant noodles. The high values obtained might be due to the fact that mushroom used in instant noodles production were rich sources of dietary fibre which therefore increased the fibre content of the product with increase in level of the composite flour incorporation. A high intake of dietary fibre is positively related to different physiological and metabolic effects (NRC, 1989). Fibre prevents constipation. Soluble fibre helps to reduce the cholesterol level in the blood, slows down digestion and sudden release of energy, thus making blood level stable. Food containing at least 3 g⁄100g dietary fiber (DF) can be referred to as a source of DF. It is high in DF when it contains at least 6 g⁄100g dietary fibres (FAO, 1995). The consumption of this product will meet the WHO recommendation for dietary fibre intake of about 25 g per day (Sandstead, 1995).

The fat content ranged from 0.5 to 1.50 % with sample WR0 (100:0) which had the highest fat content and sample WRM5 (50:50) had the lowest value. Fat content decreased slightly with the addition of mushroom powder. However there was no significant ($p< 0.05$) difference among samples WRM1 (90:10), WRM2 (80:20) and WRM3 (70:30). Fat plays a role in determining the shelf-life of foods (Brons *et al.,* 2008). Crude fat content of mushrooms is usually low. It ranged from 1.0% to 6.7% for certain species collected in China as reported by Xue-mei *et al.* (2013). A high amount of fat could accelerate spoilage by promoting rancidity which could lead to the production of off flavours and odours. Also diet high in fat predispose consumer to different illness such as obesity, heart disease among other ailments. The values obtained from this study were comparable to the values reported by Yin and Zhou (2008) in Yunnan wild edible Boletus. Pedneault *et al*. (2006) reported that fat fraction in mushrooms is mainly composed of unsaturated fatty acids. 1.0 %.

The moisture content ranged from 7.92 to 14.48 % with sample CTRL (commercial product) with the lowest value and WRM5 with (50:50) the least value. The samples varied significantly ($p< 0.05$.) The moisture content of fresh mushrooms is about 70 to 95 %, depending on the species, harvest time and environmental conditions, it falls to around 10 to 13 % when dried (Breene, 1990). The carbohydrate values obtained ranged from 58.42 to 77.45% and the CTRL (commercial product) with the highest value, WRM5 with 50% mushroom powder incorporation the least value. The carbohydrate value reduced slightly with increase in mushroom flour incorporation. The samples varied significantly ($p < 0.05$). The carbohydrate values were comparable to the values (74%) obtained by (Carneiro *et al.,* 2013) and the range (58.11 to 61.98 %) obtained by Bello *et al.* (2017). Carbohydrates in foods provide energy and digestible carbohydrates found in mushrooms are such as mannitol (0.3–5.5% dm) (Vaz *et al.,* 2011), glucose (0.5 to 3.6 % dm) (Kim *et al.,* 2009) and glycogen (1.0–1.6 % dm), Diez and Alvarez (2001). Non-digestible carbohydrates form a large portion of the total carbohydrates of mushrooms, and major compounds are oligosaccharides and non-starch polysaccharides such as chitin, β-glucans and mannans (Cheung,

2010). Polysaccharides are the best known and most potent mushroom derived substances with antitumor and immunomodulation properties.

3.5. Microbial counts of ınstant noodles from wheat, rice and mushroom flour blends

Table 8 shows the total viable and mold count of instant noodles from blends of wheat, rice and mushroom flours for four weeks' storage.

Table 8. Total viable and mold counts of instant noodles from wheat, rice and mushroom flour blends

Period of storage	**Sample**	**Total viable count (cfu/g)**	**Mould Count (cfu/g)**
Week 1	CTRL	1.78×10^3	ND
	WR0	1.42×10^3	ND
	WRM1	8.3×10^2	ND
	WRM2	1.0×10^3	ND
	WRM3	1.2×10^3	ND
	WRM4	4.3×10^2	ND
	WRM5	6.1×10^2	ND
Week 2	CTRL	2.8×10^4	1.0×10
	WR0	1.3×10^4	1.0×10
	WRM1	9.2×10^3	ND
	WRM2	7.2×10^3	ND
	WRM3	1.2×10^4	1.0×10
	WRM4	3.3×10^3	ND
	WRM5	7.7×10^3	ND
Week 3	CTRL	1.9×10^3	4.0X×10
	WR0	1.6×10^5	2.0×10
	WRM1	1.0×10^5	ND
	WRM2	8.1×10^4	ND
	WRM3	1.4×10^5	2.0×10
	WRM4	7.2×10^4	ND
	WRM5	6.1×10^4	ND
Week 4	CTRL	2.9×10^5	9.0×10
	WR0	2.7×10^5	4.0×10
	WRM1	2.1×10^5	ND
	WRM2	1.7×10^5	ND
	WRM3	2.5×10^5	3.0×10
	WRM4	1.5×10^5	ND
	WRM5	2.4×10^5	ND

Key: CTRL = Control commercial sample; WR0 = 90 % wheat flour +10 % rice flour; WRM1 = 90 % wheat/rice flour +10 % mushroom flour; WRM2 = 80 % wheat/rice flour +20 % mushroom flour; WRM3 = 70 % wheat/rice flour +30 % mushroom flour; WRM4 = 60 % wheat/rice flour + 40 % mushroom flour; WRM5 = 50 % wheat/rice flour + 50 % mushroom flour
ND = Not detected

Total viable count gives a quantitative idea about the presence of microorganisms in the sample. The total viable count of the noodles samples for the first week ranged from $1.0x10^3$ cfu/g to

$8.3x10^2$ cfu/g. Sample WRM1 (90:10) had the highest value while sample WRM2 (80:20) had the lowest value. For the second week TVC ranged from $1.2x10^4$ cfu/g to $9.2x10^3$ cfu/g and sample WRM2 (80:20) had the highest value and sample WRM3 (70:30) had the lowest value. Total viable count for the third week ranged from $1.0x10^5$ cfu/g to $8.1x10^4$ cfu/g, sample WRM2 (80:20) having the highest value and sample WRM1 (90:10) with the least value. For the fourth week of storage, the TVC ranged from $1.7x10^5$ cfu/g to $2.95x10^5$ cfu/g. Sample WRM2 (80:20) had the highest value and CTRL (commercial product) with the least value. The microbial counts were above the acceptable level ($0\text{-}10^2$) of microorganisms for noodles and pasta products (FDA, 2013). This could probably be due to contamination from storage environment as the total viable count increased on storage. Mold count was done to detect and quantify mold in the samples. For the first week mold count was not detected expect in sample CTRL (commercial product) 1.0x10. For the second week mold count was detected at 1.0x10 level for samples CTRL (commercial product), WR0 (100:0) and WRM3 (70:30). On the third week, CTRL (commercial product) has the highest mold count 4.0x10 cfu/g, WR0 (100:0) and WRM3 (70:30) 2.0x10 cfu/g. Sample CTRL (commercial product) has the highest mold count on the fourth week (9.0x10 cfu/g) and sample WRM3 (70:30) with the lowest value (3.0 x10 cfu/g). There was little or no mold growth in the samples probably due to the proper handling and good hygienic practices observed during processing.

3.6. Cooking characteristics of instant noodles made from wheat, rice and mushroom flour blends

Table 9 represents the cooking characteristics of Instant Noodles formulated from wheat, rice and mushroom flour blends.

Cooking yield of the blends samples ranged from 200 to 140 %, with sample WRM5 (50:50) having the highest value and WRM1 (90:10) the lowest value. There was no significant ($p < 0.05$) difference in all the samples. Cooking yield is dependent on the ability of noodles to absorb water during cooking. With increased mushroom flour, the cooking yield increased. This trend could probably be because sample WRM5 (50:50) has high water absorption capacity compared to other samples. The cooking yield of the CRTL (commercial sample) was higher than the noodles from the blends which could be probably due to other additives used in production.

Cooking loss is indicated by the loss of solid materials contained in noodle during cooking. Mushroom-supplemented noodles showed a significant increase in cooking loss compared with the control noodle as the mushroom flour increased. The cooking loss of the noodles with 50 % mushroom flour (4.58 per 100 g) was higher than those observed for the control sample (3.80 g per 100 g). All the cooking loss samples were below 8 g per 100 g, the value above which pasta quality was considered unacceptable (Foschia *et al.*, 2015). The higher cooking loss in noodles with added mushroom could be attributed to a loss of continuity of the noodles protein-starch matrix, as a consequence of the competitive hydration tendency of the fibre which leads to uneven distribution of water within the matrix (Tudorică *et al.*, 2002). Similarly, Kaur *et al.*(2013) studied the effect of button mushrooms on the leaching of solids from pasta and reported that the solids that leached into the cooking water increased as the level of mushroom powder was increased in the blend.

Cooking time is very important to characterize a product as instant. Optimum cooking time of mushroom fortified noodles is given in Table 9. Optimum cooking time of the noodle samples varied from 7.4 to 8.55 min. The addition of mushroom powder in noodles progressively increased cooking time, although there was no significant ($p > 0.05$) difference between samples even up to 20% level of fortification as wheat flour replacement. This could be attributed to increase in protein content of noodles with addition of mushroom powder, resulting in firmer product. Kaur *et al.* (2013) also observed increase in cooking time in mushroom supplemented pasta.

Table 9. Cooking Characteristics of Instant Noodles formulated from wheat, rice and mushroom flour blends

Sample	**Cooking yield (%)**	**Cooking loss (%)**	**Optimum cooking time (mins)**
CRTL	$220^{a} \pm 0.14$	$3.80^{a} \pm 0.02$	$5.20^{a} \pm 0.02$
WR0	$100^{b} \pm 0.28$	$4.20^{b} \pm 0.01$	$6.50^{b} \pm 0.02$
WRM1	$140^{c} \pm 0.42$	$4.35^{c} \pm 0.02$	$7.40^{c} \pm 0.28$
WRM2	$150^{d} \pm 1.13$	$4.40^{cd} \pm 0.04$	$7.80^{d} \pm 0.14$
WRM3	$160^{e} \pm 0.14$	$4.48^{de} \pm 0.05$	$8.04^{de} \pm 0.01$
WRM4	$190^{f} \pm 0.40$	$4.52^{ef} \pm 0.05$	$8.20^{e} \pm 0.02$
WRM5	$200^{g} \pm 0.28$	$4.58^{f} \pm 0.02$	$8.55^{f} \pm 0.02$

Values are means ± standard deviation of duplicate replications. Means within a column with the same superscript were not significantly ($p > 0.05$) different.

Key:CTRL=Control, commercial sample; WR0 = 90 % wheat flour +10 % rice flour; WRM1 = 90 % wheat/rice flour +10 % mushroom flour; WRM2 = 80 % wheat/rice flour +20 % mushroom flour; WRM3 = 70 % wheat/rice flour +30 % mushroom flour; WRM4 = 60 % wheat/rice flour + 40 % mushroom flour; WRM5 = 50 % wheat/rice flour + 50 % mushroom flour

3.7. Sensory properties of instant noodles formulated from wheat, rice and mushroom flour blends

Table 10 shows the average mean sensory scores of noodles samples from blends of wheat, rice and mushroom flour.

The result in Table 10 shows that there were significant ($p < 0.05$) difference in all the sensory attributes (colour, appearance, taste, aroma, texture, mouth feel, aftertaste and overall acceptability) of the instant noodles from wheat, rice and mushroom flour blends as well as the sample with 100 % wheat-rice flour blend and commercial noodles. The sample CTRL (commercial sample) and sample with 100 % wheat-rice flour blend (WR0) had the highest level of acceptance for the sensory attributes. However, the sensory acceptability of the noodles from blends of wheat, rice and mushroom flour blends are as follows.

Sample WRM1 (90:10) was rated high while noodle sample WRM5 (50:50) had the lowest level of preference. According to Hou (2001), flour colour, protein content, ash content, yellow pigment and polyphenol oxidase activity are important factors responsible for noodle colour. The preference for colour decreased with increasing amount of mushroom flour and decreasing amount of wheat flour. This could probably be due to the decrease in the brightness of the noodles colour of the mushroom flour. Noodle sample WRM5 (50:50) did not differ significantly ($p > 0.05$) from WRM4 (60:40).

Table 10. Sensory evaluation of instant noodles from wheat, rice and mushroom flour blends

Sample	Colour	Mouthfeel	Aroma	Taste	Appearance	Texture	Overall acceptability
CTRL	8.80^{f} ±0.41	8.45^{e}± 0.60	8.30^{c}± 0.80	8.60^{f}± 0.50	8.65^{f} ±0.48	8.45^{e}±0.51	8.60^{f}± 0.59
WRO	7.15^{e}±0.74	6.85^{d}±0.74	6.70^{b}± 0.73	6.70^{e}± 0.86	7.30^{e}±0.47	6.75^{d}±0.71	6.95^{e}±0.60
WRM1	4.50^{d}±1.53	4.95^{c}±1.23	4.90^{a}± 1.16	5.60^{d}± 1.04	4.80^{d}±1.50	3.95^{c}±1.31	4.40^{d}±1.35
WRM2	1.23^{c}± 0.27	3.65^{b}±1.38	4.70^{a}±1.17	3.90^{c}±0.91	2.90^{c}± 1.5	2.85^{b}±1.34	3.15^{c}±1.30
WRM3	0.93^{b}±0.21	3.20^{b}± 1.24	4.75^{b}±1.58	3.20^{b}± 0.76	2.30^{bc}±1.17	2.40^{b}±1.14	2.50^{bc}±1.14
WRM4	0.68^{a}±0.15	2.35^{a}± 1.03	6.40^{b}±1.14	2.15^{a}±0.81	1.65^{ab}±0.98	1.55^{a}±0.75	1.95^{ab}±1.05
WRM5	0.36^{a}± 0.08	2.00^{a}±1.07	7.15^{b}±1.30	1.65^{a}± 0.93	1.55^{a}±0.82	1.30^{a}±0.57	1.75^{a}±1.02

Values are means ± standard deviation of duplicate replications. Means within a column with the same superscript were not significantly ($p< 0.05$) different.
Key: CTRL= Control, commercial sample; WR0 = 90 % wheat flour +10 % rice flour; WRM1 = 90 % wheat/rice flour +10 % mushroom flour; WRM2 = 80 % wheat/rice flour +20 % mushroom flour; WRM3 = 70 % wheat/rice flour +30 % mushroom flour; WRM4 = 60 % wheat/rice flour + 40 % mushroom flour; WRM5 = 50 % wheat/rice flour + 50 % mushroom flour

The average mean scores for mouth feel ranged from 2.00-4.95. Sample WRM1 had the highest mouth feel while WRM5 had the lowest value. There is no significant ($p > 0.05$) among between the mean scores of the noodles WRM2 (80:20) and WRM3 (70:30) and between WRM5 (50:50) and WRM4 (60:40). However samples CTRL (commercial sample), WR0 (100:0) and WRM1 (90:10) differed significantly ($p < 0.05$).

The aroma of the noodles from the blends ranged from 4.90-7.15 with sample WRM5 (50:50) which had highest value and sample WRM1 (90:10) which had the lowest value. Characteristic flavour substances of wild-grown mushrooms could be classified into nonvolatile (taste) and volatile components (smell). Various volatile compounds such as terpenes, aromatic alcohols, aldehydes, ketones, eight carbon compounds and their derivatives, are the major aroma compounds in mushrooms. Eight-carbon volatiles are produced by oxidation of free linoleic acid catalysed by lipoxygenase (Cheng *et al.*, 2012). With increase in the mushroom flour, there was increase in the aroma of the samples. The preference for aroma of samples WRM4 (60:40) and WRM5 (50:50) did not differ significantly ($p > 0.05$) from WR0 (100:0). CTRL (commercial sample) which differed significantly ($p < 0.05$) from all the samples.

The taste of the formulated noodle blends ranged from 1.65-5.60 with sample WRM1 (90:10) having the highest value and sample WRM5 (50:50) having the lowest value. This could probably be because of the increasing proportion of mushroom flour in the samples and consumers did not find it very appealing. The preference for taste of CTRL (commercial sample) and WR0 (100:0) differed significantly ($p < 0.05$) from the preference of the other samples.

The appearance of the formulated noodles from blends of wheat, rice and mushroom flour ranged from 4.80-1.55 with sample WRM1 (90:10) having the highest value and sample WRM5 (50:50) had the least preference. This is probably because, the noodles from 100% what-rice flour had longer noodles strands, a relatively brighter colour and less stickiness unlike the samples with increasing proportion of mushroom flour. There was no significant ($p > 0.05$) difference between the preference for appearance among the samples however, from each other but there was no significant ($p > 0.05$) difference between samples CTRL (commercial sample), WR0 (100:0) and WRM1 (90:10).

The texture of the formulated noodles from the blends ranged from 3.95-1.30. Sample WRM1 (90:10) ranked highest while sample WRM5 (50:50) was ranked the lowest. Starch characteristics, protein content and quality play major roles in the governing the texture of cooked noodles (Hou, 2001). The preference for texture dropped with increase in mushroom flour incorporation. There was no significant ($p > 0.05$) difference between the mean scores of the samples but they differed significantly ($p < 0.05$) from CTRL (commercial sample) and WR0 (100:0).

3.8. Micronutrient content of formulated instant noodles from wheat, rice and mushroom flour blends

3.8.1. Vitamin content of formulated instant noodles from wheat, rice and mushroom flour blends

The vitamin content of formulated instant noodles from wheat, rice and mushroom flour blends are presented in Table 11. As vitamins are very unstable, a lower value in the sample was expected, since heat processing was used which could contribute to the losses. Cooking and industrial processing of mushroom was found to have pronounced effects on the amount of vitamins in the product. Vitamin B_1 and B_2 are lost during industrial processing (canning) of Boletus at a rate of 21–57 % and 8–74 %, respectively (Zhou and Yin, 2008). Thiamin stability affected by formulation, processing, and storage has been reported by Bui and Small (2007a, 2007b, 2008) in noodles, and it was inferred that the potential to use thiamin in noodles where alkaline salts are used is limited due to its instability at higher pH. But with addition of

mushroom flour there was an increase in the vitamin content. The values varied significantly ($p< 0.05$) ranging from 0.32 to 0.20 (mg/100 g) for vitamin B_1, 0.10 to 0.06 (mg/100 g) for vitamin B_2 and (3.68-1.20 mg/100 g) for vitamin B_3. Noodle sample WRM5 (50:50) had the highest in all the vitamins and CTRL (commercial sample) having the lowest value in all the vitamins.

Table 11. Vitamin content of instant noodles formulated from wheat, rice and mushroom flour blends

Sample	**Vitamin B_1 (mg/100g)**	**Vitamin B_2 (mg/100g)**	**Vitamin B_3 (mg/100g)**
CTRL	$0.20^{a}\pm 0.01$	$0.06^{a}\pm 0.02$	$1.20^{a} \pm 0.28$
WR0	$0.22^{ab} \pm 0.02$	$0.07^{a} \pm 0.01$	$2.90^{b} \pm 0.14$
WRM1	$0.24^{abc}\pm 0.01$	0.07a ±0.02	$3.00^{b}\pm 0.14$
WRM2	$0.26^{abc} \pm 0.02$	$0.65^{b} \pm 0.21$	$3.20^{bc} \pm 0.02$
WRM3	$0.34^{d} \pm 0.01$	$0.04^{a} \pm 0.03$	$3.25^{bc}\pm 0.07$
WRM4	$0.30^{bcd} \pm 0.04$	$0.09^{a} \pm 0.02$	$3.60^{cd}\pm 0.28$
WRM5	$0.32^{cd} \pm 0.04$	$0.10^{a} \pm 0.02$	$3.68^{d}\pm 0.02$

Values are means ± standard deviation of duplicate replications. Means within a column with the same superscript were not significantly ($p< 0.05$) different.
Key: CTRL: Control commercial sample; WR0 = 90 % wheat flour +10 % rice flour; WRM1 = 90 % wheat/rice flour +10 % mushroom flour; WRM2 = 80 % wheat/rice flour +20 % mushroom flour; WRM3 = 70 % wheat/rice flour +30 % mushroom flour; WRM4 = 60 % wheat/rice flour + 40 % mushroom flour; WRM5 = 50 % wheat/rice flour + 50 % mushroom flour

Thiamin functions as the co-enzyme thiamin pyrophosphate (TPP) in the metabolism of carbohydrates and branched-chain amino acids. Hence, when there is insufficient thiamin, the overall decrease in carbohydrate metabolism and its inter-connection with amino acid metabolism (via α-keto acids) have severe consequences, such as a decrease in the formation of acetylcholine for neural function. According to FAO (2001), the required daily intake of thiamin for the adult male and female is 1.2 mg/100g and 1.1 mg/100g, respectively. The sample WRM5 (50:50) containing 0.32 mg/10 g provides about 27 % of the required daily intake for the adult male and 29 % for the adult female. The major cause of hypo-riboflavinosis is inadequate dietary intake as a result of limited food supply, which is sometimes exacerbated by poor food storage or processing. According to FAO, (2001) the required daily intake of riboflavin for the adult male and female is 1.3 mg/100 g and 1.1 mg/100 g respectively. Sample WRM5 (50:50) containing 0.10 mg/100g noodles from wheat, rice and mushroom flour blends provides about 7 % of the required daily intake for adult male and 9 % for adult female. The contents of vitamins B_1 and B_2 found in the noodles indicate that mushrooms could not be considered as sources of vitamins B_1 and B_2, since their contribution in terms of these vitamins to the diet is not significant although they might have contributed to the sums of these nutrients in the diet.

Niacin (nicotinic acid) deficiency classically results in pellagra, which is a chronic wasting disease associated with a characteristic erythematous dermatitis that is bilateral and symmetrical, a dementia after mental changes including insomnia and apathy preceding an overt encephalopathy, and diarrhoea resulting from inflammation of the intestinal mucous surfaces (Tannenbaum *et al.,* 1991). The required daily intake of niacin for the adult male and

female is 16 m/100g and 14 mg/100g respectively (FAO, 2001), and sample WRM5 (50:50) had the highest value (3.68 mg/100g) provides about 23 % and 26 % for both male and female adult, respectively.

3.8.2. Mineral content of instant noodles formulated from wheat, rice and mushroom flour blends

The mineral content of the instant noodles formulated from wheat, rice and mushroom blends is presented in Table 12.

The Iron content of this study ranged from 0.49 – 3.42 mg/100 g. Sample WR0 (100:0) had the lowest value and sample WRM5 (50:50) had the highest value and it was lower than the recommended daily allowance (RDA) - 10 mg of iron per day(Sandstead 1995). Thus, it could be deduced from the Table that both the control sample and the WR0 (100:0) were not a good source of iron. Iron content increased with addition of mushroom powder. All the values varied significantly ($p < 0.05$). The values obtained in this study was similar to those reported by Bello *et al.* (2017) who reported 1.68 – 2.89 mg/100g in biscuit made from wheat and mushroom flour blends. Iron is a major component of haemoglobin that carries oxygen to all parts of the body. Iron also has a critical role within cells assisting in oxygen utilization, enzymatic systems, especially for neural development, and overall cell function.

The potassium content of the samples ranged from 1.86 to 16.00 mg/100g. With CTRL (commercial product) having the lowest and WRM5 (50:50) having the highest value. The increase in the potassium content of the instant noodles increased in the level of mushroom flour addition indicating that mushrooms is a good source of minerals. The values obtained in this study were lower than the values obtained by obtained by other researchers Bello *et al.* (2017) 40.63 - 154.07 mg/100g. The result could be attributed to variation in the different species of mushroom. All the values varied significantly ($p < 0.05$). Phosphorous content of the samples ranged from 0.16 to 0.070 mg/100g with sample WRM5 (50:50) having the highest and sample CTRL (commercial product) with lowest value. These values were lower than12.5 - 54.62 mg/100g as reported by Bello *et al.* (2017).There was no significant ($p > 0.05$) difference between samples CTRL (commercial product) and others WRO (100:0), WRM1 (90:10) and WRM2 (80:20). The mineral composition obtained in this study showed that there was an increase in the phosphorous content of the noodles with increase in the level of mushroom flour addition is an indication that mushrooms is a good source of minerals as shown in Table 12.

Table 12. Mineral content of instant noodles from wheat, rice and mushroom flour blends

Sample	**Iron (mg/100g)**	**Potassium (mg/100g)**	**Phosphorus(mg/100g)**
CTRL	$0.73^{b} \pm 0.02$	$1.86^{a} \pm 0.02$	$0.07^{a} \pm 0.01$
WR0	$0.49^{a} \pm 0.02$	$2.48^{b} \pm 0.02$	$0.08^{ab} \pm 0.01$
WRM1	$2.02^{c} \pm 0.14$	$12.48^{c} \pm 0.56$	$0.09^{abc} \pm 0.01$
WRM2	$2.21^{d} \pm 0.28$	$13.40^{d} \pm 0.01$	$0.10^{abc} \pm 0.01$
WRM3	$2.32^{e} \pm 0.14$	$14.00^{e} \pm 0.04$	$0.13^{bcd} \pm 0.02$
WRM4	$3.18^{f} \pm 0.28$	$15.20^{f} \pm 0.02$	$0.14^{cd} \pm 0.02$
WRM5	$3.42^{g} \pm 0.28$	$16.00^{g} \pm 0.02$	$0.16^{d} \pm 0.02$

Values are means ± standard deviation of duplicate replications. Means within a column with the same superscript were not significantly ($p < 0.05$) different.

Key: CTRL: Control, WR0=90 % wheat flour +10 % rice flour; WRM1 = 90 %wheat/rice flour +10 % mushroom flour; WRM2 = 80 %wheat/rice flour +20 % mushroom flour; WRM3 = 70 %wheat/rice flour +30 % mushroom flour; WRM4 = 60 %wheat/rice flour + 40 % mushroom flour; WRM5 = 50 %wheat/rice flour + 50 % mushroom flour

4. CONCLUSION

The incorporation of mushroom flour in noodles formulation affected the chemical, cooking and sensory properties. Mushroom flour therefore could be incorporated into instant noodles to obtain a product rich in dietary fiber, protein, vitamin B_3 and potassium and low in fat. The incorporation of mushroom flour up to 10 % produced instant noodles with high acceptability and nutritional quality beneficial to the consumers.

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FARKLI BUĞDAY TÜRLERİ VE YEREL ÇEŞİTLERİ İLE SON ÜRÜN KALİTE VE BESLENME ÖZELLİKLERİ

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ÖZET

Beslenmemizde çok önemli bir yere sahip olan buğday, tahıllar içerisinde, ekonomik, toplumsal, tarihi ve kültürel bakımdan stratejik öneme sahiptir. Son yıllarda yapılan araştırmalarda buğday ile tarımın ilk kez Türkiye'nin güneydoğu bölgesini de içine alan ve 'Bereketli Hilal' adıyla bilinen bölgede başladığı belirtilmektedir. Yabani ve yerel buğday çeşitlerini içeren zengin genetik kaynaklara sahip olan ülkemiz, buğdayın dünyaya yayıldığı coğrafya olması ile önemli bir yere sahiptir. Son yıllarda fonksiyonel gıdanın öneminin anlaşılması ve besinlerin kalitesine, organik ürünlere karşı artan ilgi nedeniyle geleneksel beslenme arayışı gündeme gelmiştir. Bu nedenlerle insan sağlığına daha uygun biçimde iyileştirmeler araştırılmakta ve yüksek oranda katma değer oluşturan ürünlerin eldesi için çalışılmaktadır. Beslenme fizyolojisi açısından önemli vitamin, mineral ve lifli yapısının zenginliği ile öne çıkan yabani ve yerel buğdayların, insan sağlığına ve beslenmesine ciddi katkı sunacağı her geçen gün biraz daha anlaşılmakta ve yapılan araştırmalarla desteklemektedir. Yerel buğdayların kullanılması, yararlı genlerin kaynağı olarak bitki ıslahında önemli bir rol oynamaktadır. Bununla birlikte yerel buğday kullanımının tarım-gıda biyoçeşitliliğini arttırabileceği, sağlığa olumlu etki eden gıdaların üretimi ve geliştirilmesi için yeni hammaddelerin sağlanmasına katkıda bulunabileceği düşünülmektedir. Yapılan çalışmalarda besin kalitesi yüksek gıdalar tüketicilerin ve araştırmacıların dikkatini çekmektedir, çünkü bunların tüketimi çeşitli hastalıkların önlenmesinde önemli bir rol oynamaktadır. Yüksek protein içeriği, düşük alerjik özelliğine ve yüksek antioksidan içeriğine sahip olmaları; yerel buğdaylara olan ilgiyi artırmıştır. Buğday türleri ve yerel buğdayların içerdiği antioksidan bileşikler (flavonoidler, fenolik asit, fitik asit, tokoforoller ve karotenoidler) ve besinsel lifler gibi bazı bileşenler, tahıl ürünlerinin fonksiyonel özelliklerini geliştirme ve kronik hastalıkları önlemede etkilidirler. Bu çalışmada farklı buğday türleri ve yerel çeşitleri ile son ürün kalite ve beslenme özellikleri üzerine yapılan bazı araştırmalar değerlendirilmiştir.

Anahtar Kelimeler: *Buğday türleri, yerel çeşitler, son ürün kalitesi, beslenme kalitesi.*

DIFFERENT WHEAT SPECIES AND THEIR LOCAL VARITIES; AND THE QUALITY AND NUTRITIONAL FEATURES OF THE FINAL PRODUCT

ABSTRACT

Wheat, as a crucial substance of the human diet, has a strategic importance in terms of economic, social, historical and cultural aspects. According to recent studies, wheat based agriculture has started originally in so called 'Fertile Crescent', which involves the south eastern region of Turkey. Our country, which has rich genetic resources including wild and local wheat varieties, has an important place as the geography where wheat spreads to the world. In recent years, the search for traditional nutrition has come to the fore due to the understanding of the importance of functional food and the increasing interest in the quality of foods and organic

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products. For these reasons, improvements in a more suitable way for human health are researched and efforts are made to obtain products that create high added value. It is understood more and more every day that wild and local wheat, which stands out with its richness of vitamins, minerals and fibrous structure, which is important in terms of nutritional physiology, will make a serious contribution to human health and nutrition, and it is supported by researches. The use of local wheat varieties plays an important role in plant breeding as a source of beneficial genes. In addition, it is thought that the use of local wheat can increase agro-food biodiversity and contribute to the provision of new raw materials for the production and development of foods that have a positive effect on health. In studies, foods with high nutritional quality attract the attention of consumers and researchers, because their consumption plays an important role in the prevention of various diseases. High protein content, low allergy and high antioxidant features has increased the interest towards local wheat. Some components such as antioxidants (flavonoids, phenolic acid, phytic acid, tocopherols and carotenoids) and dietary fibers contained in cereals are effective in improving the functional properties of wheat species and local varieties products and preventing chronic diseases. In this study, researches on final product quality and nutritional properties of different wheat species and local varieties were examined.

Keywords: *Wheat species, landraces, end-use quality, nutritional quality.*

1. GİRİŞ

Tahıllar, dünya nüfusunun yaklaşık %35'inin temel besin kaynağı olarak kullanılmakta olup tahıllar içerisinde buğday, stratejik önemi yüksek olan ve insanoğlu tarafından ilk çağlardan beri kültüre alınan bir besin kaynağıdır (Dede, 2007). Yürütülen arkeobotanik çalışmaların sonuçlarına göre buğdayın çok uzun yıllar önce Türkiye'nin güneydoğu bölgesini de içine alan ve 'Bereketli Hilal' adıyla bilinen, dünyaya yayıldığı coğrafya olarak uygarlık tarihinde belirleyici olan Mezopotamya bölgesinde kültüre alındığı belirtilmektedir (Demirel, 2018; Anonim, 2016). Ekonomik öneminin yanı sıra ülkemiz için tarihi, toplumsal, kültürel ve hatta arkeolojik değerler taşımakta olan buğdayın, Anadolu'da binlerce yıldır tarımı yapılmakta olup avcı-toplayıcı insan topluluklarının güçlenip çoğalmalarında, yerleşik yaşama geçmelerinde ve yerleşim alanlarının küçükten büyük kentlere dönüşmesinde çok önemli bir rol oynadığı bilinmektedir (Anonim, 2016). Türk insanının başlıca gıda maddesi ve yaşantısının vazgeçilmez bir parçası olan ve israf edilmemesi gereken kutsal bir değer olarak görülen buğday, aynı zamanda kültürlerin oluşması ve gelişmesi bakımından itici bir güç ve bereketin göstergesi olmuştur (Özberk ve ark., 2016).

Buğday ekmek, makarna, bisküvi ve unlu mamullerin üretiminde hammadde olarak kullanılmaktadır. Bu nedenle buğday türleri ve yerel çeşitlerin kalite özelliklerinin, buğdayların genetik ve çevre ile ilgili faktörlerinden başlayarak son ürün yapımına kadar etkili olan tüm faktörlerin araştırılması gerekmektedir. Bu amaca yönelik yeterli düzeyde ve kalitede üretim için birçok çalışma yapılmaktadır (Zengin, 2015). Bu çalışmada farklı buğday türleri ve yerel çeşitleri ile son ürün kalite ve beslenme özellikleri üzerine yapılan araştırmalar değerlendirilmiştir.

2. BULGULAR VE TARTIŞMA

2.1. Farklı Buğday Türleri ve Yerel Çeşitleri

Buğday grubu olarak adlandırılan *Triticum, Gramineae* familyasının *Triticeae* oymağında yer almaktadır. *Triticum* cinsine ait tüm türler, her biri üretken ve vejetatif hücrelerdeki kromozom sayısına göre ayırt edilen üç temel gruba ayrılabilmektedir. Döllenmemiş yumurta hücreleri 7,

14 veya 21 kromozom içermekte olup vejetatif hücrelerde bu sayı iki katına çıkmaktadır. Özetle; diploid, tetraploid ve hexaploid buğday türleri sırasıyla 2x7=14, 4x7=28 ve 6x7=42 kromozom taşımaktadır (Belderok ve ark., 2000). Tahıl türleri yaklaşık 13 milyon yıl öncesinde tek bir atasal bitki olmasına rağmen, tarihi boyunca görülen çevresel etkileşimler ile doğal mutasyonlar sonucunda birbirinden ayrılmaya başlamışlardır. Diploid buğday türlerinden olan *Triticum urartu* ve *Triticum monococcum,* günümüzden yaklaşık 0,5-1 milyon yıl önce birbirinden ayrışarak dünya üzerinde iki ayrı tür olarak yer almışlardır (Atak, 2017). *Aegilops speltoides* (2n=14) ve *Triticum urartu*'nun (2n=14) doğada kendiliğinden melezi sonucu oluşan yabani *T. dicoccoides* buğday türünden Tetraploid buğdaylar meydana gelmiştir. Yabani *T. dicoccoides* buğday türü, geçmişte Anadolu'da yetiştirildiği bildirilen kültürü yapılmış olan kavuzlu *Triticum dicoccum*'a (syn: *T. dicoccon*) daha sonra da çıplak taneli tetraploid (2n=28) makarnalık buğdaylara (*T. turgidum, T. polonicum, T. turanicum*) dönüşmüştür (Gökgöl, 1969). Hexaploid ekmeklik buğday *(T. aestivum*) ise *T. dicoccoides* ile *Ae. tauschii* arasındaki doğal melezlemeden ortaya çıkmıştır. Ekmeklik buğdayların yabani tür/alt türleri yoktur (Atak, 2017). Doğal-yapay seleksiyonlar sonucu kültür yapılan Gernik buğdayı, *Triticum dicoccoides* türünden (*Triticum dicoccum*, 2n=28 kromozomlu ve AABB genomik formüllü) evcilleştirilmiş olup bu buğdayın alt türü günümüzde Gernik ya da Emmer adlarıyla bilinmektedir. Bu buğday türü de kendiliğinden doğal olarak bir başka çim bitkisi, keçi çimi olarak bilinen diploid (*Aegilops tauschii,* 2n=14 kromozomlu ve DD genomik formüllü) ile melezlenmesi ve kromozomlarının katlanması sonucu Spelt buğdayı (*Triticum spelta,* 2n=42, AABBDD genomik formüllü), M.Ö. 7000-9000 yıllarda ortaya çıkmıştır (Atak, 2017). Günümüzde dünya üzerinde yaygın olarak kültür oluşturulan makarnalık ve ekmeklik buğdayların ortaya çıkmasında ve kültüre alınmasında yabani Tetraploid buğday alt türü *Triticum dicoccoides* önemli rol oynamıştır (Peng ve ark., 2011).

Tohumla çoğaltılan bir türün yerel çeşidi, tanımlanabilir genetik çeşitliliğe ve genellikle yerel bir isme sahip, resmî bir ıslah işleminden geçmemiş, yetiştirildiği alanının çevresel koşullarına (bölgenin biyotik ve abiyotik baskılarına toleranslı), belirli bir süre yöre koşullarına adapte olma süreci geçirmiş, onu geliştiren toplulukların yerel bilgilerine, alışkanlıklarına ve geleneklerine uygun çeşitlerdir" şeklinde ifade edilmektedir (Bioversity International, 2013). Buğdayın Türkiye'de bulunan yabani türlerinden doğal ve yapay seleksiyonlar sonucu önce kavuzlu kültür formları, daha sonra da çıplak taneli kültür formları oluşmuştur (Anonim, 2016). Ülkemiz, 20'den fazla yabani buğday ile buğday akraba türlerine ve 600'den fazla ıslah edilmiş buğday çeşidine ev sahipliği yapmaktadır (Anonim, 2020). Ülkemizde yetiştirilen yerel çeşitlerin; geniş adaptasyon yeteneğine sahip, tane kaliteleri yüksek, kurak ve sıcağa toleranslı genetik kaynaklar olduğu (Özberk, 2010); yetiştirilmekte olan yerel buğday çeşitleri içinde en geniş ekim alanı bulan 11 çeşidin sırasıyla Zerun, Ak Buğday, Kırmızı Buğday, Sarı Buğday, Karakılçık, Kırık, Siyez, Koca Buğday, Topbaş, Şahman ve Üveyik Buğdayı olduğu bildirilmiştir (Özberk ve ark., 2016).

Buğday, ticari kullanım amacına göre iki gruba ayrılmaktadır Hekzaploid (2n=42, AABBDD) olan ekmeklik buğday (*Triticum aestivum*) ve tetraploid (2n=28, AABB) olan makarnalık *(Triticum durum*) buğdaydır. Bununla birlikte az miktarda da olsa, günümüzde kültürü yapılan diploid (2n=14, AA) olan siyez (*Triticum monococcum*) buğdayı ve tetraploid (2n=28, AABB) olan gernik (*Triticum dicoccum*) buğdayının yetiştiriciliği yapılmaktadır. Hekzaploid olan buğdaylar; bisküvi, börek, ekmek, baklava ve pasta yapımında kullanılmaktadır. Tetraploid buğdaylar ise; özellikle makarna ve bulgur yapımında yoğun olarak kullanılmakta olup, diploid buğdaylar ise makarna ve bulgur yapımında kullanılmaktadır (Yalçın, 2007; Šramková, 2009; Demirel, 2018).

2.2. Buğday Türleri ve Yerel Çeşitlerinin Son Ürün Kalite Ve Beslenme Özellikleri Üzerine Yapılan Örnek Çalışmalar

Triticum monococcum (einkorn-siyez) ve *Triticum dicoccum* (emmer-gernik) buğdaylarının bazı kalitatif ve besinsel özellikleri bakımından karşılaştırıldığı bir çalışmada fiziksel, kimyasal ve reolojik test sonuçlarına göre, gernik buğdaylarının daha düşük protein içermesine rağmen daha iyi protein kalitesi gösterdiği ve siyez buğdayına göre daha iyi ekmekçilik kalitesi sağlayabileceği belirtilmiştir. Beslenme açısından ise; siyez buğdayının fitik asit bakımından daha zengin olduğu, antioksidan kapasite ve toplam fenolikler açısından aralarında önemli bir farklılığın bulunmadığı görülmüştür. Kül bileşeni bakımından zengin olan siyez buğdayının demir elementi hariç, kalsiyum, fosfor, potasyum, magnezyum, mangan, çinko ve demir gibi önemli mineraller bakımından daha zengin olduğu tespit edilmiştir (Zengin, 2015). Yerel çeşitlerin tescilli çeşitlere göre daha yüksek besin değerlerine sahip olduğu gözlemlenmiştir. Besin elementi konsantrasyonları yönüyle Fe, Zn, B, K, Mn, Cu, Mg, Ca ve Mo gibi minerallerin yerel çeşitlerde tescilli çeşitlere göre daha yüksek olduğu tespit edilmiştir. Bu nedenle ülkemizde ekmeklik buğdayda element içeriğinin artırılmasına yönelik yapılacak ıslah çalışmalarında genetik kaynak olarak kullanılabileceği belirtilmiştir (Akçura ve ark., 2013). Siyez buğdayı yüksek fenolik madde, karotenoid pigmentleri, B vitamini ve antioksidan aktivitesine sahip olmakla birlikte daha düşük glisemik indeks ve kolesterol yönüyle avantajlıdır (Emeksizoğlu, 2016). Eski Kafkas Buğday türlerinden *Triticum timopheevii* (tetraploid AuAuGG) ve *Triticum zhukovskyi* (hexaploid AuAuAmAmGG) türlerinin özelliklerinin araştırıldığı bir çalışmada; her iki Kafkas türü de, özellikle *T. zhukovskyi*'de olmak üzere, düşük gluten indeksi ile ilişkili yüksek bir protein oranı (ortalama olarak %18.5) ve ticari buğdaylarla karşılaştırılabilir hektolitre ağırlığı değerleri vermiştir. Toplam antioksidan aktivite kapasitesinin durum buğdayının iki katı olduğu ortaya çıkmıştır, bu da sağlıklı gıdaların üretimi için eski Kafkas buğdaylarının kullanılabileceğini göstermektedir Kafkas buğdaylarını yassı ekmek veya bisküvi formülasyonu için potansiyel bir hammadde olarak tanımlarken, çok yüksek protein içeriği nedeniyle iyi bir makarna yapma kapasitesi bulunabildiği belirtilmiştir (Nocente,2022). Çakmak ve ark. (2004), tahıl ürünlerinde çinko (Zn) ve demir (Fe) gibi mikro besinlerin tanede doğal genetik varyasyondan yararlanılarak arttırılabileceğini; yabani buğdayların, tanedeki mikro besin konsantrasyonlarını arttırmak için önemli bir genetik kaynak olabileceğini; *Triticum turgidum L. var.dicoccoides'in*, modern buğday çeşitlerinin tanelerinde Zn ve Fe konsantrasyonlarını iyileştirmek için çok umut verici bir genetik kaynağı temsil ettiğini belirtmişlerdir.

Sevim ve Erekul (2020), 17 ileri kademe ekmeklik buğday, 8 adet yazlık karakterli tescilli çeşit ve 5 adet yerel çeşit kullanarak bu genotiplere ait protein oranı (%), Zeleny sedimantasyon değeri (ml) ve farinograf özelliklerini incelemiştir. Yerel çeşitlerin protein oranları yüksek, ancak Zeleny sedimantasyon değerleri bakımından zayıf özellik gösterdiği, zayıf hamur oluşturduğu, bunun da gluten kalitelerinin düşük olduğunun bir göstergesi olduğu görülmüştür. Bu nedenle yerel çeşitlerin somun ekmek yapımından ziyade yassı ekmek yapımına uygun oldukları, aynı zamanda yerel çeşitlerin incelenen özelliklerinin yanında beslenme fizyolojisi bakımından da incelenmesi gerektiği belirtilmiştir . Bazı yerel çeşitler, modern çeşitler, eski çeşitler, farklı buğday türleri, türler arası ve türler arası buğday melezlerinin teknolojik kalitelerini incelemek ve karşılaştırmak amacıyla yapılan bir çalışmada; *T. petropavlovskyi* ve *T. İspahanicum*, yüksek gluten kalitesi ve reolojik özellikler göstermiştir. *Aegilotriticum, Triticum sphaerococcum, Triticum dicoccum* da güçlü gluten kalitesine sahip bulunmuştur. Bununla birlikte *Triticum aestivum cv. Köse 220/39*, diğer eski çeşitlere ve yerel bir türe göre daha iyi gluten kalitesine sahip bulunmuştur. Bu eski buğday türlerinin kaliteli ekmek yapımı için daha faydalı olabileceği belirtilmiştir. Diğer taraftan, zayıf gluten gücü ve yumuşak endosperm yapısı ile *Triticum compactum* ve *Triticum monococcum*'un yumuşak bisküvilik buğday ıslah programlarında kullanılabileceği belirtilmiştir (Akman ve Karaduman, 2021).

Coda ve ark. (2010), Spelt ve Emmer'in uygun ekmek ürünlerine kullanılabileceğini göstermiştir. Farklı konsantrasyonlarda (% 0-0.5 ve 1) hem agar hem de selüloz gam ile zenginleştirilmiş kavılca (*Tr. Spelta L.*) unundan yapılan hamurların reolojik özellikleri ile sonrasında elde edilen ekmeklerdeki tekstür profil analizlerinin incelendiği bir çalışmada; hamur örneklerinin viskozite değerleri bir miktar azalma gösterirken, elastikiyet oranlarında ise artma gözlemlenmiştir. Buna bağlı olarak ekmeklerdeki sertlik, yapışkanlık ve çiğnenebilirlikte de artışlar görülmüştür. Bu nedenle, spelt unundan ekmek üretimi için kullanılacak hidrokolloidlerin tek başına yeterli olmadığı ve istenen tekstürde ekmek elde edebilmek için spelt ununun ekmeklik buğday unları ile desteklenmesinin gerektiği belirtilmiştir (Yüksel, 2019).

Makarna işlemede *Triticum durum* irmiği yerine *Triticum aestivum* ve *Triticum dicoccum'*dan elde edilen irmiğin kullanımının araştırıldığı bir çalışmada; duyusal ve pişirme kalitesi açısından, *T. aestivum*'dan elde edilen makarna en düşük puanı alırken, *T. dicoccum* makarnası, T. durum makarnası ile karşılaştırılabilir değerler almıştır. *T. aestivum* ve *T. dicoccum* 'dan yapılan makarna kalitesinin, özgün bir katkı maddesi kombinasyonu ile önemli ölçüde iyileştirilebileceği bildirilmiştir (Fuad ve Prabhasanka, 2011). Cankurtaran ve Bilgiçli (2021)'nin yaptığı bir çalışmada kuskus üretiminde durum bulguru yerine siyez bulguru kullanılmış, siyez bulgurunun kaplanması için ise kontrol olarak buğday unu yerine siyez unu kullanılmıştır. Diğer formülasyonlarda siyez unu, kuskusun besinsel özelliklerini iyileştirmek için çeşitli oranlarda amaranth unu (AF), karabuğday unu (BF) ve kinoa unu (QF) ile ikame edilmiştir. Duyusal değerlendirmede AF ile hazırlanan kuskus genel kabul edilebilirlik açısından panelistler tarafından en çok beğenilen olmuştur. Geleneksel Türk eriştesi üretiminde siyez ununun (*Triticum monococcum L.*) performansının araştırıldığı bir çalışmada; numunelerin fizikokimyasal, duyusal özellikleri ve pişirme kalitesi göz önüne alındığında, Siyez Buğday Unu'nun Türk erişte formülasyonunda %60 seviyesine kadar başarıyla kullanılabileceği bildirilmiştir (Levent, 2019). Durum (*Triticum durum*) ve siyez (*Triticum monococcum*) buğday türleri ile bulgur örneklerinin altı farklı prosesle; üç pişirme (geleneksel, mikrodalga, otoklav) ve iki kurutma (sıcak hava, mikrodalga) tekniğinin kombinasyonu ile üretildiği bir çalışmada analiz sonuçlarının çoğu, siyez'in makarnalıktan farklı yönlerden farklı özelliklere sahip olduğunu, ancak bu farklılıkların kabul edilebilir olduğunu ve hatta bazı bulgur kalite özellikleri açısından daha iyi olduğunu göstermiştir. "Otoklavda pişirme ve mikrodalga kurutma"nın çeşitli özellikler üzerindeki olumsuz etkilerinden dolayı "geleneksel pişirme ve sıcak havayla kurutma" ile "mikrodalga pişirme ve sıcak havayla kurutma" yöntemlerinin her iki buğday çeşidi için de önerilebileceği belirtilmiştir (Yılmaz ve Koca, 2020).

Siyez unu (*Triticum monococcum* L.) ile üretilen bebe bisküvilerinin protein ve karbonhidrat sindirilebilirliğinin incelendiği bir çalışmada, siyez un miktarı arttıkça; triptofan miktarının arttığı, % protein sindirilebilirliği (PS) değerinin, glisemik indeks (GI) değerinin, hızlı sindirilebilirlik (RDS) değerinin, yavaş sindirilebilirlik (SDS) değerinin, toplam nişasta (TS) değerinin, hidroliz indeksi (HI) ve tahmini glisemik indeks (pGI) değerlerinin azaldığı tespit edilmiştir (Kızılaslan, 2020). Siyez taneleriyle zenginleştirilmiş fonksiyonel bisküvilerin fiziksel özelliklerinin incelendiği bir çalışmada ise; siyez ununa eklenen siyez gevreği miktarının artmasının, pişme kayıplarının ve pişmiş bisküvi hacminin biraz daha düşük olmasına neden olduğu sonucuna varılmıştır (Dimov ve Stamatovska, 2018). Siyez unlu kurabiyelerin fiziko-kimyasal ve beslenme özelliklerinin araştırıldığı başka bir çalışmada; sonuçları siyezin yüksek besin değeri olan kurabiyeler üretmek için çok uygun olduğunu göstermektedir (Hidalgo ve ark., 2019). Siyez kepeği ilavesinin geleneksel kurabiyelerin bazı fiziko-kimyasal ve besinsel parametreleri üzerindeki etkisini araştırmayı amaçlayan bir diğer çalışmada siyez ile zenginleştirilmiş kurabiyelerin, sade ekmeklik buğday kurabiyelerinden daha iyi fiziko-kimyasal ve besinsel özelliklere sahip olduğunu göstermiştir (Nakov ve ark., 2018). Siyez (*Triticum monococcum* L.) kepekli un ilavesinin kurabiyelerin fiziko-kimyasal

özellikleri, biyolojik aktif bileşikleri ve in vitro nişasta sindirimi üzerine etkisinin araştırıldığı çalışmada, siyez ile zenginleştirilmiş kurabiyelerin, sade ekmeklik buğday kurabiyelerinden daha iyi fiziko-kimyasal ve besinsel özelliklere sahip olduğu; siyez ile zenginleştirilmiş kurabiyelerin yayılmasının, tüketicilere sağlığı teşvik edici özelliklere sahip yeni bir tahıl bazlı ürün sunabileceği belirtilmiştir (Nakov ve ark., 2018). Siyez buğday ununun (*Triticum monococcum L.*) kek kalite özellikleri üzerine etkisinin araştırıldığı diğer bir çalışmada; %30 siyez unu içeren kek numuneleri, kontrol ve %10 siyez unu içeren numunelerden daha yüksek genel kabul edilebilirlik puanlarına sahip bulunmuştur. Bu çalışma sonucunda kek formülasyonunda herhangi bir olumsuzluğa yol açmadan siyez unu kullanılabileceği ve bundan sonraki çalışmalarda %30'dan fazla siyez unu kullanımının araştırılabileceği belirtilmiştir (Levent ve Aktaş, 2019).

3. SONUÇ

Yapılan çalışmalarda da belirtildiği gibi, son yıllarda besin kalitesi yüksek gıdalar tüketicilerin ve araştırmacıların dikkatini çekmektedir, çünkü bunların tüketimi çeşitli hastalıkların önlenmesinde önemli bir rol oynamaktadır. Farklı buğday türleri ve yerel çeşitlerinin yüksek protein içeriği, düşük alerjik özelliği ve yüksek antioksidan içeriğine sahip olmaları; aynı zamanda içerdiği antioksidan bileşenler (flavonoidler, fenolik asit, fitik asit, tokoforoller ve karatenoidler) ve besinsel lifler gibi bazı bileşenler ile fonksiyonel özelliklere sahip olmaları ve kronik hastalıkları önlemede etkili olmaları bu buğdaylara olan ilgiyi daha da artırmaktadır. Farklı buğday türleri ve yerel buğday çeşitlerinin kullanılması, yararlı genlerin kaynağı olarak bitki ıslahında önemli bir rol oynamakta; bu buğdayların kullanımının tarım-gıda biyoçeşitliliğini arttırabileceği, sağlığa olumlu etki eden gıdaların üretimi ve geliştirilmesi için yeni hammaddelerin sağlanmasına katkıda bulunabileceği düşünülmektedir.

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ET VE ET ÜRÜNLERİNDE POLİSİKLİK AROMATİK HİDROKARBON (PAH) BİLEŞİKLERİNİN OLUŞUMU ÜZERİNE UYGULANAN FARKLI PİŞİRME YÖNTEM VE PARAMETRELERİNİN ETKİLERİ

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ÖZET

Polisiklik Aromatik Hidrokarbon **(**PAH) bileşikleri çeşitli fosil yakıtların, karbon içeren maddelerin, gıda gibi diğer organik bileşiklerin pirolizi veya tam yanmaması sonucunda oluşan toksik, mutajenik ve karsinojenik bileşiklerdir. Çevresel kirleticilerin önemli bir kısmını PAH bileşikleri oluşturmaktadır. PAH bileşikleri kirlenmiş toprak, hava ve su ile gıdalara bulaşabilmekte, bunun yanında tütsüleme ve ısıl işlemler de gıdalarda PAH oluşumuna yol açabilmektedir. Proteince zengin gıdalardan olan et ve et ürünleri yaygın olarak diyetlerde yer alması ve tüketilebilmesi için ısıl işleme ihtiyaç duyulması nedeniyle insan vücuduna PAH alımında etkin taşıyıcılardan kabul edilmektedir. Yapılan çalışmalar incelendiğinde farklı pişirme yöntemleri (haşlama, ızgara, mangal, fırın, kızartma, kavurma, ohmik pişirme vb) ve parametreleri uygulanan et ve et ürünlerinde PAH bileşiklerinin oluşum düzeyinin değişim gösterdiği tespit edilmiştir. Ayrıca bu karsinojenik ve mutajenik bileşiklerin gazlı ocak ve odun ateşinde pişirilen döner örneklerinde de farklı miktarlarda oluştuğu gözlenmiştir. Yapılan sınırlı sayıda çalışma ile Türk Gıda Kodeksi Bulaşanlar Yönetmeliği (TGK, 2011-28157) ve Avrupa Birliği Mevzuatı (EC No: 1881/2006) tarafından belirlenen PAH bileşikleri limit değerlerinin bazı döner pişirme yöntem ve parametrelerine bağlı olarak aşılabildiği belirlenmiştir. Son yıllarda yapılan çalışmalar sonucunda pişirme işleminde kullanılan odun çeşidinin farklılığının da PAH bileşiklerinin miktarını etkilediği bildirilmiştir. Diğer pişirme yöntemleri ile karşılaştırıldığında ohmik pişirme uygulanan et ürünlerinde oluşan PAH miktarının düşük düzeyde olduğu saptanmıştır.. Başta yağ içeriği olmak üzere gıdanın kimyasal kompozisyonu da bu bileşiklerin oluşumunda önemli rol oynamaktadır. Bu nedenle yapılan çalışmalarda tüm bu faktörlerin incelenerek ele alınması daha sağlıklı bir değerlendirme yapılmasına olanak sağlayacaktır. Bu çalışmada Polisiklik Aromatik Hidrokarbon bileşiklerinin önemi ile et ve et ürünlerinde oluşumları üzerine uygulanan farklı pişirme yöntem ve parametrelerinin etkileri ortaya konulmuştur.

Anahtar Kelimeler: *Polisiklik aromatik hidrokarbon, PAH, et, et ürünleri, pişirme parametreleri, Benzo (a) piren.*

THE EFFECTS OF DIFFERENT COOKING METHODS AND PARAMETERS ON THE FORMATION OF POLYCYCLIC AROMATIC HYDROCARBON (PAH) COMPOUNDS IN MEAT AND MEAT PRODUCTS

ABSTRACT

Polycyclic Aromatic Hydrocarbon (PAH) compounds are toxic, mutagenic and carcinogenic compounds formed as a result of pyrolysis or incomplete combustion of various fossil fuels, carbon-containing substances and other organic compounds such as food. PAH compounds

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constitute a significant part of environmental pollutants. PAH compounds may contaminate foods with contaminated soil, air and water, besides that smoking and heat treatments can lead to PAH formation in foods. Meat and meat products, which are protein-rich foods, are accepted as effective carriers for PAH intake into the human body because they are widely included in diets and require heat treatment to be consumed. Many studies have reported that the level of formation of PAH compounds changed in meat and meat products that were applied to different cooking methods (boiling, grilling, barbecue, oven, frying, roasting, ohmic cooking, etc.) and parameters. In addition, it was reported that these carcinogenic and mutagenic compounds were formed in different amounts in the doner samples cooked in gas and wood fire. Limited studies revealed that the limit values for PAH compounds determined by the Turkish Food Codex Contaminants Regulation (TGK, 2011-28157) and the European Union Legislation (EC No: 1881/2006) can be exceeded depending on doner cooking methods and parameters. In recent years as a result of the studies carried out has been reported that the difference in the type of wood used in the cooking process also affects the amount of PAH compounds. The amount of PAH in meat products with ohmic cooking was found to be lower than those of other cooking methods. The proximate composition of the food, especially the fat content, plays an important role in the formation of these compounds. For this reason, examining and considering all these factors in studies will provide a healthier evaluation. In this study, the importance of Polycyclic Aromatic Hydrocarbon compounds and the effects of different cooking methods and parameters on their formation in meat and meat products were investigated.

Keywords: *Polycyclic aromatic hydrocarbon, PAH, meat, meat products, cooking parameters, Benzo (a) pyrene.*

1. GİRİŞ

Polisiklik Aromatik Hidrokarbonlar **(**PAH) karbon ve hidrojen atomlarından oluşan iki veya daha fazla kaynaşmış aromatik halka içeren kimyasal olarak kararlı lipofilik bileşikler olarak tanımlanmaktadır (Wang et al., 2010). PAH'lar lipofilik karakterlerinden dolayı yağ dokusunda birikme eğilimi yüksek olan polar olmayan bileşiklerdir (Chen and Chen, 2003). Çeşitli fosil yakıtların, karbon içeren maddelerin, gıda gibi diğer organik bileşiklerin pirolizi veya tam yanmaması sonucu oluşan bileşiklerdir (Chung et al., 2011). Dörtten daha az benzen halkasına sahip ve sudaki çözünürlükleri daha fazla olanlar hafif PAH, dört ve daha fazla benzen halkası bulunduranlar ise ağır PAH grubuna girmektedir (Veiga et al., 2014). PAH'ların molekül ağırlıkları arttıkça sudaki çözünürlükleri azalırken toksik ve karsinojenik özellikleri artmaktadır (Alver et al., 2012). PAH'lar, canlı organizmalar üzerinde toksik, genotoksik, mutajenik ve karsinojenik etkiler göstermektedir. Bu bileşikler insan vücuduna yutma, soluma ve cilt teması ile girmektedir Ancak büyük oranda (%88-98) kontamine gıdaların tüketilmesi ile maruz kalındığı bildirilmektedir (Zhu et al., 2022).

Et ve et ürünleri, yaygın olarak diyetlerde yer alması ve tüketilmeleri için ısıl işleme ihtiyaç duyulması nedeniyle, vücuda PAH alımında etkin taşıyıcılardan biri olarak kabul edilmektedir (Aydın ve Şahan, 2018). PAH bileşikleri kanserojen olmaları, mutasyona yol açmaları, hücre için zehirleyici etkileri ve çevresel kirliliğe yol açmaları bakımından önemli bir bileşik sınıfını oluşturmaktadırlar (Ustaosman ve Aygün, 2010). Doğada 100'den fazla PAH bulunmakla beraber bunlardan 16 tanesi U.S. EPA (Birleşik Devletler Çevre Koruma Ajansı) tarafından 'Öncelikli Kirleticiler' olarak gruplandırılmıştır (Chung et al., 2011). İnsanların PAH bileşiklerine maruz kalması ile kanser riskinin artmasından dolayı yüksek protein içerikli işlenmiş gıdalarda bu bileşiklerin oluşumunu sınırlamanın yolunu bulmak oldukça önem arz etmektedir (Bulanda and Janoszka, 2022).

2. POLİSİKLİK AROMATİK HİDROKARBON (PAH) OLUŞUM MEKANİZMASI

Isıl işlem görmüş gıdalarda PAH'ların oluşum mekanizması tam olarak bilinmemektedir. Bununla birlikte aşağıda özetlenen üç olası mekanizma üzerinde durulmaktadır:

1. Uygulanan yüksek sıcaklığın gıda yüzeyinde PAH oluşturması
2. Eriyen yağ damlacıklarının ısınan yüzeye düşmesi ve pirolizi
3. Kullanılan yakıtın tam yanmaması / eksik yanması (Singh et al., 2020).

Bazı araştırmacılar tarafından, PAH'ların serbest radikal reaksiyonu, molekül içi eklenmesi veya küçük moleküllerin polimerizasyonu yoluyla oluşabileceği öne sürülmektedir (Wongmaneepratip and Vangnai, 2017).
Yüksek sıcaklıkta gıdaların yanması sırasında üretilen serbest radikaller, hafif PAH'ları oluşturmak için rekombinasyona uğramaktadır. Ardından hidrofobik gıda zinciri bölmelerine hareket eden ağır PAH'lar gelmekte ve sonunda yağ açısından zengin gıda maddelerinde tutulmaktadırlar (Luzardo et al., 2013). Tekli doymamış hidrokarbonlar, aromatizasyona ve dehidrosiklizasyona uğrayarak PAH oluşumuna neden olmaktadır (Olatunji et al., 2014). Su varlığı, PAH'ların oluşumunu etkileyebilmektedir. Su, pişirme sırasında oksijen kaynağı sağladığı için eksik yanmayı önlemekte ve PAH oluşumunu engelleyici bir etkiye neden olmaktadır (Min et al., 2018).

3. PAH BİLEŞİKLERİNİN YASAL LİMİTLERİ

PAH içeriklerinin Türk Gıda Kodeksi Bulaşanlar Yönetmeliği (TGK, 2011-28157) ve Avrupa Birliği Mevzuatı (EC No: 1881/2006) tarafından belirlenen limit değerleri 2014 yılında güncellenerek; Benzo(a)piren için 2.0 µg/kg, 4 PAH bileşeninin (Benzo(a)piren, benzo(a)anthrasen, benzo(b)floranthen ve krisen) toplam değeri için ise 12 µg/kg olarak bildirilmiştir (Tablo 1).

Tablo 1. PAH bileşiklerinin yasal limitleri

Gıda	**Maksimum Limit (µg/kg)**	
Tütsülenmiş et ve tütsülenmiş et ürünleri	Benzo (a) piren	Benzo (a) piren, benzo (a) anthrasen, benzo (b) floranthen ve krisen toplamı
	5.0	30.0 (1.9.2012 tarihinden sonra)
	2.0 (1.9.2014 tarihinden sonra)	12.0 (1.9.2014 tarihinden sonra)

B[a]P en güçlü karsinojenlerden biri olduğundan ve gıdalarda PAH varlığının göstergesi olarak kullanıldığından üzerinde en fazla çalışılmış PAH bileşiğidir (Aaslyng et al., 2013). Avrupa Gıda Güvenliği Otoritesi (EFSA, 2008), B[a]P'in gıdalarda PAH oluşumu için artık uygun bir gösterge olmadığını, B[a]P, Chr, B[a]A ve B[b]F'nin toplamını değerlendirdiğini bildirmiştir.
Dünya Sağlık Örgütü'ne (WHO, World Health Organization) bağlı olan Uluslararası Kanser Araştırmaları Ajansı (IARC, International Agency for Research on Cancer) insanlar için

- Benzo[a]piren'i (BaP) karsinojenik,
- Dibenzo[a,h]anthracene'i (DBahA) büyük olasılıkla karsinojenik,

- Naftalen (Nap), Benzo[a]antrasen (BaA), Krisen (Chr), Benzo[b]floranten (BbFlu), Benzo[k]floranten'i (BkFlu) karsinojenik olma ihtimali olan şeklinde sınıflandırmıştır (IARC, 2019).

4. POLİSİKLİK AROMATİK HİDROKARBON (PAH) OLUŞUMUNU ETKİLEYEN FAKTÖRLER

PAH, gıdaların yüksek sıcaklıkta pişirilmesiyle oluşabilmekte ve bu bileşiklerin oluşum miktarı ile karsinojenik aktivitesi, uygulanan sıcaklık ve süreye bağlı olarak değişmektedir (Park vd., 2011; Kılıç vd., 2017). Bu bileşiklerin oluşumunu etkileyen faktörler, etin yağ içeriği, pişirme yöntemi (kızartma, ızgara, kavurma, haşlama, tütsüleme vb.), sıcaklık ve pişirme süresi, ısı kaynağı türü (elektrik, gaz, odun kömürü vb.), ısı kaynağına olan mesafe, ısı kaynağı ile temas türü (doğrudan veya dolaylı) olarak sıralanabilmektedir (Ghorbani et al., 2020).

5. PİŞİRME YÖNTEM VE PARAMETRELERİNİN PAH OLUŞUMUNA ETKİLERİ

Pişirme yöntemleri et ürünlerinde farklı seviyelerde PAH oluşumuna neden olabilmektedir. Yapılan çalışmalar tütsüleme, kızartma ve kavurmanın yüksek düzeyde, bunun yanında haşlama ve fırında pişirme yöntemlerinin daha düşük düzeyde PAH oluşumuna neden olduğunu ortaya koymuştur (Yıldız Turp et al., 2013; Lee et al., 2019). PAH oluşumunun, yağ içeriği ve etin ısı kaynağından uzaklığı ile ilişkili olduğu bildirilmiştir. Alevle temas eden et yağının doğrudan pirolizi sonucunda PAH oluşmakla birlikte, aleve damlayan ve duman olarak ete geri dönen yağın da PAH oluşumuna neden olabileceği bildirilmiştir (Oz, 2020).
Pişirme yöntem ve parametrelerinin et ve et ürünlerinde PAH oluşumuna etkilerinin incelendiği çalışmalar Tablo 2'de verilmiştir.

Tablo 2. Pişirme yöntem ve parametrelerinin et ve et ürünlerinde pah oluşumuna etkilerinin incelendiği çalışmalar

Pişirme Yöntemi	**Et**	**Sonuçlar**	**Referans**
Mangal	Kuzu Eti	6 dakika süreyle pişirilen (normal düzeyde pişirme) kuzu etinde 43.80 µg/kg; 8 dakika süreyle pişirilen (aşırı düzeyde pişirme) kuzu etinde 62.60 µg/kg düzeyinde BaP tespit edilmiştir.	(Aygün and Kabadayı, 2004)
Kömür Ateşli Gazlı Ocak	Döner	Döner örneklerinin ortalama benzo[a]piren seviyelerinin kömür ateşli ocakta pişirilenlerde 24.2 (µg/kg), gazlı ocakta pişirilenlerde ise 5.7 (µg/kg) olduğu saptanmıştır. Özellikle kömür ateşli ocakta pişirilen örneklerin benzo[a]piren seviyesinin Türk Gıda Kodeksi	(Terzi vd., 2008)

		Bulaşanlar Yönetmeliği'nde bildirilen en yüksek limitin (2.0 µg/kg) oldukça üzerinde olduğu gözlenmiştir	
Kömür ateşi Gazlı pişirme Fırın	Dana eti Balık Tavuk eti	Örneklerin PAH içeriklerinin önemli düzeyde farklılık gösterdiği, en yüksek PAH içeriğinin kömür ateşinde pişirilen örneklerde oluştuğu, bunu sırasıyla gaz alevinde ve fırında pişirme yöntemlerinin izlediği tespit edilmiştir. Tavuk ve dana eti örnekleri arasında önemli düzeyde farklılık olmadığı, farklı ısı kaynakları, farklı yağ oranına sahip örnekler ve marinasyon ingredientleri kullanılarak PAH miktarının azaltılması ile ilgili çalışmaların yapılması gerektiği bildirilmiştir.	(Farhadian et al, 2010)
Kömür ateşi Izgara	Domuz eti Sığır eti	Kömür ateşinde pişirilen domuz etinde, sığır etine göre daha yüksek düzeyde PAH içerdiği (ortalama 10,2 µg / kg) tespit edilmiştir. Sığır etindeki PAH seviyelerinin ortalama 0.80 µg / kg'ı geçmediği bildirilmiştir. Domuz etinin odun kömürü ateşinde pişirilmesi son derece yüksek seviyelerde benzo (a) piren (3.0 µg / kg) oluşumu ile sonuçlanırken, ızgarada pişirilen dana eti örneklerindeki ortalama benzo (a) piren seviyeleri 0.15 µg / kg olarak tespit edilmiştir.	(Chung et al, 2011)

Ohmik Pişirme *3 farklı voltaj gradyanı (17.5, 20.0 ve 22.5 V/cm)	Köfte	B[a]P değerleri sırasıyla 0.10, 0.09 ve 0.09 ppb olarak tespit edilmiştir. B[a]P düzeyinin limit değerlerinin çok altında bulunması nedeniyle, ohmik pişirmenin PAH oluşumu açısından güvenilir bir pişirme yöntemi olduğu sonucuna varılmıştır.	(Icier et al., 2012)
Ohmik Pişirme (ön pişirme) Kızılötesi pişirme	Köfte	Toplam PAH4 miktarının 0.62 ile 6.35 μg / kg arasında olduğu tespit edilmiştir. Benzo [a] piren (B [a] P) ve PAH4 (B[a]P, krisen (Chr), benzo [a] antrasen (B [a] A) ve benzo [b] floranten (B [b] F)) köftelerde tespit edilen düzeylerin Avrupa Birliği Mevzuatında bildirilen sınırların altında olduğu bildirilmiştir. Kızılötesi pişirme parametrelerinin köfte örneklerinde PAH oluşumu üzerinde önemli ($p<0.05$) etkileri olduğu belirlenmiştir. Uygulama süresinden bağımsız olarak 8.475 kW/m^2 ve 13.5 ve 16.5 cm uygulama mesafeleri kullanılan örneklerde minimum toplam PAH oluşumu gözlemlenmiştir. Köfte örneklerinin kızılötesi pişirilmesi sırasında daha yüksek ısı akıları, daha yüksek sıcaklık artışlarına neden olmuştur. Fakat toplam PAH düzeylerinin ısı akıları arttıkça düştüğü saptanmıştır.	(Kendirci et al., 2014)

		Kızılötesi pişirmenin farklı ısı akıları ile farklı derinliklerde kabuk oluşumuna neden olduğu ve bu kabuk tabakasının potansiyel bir bariyer görevi gördüğü düşünülmüştür. Kabuk oluşumu ile yağın yüzeye hareketi engellenmekte ve pirolizi azaltılabilmektedir. Çoğu PAH oluşumu yağın pirolizi sırasında meydana geldiğinden, yüksek ısı akılarının PAH seviyelerindeki azalmanın nedeni olabileceği bildirilmiştir.	
Ohmik Pişirme (15.26 V/cm voltaj gradyanı)	Köfte	Ohmik olarak pişirilen köfte örneklerinde B[a]A ve Chr tespit edilmezken, B[a]P ve B[b]F miktarları 0.09 ve 0.19 mg/kg olarak bulunmuştur. Diğer PAH'lar da düşük miktarlarda tespit edilmiştir.	(Sengun et al., 2014)
Izgara	Mısır Alabalık Sığır Eti Karides Domuz eti	En yüksek PAH miktarı yağlarca zengin olan domuz eti, alabalık, sığır eti gibi gıdalarda belirlenmiştir. Domuz eti için toplam PAH konsantrasyonları alabalıktan yaklaşık 35 kat, sığır etinden ise 52 kat daha yüksektir. PAH'ların parçacık boyutunun çok küçük olması sebebiyle akciğer alveollerine kadar ulaşabileceği belirtilmiştir.	(Saito et al., 2014)
Mangal	Domuz eti Sığır eti Tavuk eti	PAH4 (benzo [a] piren, benzo [a] antrasen, krisen ve benzo [b] fluoranten) toplamı, domuz eti bonfilesi için en yüksek iken (195 mg /	(Duedahl-Olesen et al., 2015)

	Somon Kuzu eti	kg), tavuk göğsünde (0.1 mg / kg) en düşük düzeyde tespit edilmiştir.	
Gazlı ocak Kömür Ateşli Ocak	Döner Kebap Tavuk Balık	B(a)P miktarı, gazlı ocakta pişirilen örneklerde döner için ortalama 2,3 µg/kg, tavuk için 2,5 µg/kg, balık için 2,0 µg/kg olarak saptanmıştır. Kömür ateşli ocakta pişirilen örneklerde ise döner için ortalama 10 µg/kg, tavuk için 11,6 µg/kg, balık için 8,4 µg/kg olarak saptanmıştır. Belirlenen B(a)P değerlerinin Avrupa Birliği Mevzuatı (2014) tarafından izin verilen limit değerinin (2 µg/kg) üzerinde olduğu belirlenmiştir.	(Jasim and Shkhaier, 2016)
Haşlama Kızartma Fırın Elektrikli ızgara Odun kömürü ile mangalda pişirme	Dana But Kuzu But Tavuk İncik Hindi But	PAH4 (benzo[a]antrasen, krisen, benzo[b]fluoranthene ve benzo[a]piren) konsantrasyonunun etin kimyasal özelliklerine ve pişirme yöntemine göre değiştiği belirlenmiştir. Mangalda pişirilmiş etlerin toplam PAH4 seviyelerinin 1.10 ve 3.30 µg/kg arasında değiştiği saptanmıştır. Mangalda pişirilmiş tavuk etlerinin PAH4 içerikleri en yüksek bulunmuş, bunu hindi eti takip etmiştir. Et örneklerinde belirlenen PAH4 seviyelerinin, Türk Gıda Kodeksi (TGK) ve Avrupa Birliği limit değerlerinin altında olduğu tespit edilmiştir.	(Aydın ve Şahan, 2018)

Mangal (Odun kömürü- Briket kömürü)	Alabalık Çipura Levrek Somon Ringa balığı	Ringa balığı hariç mangalda pişirilmiş tüm balıklarda PAH bileşikleri yasal limitin altında bulunmuştur. Ringa balığı yağ içeriği yüksek bir balık olduğundan, damlama ve / veya piroliz nedeniyle duman oluşumunu arttırabilmektedir. Balıkların yağ miktarı ile kullanılan kömür türlerinin PAH oluşumunu etkilediği bildirilmiştir. Odun kömürü, brikete kıyasla balıklarda daha az PAH oluşumuna neden olmuştur. Bu durumun, briket kömürünün odun kömüründen daha yüksek kalori vermesi ve dolayısıyla daha uzun süre yanmasından kaynaklı olabileceği düşünülmüştür. Sağlık açısından bakıldığında odun kömürünün briketten daha güvenli olduğu söylenebilmektedir. Bu nedenle mangal işleminde odun kömürü kullanılması önerilebilir. En yüksek PAH seviyeleri, en yüksek yağ içeriğine sahip olan ringa balığında tespit edilmiştir. Bu nedenle, mangalda ringa balığı pişirilmesinden kaçınılması önerilmiştir.	(Oz, 2021)
Izgara Siyah kömür Beyaz kömür	Sığır filetosu Domuz karnı Tavuk budu	Ekstrüde edilmiş kömür kullanılarak ızgara pişirme yöntemi uygulanan etlerde, diğer tip kömürlerin kullanılarak pişirilen etlere	(Kim et al., 2021)

Ekstrüde kömür		kıyasla en yüksek PAH oluşumu belirlenmiştir. Yüksek yağ içeriği nedeniyle domuz karnında dana fileto ve tavuk but etinden daha yüksek düzeyde 4 PAH seviyesi bulunmuştur. Beyaz kömür ve az yağlı et kombinasyonunun, ızgarada pişirilen ette PAH oluşumunu azaltabileceği bildirilmiştir.	
Mangal	Köfte (sığır intermuskuler yağ/koyun kuyruk yağı)	Farklı hayvansal yağ kullanımının BaP ve PAH4 miktarını önemli ölçüde etkilediği ve BaP ve PAH4 düzeylerinin sırasıyla 2.33-4.30 ve 8.41-15.48 ng/g arasında değiştiği gözlenmiştir. Sadece koyun kuyruğu yağı kullanılan köfte grubuna kıyasla, intermusküler yağ ve koyun kuyruğu yağı karışımının kullanılması PAH oluşumunu yaklaşık %46 azaltmıştır. Uygulama grupları arasında, koyun kuyruğu yağı ile formüle edilen köfte grubunda, PAH4 miktarı önemli ölçüde daha yüksek seviyelerde tespit edilmiştir.	(Oz, 2021b)

6. SONUÇ

Et ve et ürünlerinde PAH bileşiklerinin oluşum nedenleri ve azaltma yöntemleri üzerine yapılan çalışmalar bu bileşiklerin kanserojenik ve mutajenik özellik taşıması nedeniyle önemlidir. Yapılan çalışmalar sonucunda uygulanan pişirme tekniği ve parametrelerinin et ve et ürünlerinde oluşan PAH bileşiklerinin miktarlarında önemli değişimlere yol açtığı tespit edilmiştir. Kömür ateşinde pişirilen et ve et ürünlerinde, diğer örneklere kıyasla önemli düzeyde daha yüksek PAH bileşiklerinin oluştuğu belirlenmiştir. Bunun yanında et ve et ürnlerine haşlama, fırında, tavada, ızgarada ve ohmik pişirme tekniklerinin uygulanması sonucunda daha düşük düzeyde PAH bileşiklerinin oluştuğu gözlemlenmiştir. Kömür tipinin, etin ısı kaynağına uzaklığının, pişirme süresinin, et türünün, etin yağlılık düzeyinin PAH

bileşiklerinin farklı düzeylerde oluşmasına etki ettiği yapılan çalışmalarla ortaya konulmuştur. Et yağının ateş üzerine damlamasına neden olan, ayrıca uzun süreli ve yüksek güçte uygulanan pişirme sistemlerinin de et ve et ürünlerinde farklı tipte PAH bileşiklerinin miktarlarını arttırabildiği belirlenmiştir. Sağlıklı ve güvenilir et ve et ürünleri tüketiminin sağlanabilmesi için pişirme yöntem ve parametrelerin seçiminde kanserojenik PAH bileşiklerinin oluşumunun göz önünde bulundurulması önem taşımaktadır. PAH bileşikleri oluşumu üzerine etkili çok sayıdaki faktörün birbirleri ile etkileşimleri de göz önünde bulundurularak yapılacak kapsamlı çalışmalar bu konuya ışık tutacaktır.

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ORANGE PRODUCTS AND BY-PRODUCTS IN TURKEY

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ABSTRACT

Among citrus fruits, orange is the most preferred fruit worldwide in terms of fresh consumption, beverage and aroma industry. The ecological conditions of our country allow citrus cultivation to be carried out successfully in the Mediterranean and Aegean regions. Among the reasons why this fruit group, which has a very wide usage area, is preferred, is its high nutritional value, unique flavor and aroma, as well as its longevity on the tree. In Turkey, which differs a lot in terms of citrus varieties, enough attention is not given to domestic orange varieties, and industrial orange production is mostly carried out with foreign varieties. In recent years, as in all other agricultural products, there have been great difficulties in the production and evaluation of citrus fruits, which have an important place for the country's economy. In this context, citrus products produced in our country are sold below their cost, in many citrus gardens the products are left at on trees and cannot find buyers. One of the main reasons for this is the weak relationship between citrus producers and the processing industry. The studies and activities carried out for the evaluation of wastes in our country are not sufficient and efficient. Every year in Turkey, 40 thousand tons of orange peel goes to waste as industrial waste. However, there is a potential to produce many products from oranges. Orange can be processed into many products such as fresh consumption, fruit juice and concentrate production, as well as orange wine, dried orange slices, jam-marmalade and confectionery, while it can also be evaluated with its by-products such as orange peel oil-flavor and orange peel powder. Orange can be processed into many products other than fresh consumption, fruit juice and concentrate production, like orange wine, dried orange slices, jam-marmalade and confectionery, while it can also be evaluated with its by-products such as orange peel oil-flavor and orange peel powder. In this study, economically important orange products and their potential to produce new products are explained.

Keywords: *Orange, orange products, marmalade, jam, orange peel powder.*

1. INTRODUCTION

Orange is a very important fruit worldwide in terms of fresh consumption, beverage and flavor industry (Lado et al., 2018). Although Türkiye is not a natural genetic center of citrus fruits, citrus fruits have been grown in this country for many years. Citrus is in the family *Rutaceae*, genus *Citrus*; which are dicotyledonous plants originating from China and India. (Aybak & Kaygısız, 2005). The ecological conditions of Türkiye allow citrus cultivation to be carried out successfully in the Mediterranean and Aegean regions (Yılmaz et al., 2013).

Local oranges grown in Türkiye are; Alanya Dilimlisi (Sliced skin), Finike, Kozan, Dörtyol, Akçay Şekeri, Arsuz, Adana, Mersin, Misis and Cyprus Native oranges (Ozsan & Bahcecioglu, 1970). According to 2020 data, approximately 70% of the oranges produced in Türkiye are Navel oranges (Washington navel, Thompson navel etc.), 4% are Jaffa oranges, 26% are other oranges (Valencia oranges, Dörtyol, Kozan, Alanya Native oranges etc.)(Aygören, 2021). Orange production, along with other citrus fruits, is economically important for Türkiye (Gültekin et al., 2022). The leading countries in world orange production in the 2020/21 production season, according to their production shares; Brazil (34%), China (15%), EU (13%)

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and USA (8%), respectively. Türkiye ranks 8th in world orange production with a production amount of 1.4 million tons (Aygören, 2021). In Türkiye, which differs a lot in terms of citrus varieties, enough attention is not given to native orange varieties, and industrial orange production is mostly carried out with foreign varieties (Bozkır, 2010). When the citrus production in Türkiye between 2016 and 2020 is examined, it is seen that although the total citrus production increased by 1.3% compared to 2016, the production of Washington orange variety decreased by 31%. It was reported that the total orange production decreased by 22%, compared to the previous season. This change is explained by the shift of production to tangerine and lemon types in recent years (Aygören, 2021). In 2020, 85% of the orange production was met from the Mediterranean and 15% from the Aegean Region in Türkiye. In the same season, Antalya ranks first in the production of 1.3 million tons of oranges in Türkiye with 39%, followed by Adana (20%) and Mersin (15%) (Aygören, 2021). According to 2020 TUIK data, Türkiye's orange exports have been reported as approximately 280000 tons, mainly to Russia, Iraq and Ukraine. The consumer price of orange has been reported as 5.10 TL in 2020 (Aygören, 2021).

Navel, which is the most grown variety in our country, is juicy, easily peeled, sugar: acid ratio is 5.5:1, total carotenoids are 5-8 mg/L and limonin content is 7-17 ppm. When the fruit flesh is damaged, a slight bitterness occurs. Jaffa is a seedless, thick-skinned, easily peeled, sweet and aromatic variety. The sugar: acid ratio is 5:1. Valencia is in the sweet orange class. Harvest time is long and yield is high. Harvest continues from mid-February to the end of April in Türkiye. It has a thin skin, and its juice yield is high. Fruit juice has low pectin content and high vitamin C content. Sugar: acid ratio is 5.5:1, total carotenoid content is 12-15 mg/L, limonin content is 1-5 ppm (Cemeroğlu & Karadeniz, 2001). Kozan orange is the most studied local variety. (kaynak) Kozan oranges has been described as the best commercial quality for processing. It's sugar: acid ratio is 8-11 which has a good balance of sweet taste and a refreshing aroma. The fruit is medium size with a bright orange flesh (Altan, 1995; Cemeroğlu & Karadeniz, 2001; Selli et al., 2008). In the studies, it has been reported that it is a very successful variety for the production of fruit juice with its high water-soluble dry matter content (sugar) (Altan, 1995).

Citrus fruits have many healthy and high nutritional components such as vitamin C, carotenoids and phenolic compounds. Phenolic acids attract much more attention with their antioxidant behavior and health-promoting effects in various diseases. Ascorbic acid is an important nutritional compound and is used as an additive in many foods due to its antioxidant capacity (Biçgel, 2008). The composition of orange can be quite different depending on the variety. The harvest year also affects the composition considerably (Altan, 1995). But approximately, there can be found 11.54 g carbohydrates (sugars 9.14 g, dietary fiber 2.4 g), 0.21 g fat, 0.70 g protein, 0.100 mg vitamin B1, 0.250 mg pantothenic acid, 45 mg vitamin C, 45 mg calcium, 10 mg magnesium and 169 mg potassium in 100 g of orange (Biçgel, 2008).

In recent years, as in all other agricultural products, there have been great difficulties in the production and evaluation of citrus fruits, which have an important place for the country's economy. In this context, citrus products produced in our country are sold below their cost, in many citrus gardens the products are left at on trees and cannot find buyers. According to the studies, producer prices have decreased to the detriment of the producers in 15 years compared to the real prices of oranges (2017=100) (Ertek et al., 2020). One of the main reasons for this is the weak relationship between citrus producers and the processing industry (Biçgel, 2008). The studies and activities carried out for the evaluation of wastes in our country are not sufficient and efficient. Every year in Türkiye, 40 thousand tons of orange peel goes to waste as industrial waste (Biçgel, 2008). However, orange can be processed into many products other than fresh consumption, fruit juice and concentrate production, like orange wine, dried orange slices, jam-marmalade and confectionery, while it can also be evaluated with its by-products such as

orange-peel oil-flavor and orange-peel powder. In this study, economically important orange products and their potential to produce new products are explained.

2. ORANGE PRODUCTS AND BY-PRODUCTS IN TÜRKİYE

Orange is a fruit that has the potential to be converted into many different products. After processing the orange's juice and concentrate, the remaining skin, seeds, pulp, etc. residues can be used for many purposes. In Europe and America, these residues are used as raw materials in the cosmetics and pharmaceutical industries, and they contribute millions of dollars to the economy (Biçgel, 2008). It is necessary for Türkiye to utilize these agricultural goods in the most effective way and to focus on the production of products that will create added value in economic terms. Fruit juice and concentrate, dried oranges, orange peel powder, orange peel oil and a wide variety of confectionery and jam products are produced in Türkiye. However, there are also various opportunities that our country should evaluate.

2.1. Orange juice and concentrate

Orange juice, which is in high demand by consumers around the world, is a very important and high value-added product. Turkish fruit juice industry has many advantages. Among them; Türkiye's geographical location suitable for agriculture, its special location increasing its export power, climatic opportunities and young population can be counted (Aygören et al., 2014). Fruit juice production in our country started in the late 1960s. Over the years, technological developments have been closely followed and product diversification has been made. Fruit juice and fruit juice concentrate industry is a branch of food industry that processes fruit and a small amount of vegetables as the main raw material input, obtains fruit juice concentrate and fruit puree as an intermediate product and produces fruit juice, fruit nectar and fruit drinks from these products. (Aygören et al., 2014). According to the definitions of the Turkish Food Codex, "Fruit Juice Concentrate" means the product obtained from fruit juice obtained from one or more fruits by physical means of removing water at certain rates; "Fruit Puree", on the other hand, represents the unfermented but fermentable product obtained by sieving the edible part of the whole or peeled fruit without removing the juice (Codex, 2014).

In terms of production amount, apple juice is the most produced fruit juice in Turkiye, followed by peach and pomegranate juices. Orange juice, on the other hand, ranks 4th in terms of production amount with a share of 9.3% (Economy, 2016). According to USDA data; Türkiye produced 10 thousand tons of orange juice in the 2019/20 production season, exporting 55% of the production (5,500 tons), taking its place in the seventh place in the world's orange juice exports (TEPGE, 2020). In the annual report of United States Department of Agriculture (USDA) for Turkish citrus production was reported as insufficient for industry. In the same report it is concluded as, the Turkish fruit processing industry is still under development and is seeking government support to develop the industry (Duyum, 2020).

2.2. Dried orange peel powder

Dried orange peel powder has become very popular recently. The main purpose of drying is to extend the shelf life by reducing the amount of moisture in the product to a certain value. Thus, the product will be dried and microbial growth and enzyme activity will be prevented (Aktaş et al., 2014). Dried orange peel is an important alternative in the evaluation of juice industry waste. Orange peel is a valuable food that contains many vitamins, especially vitamin C, and important minerals such as iron, copper, calcium, magnesium and potassium. It also contains 8% carbohydrates, 3% protein and 42% total dietary fiber in dry matter (Can, 2015). The peel part, which is very rich in natural flavonoids, contains 15 per cent higher phenolics than other edible parts of the orange (Rani et al., 2020). Dried orange peel, which has been commercially produced recently, is used as flavoring and/or coloring agent in all kinds of desserts, meat, soup,

rice, pasta and vegetable dishes, cakes and milk desserts. It can also be used in jam production, essential oil production and various herbal tea mixtures (Yaman, 2012). Orange peel powder is also a good product to increase the nutritional quality, bio-availability, antioxidant property and dietary fiber content of bakery products in a cost-effective and natural way (Rani et al., 2020). For example in their study, Rani et al. (2020) produced a sensory acceptable fiber-antioxidant rich biscuits with incorporation of orange peel powder up to 20 per cent. With orange peel powder, Han et al. (2021) modified the wheat dough properties regarding its components of fiber, pectin, and polyphenols.

These types of nutritional supplements are products that can help with hidden hunger and malnutrition problems, especially in the nutrition of growing children and vulnerable groups. Orange peel powder is generally produced in small quantities by small producers in Türkiye. It is known that the peel of the orange, which is used as a raw material in sectors such as food, cosmetics and pharmaceutical industry, finds buyers in the domestic market and is exported to European countries such as Germany, France and England (Aktaş et al., 2014). The production of this product still needs to be supported and increased.

2.3. Orange peel oil

Orange peel oil is a product with high added value that has been widely used in food, cosmetic and pharmaceutical industries. Essential oils are produced as secondary metabolites of plants with antimicrobial and anti-inflammatory effects (Gönülşen et al., 2016). Orange oil is a widely used food flavoring in areas such as flavored beverages and ice cream. Nowadays, it is becoming more and more common to use essential oils instead of chemicals in different foods and applications due to increasing sensitivities in health issues (Gavahian et al., 2019). For example, Paggiola et al. (2016) stated in their study that limonene, the main component of orange oil, can be used instead of toluene, a petroleum derivative (a general industrial cleaning agent). With this feature, it is widely used in cleansing formulations such as shampoo and soap. It is also used in cosmetic products such as perfume, deodorant and antiperspirant (Aktaş, 2017; Gavahian et al., 2019; Gönülşen et al., 2016)..

Limonene, as the main component of orange oil (more than 90%), is regarded as Generally Recognized As Safe (GRAS) by the U.S. Food and Drug Administration (FDA) and also Environmental Protection Agency (EPA) acclaimed it as a natural pesticide and an insect repellent (John et al., 2017).

Various advanced extraction techniques such as cold press, hydrodistillation, microwave, ultrasound, enzymatic and supercritical fluid extraction can be used for essential oil extraction (Gavahian et al., 2019; Gölükçü et al., 2015), but generally cold press extraction is preferred (BAKA, 2020). Once the oil of the orange peel is extracted, it can be used in many areas without spoiling for 6 months (BAKA, 2020).

Like dried orange peel powder, orange peel oil is generally produced in small quantities by small producers in Türkiye. In the technical reports about the sector for 2020, it is stated that there is no regular orange oil production in Türkiye. The production of orange oil in Türkiye cannot meet the needs of the domestic market and is imported especially from Brazil, the USA and the United Kingdom. Import amounts fluctuate from year to year, and it is stated that 173 tons of orange oil were imported for 2019 (BAKA, 2020).

2.4. Orange confectionery products

Orange peels, which are dried after cooking with sugar, are prepared by coating with chocolate or in other different ways. Orange peel jam and confectionery production in Türkiye are made regionally by small companies. As in other product groups, this area also needs to be supported and developed.

3. POSSIBILITIES

In addition to the fresh consumption of oranges in Türkiye, there is the potential to produce many products with high added value, apart from a limited number of products obtained from this fruit. Orange wine-liquor and pectin are among these kinds of products that are in high demand both inside and the outside of the country and can be produced. Orange peels are materials that can be valued in many other ways. In this study, only the most basic products are emphasized.

3.1. Pectin

Pectin is a complex heteropolysaccharide located in the primary cell wall and intercellular regions of the middle lamella of all higher plants. Pectin, which has an important place among cell wall polysaccharides (Atalay et al., 2018). Pectin (E 440); It is an additive used as a gelling, stabilizer, thickener, brightener, corrosion inhibitor and emulsifier in the food, nutrition, cosmetics, pharmaceutical and health industries (John et al., 2017). Pectin has a wide usage, as gelling agent in foods such as jam; as stabilizer in some confectionery, beverages and dairy products; as a fat substitute in salad dressings, ice cream and emulsified meat products. It can also be used as a carrier polymer in the encapsulation of food ingredients (Atalay et al., 2018). Although all fruits contain pectin, the highest amount of pectin is found in citrus fruits and apples. In addition, sugar beet contains a significant amount of pectin (MKA, 2021). Orange peel is generally used for pectin production among citrus fruits. Müller-Maatsch et al. (2016) was stated that pectin production was carried out using 26 different food residues, and the highest pectic polysaccharide content was found in orange peel (247 mg/g - %11-25). Pectin extraction; in addition to the traditional acid extraction, which is widely used, in recent years alternative aspect; It can be carried out by methods such as ultrasonic, microwave, sub-critical water and enzymatic extraction. Among these extraction methods, acid extraction is the most common method used to produce pectin, since the production is practical, low cost and high efficiency. In this method, the extraction of pectin is carried out by extracting and dissolving the pectin in the raw material at high temperatures, usually using hydrochloric acid, nitric acid, citric acid or sulfuric acid. High temperature and acidic environments; It contributes to the dissolution of insoluble protopectin to increase pectin yield, which is significantly affected by extraction conditions such as pH, temperature, time and solid-liquid ratio (Emine et al., 2021). The demand for pectin is increasing day by day due to its wide usage possibilities around the world (Raji et al., 2017). There is no pectin production in Türkiye, the annual need for pectin is met from abroad. In 2019, Türkiye reached the highest pectin import amount of all time and 676,267 kg of pectin was imported. While the rate of increase in the amount of imports was 19%, the rate of increase in the import amount was 10% (MKA, 2021). Imported pectin od Türkiye worth 40,587,813 USD between 2015-2019. During this period, Türkiye made the most imports from Germany. The share of Germany in all countries is 38.43%. Germany is followed by China with 20% and Ireland with 10%. Although Germany is not in an important position in world pectin export, it has an important position in Türkiye's import (MKA, 2021).

3.2. Orange wine- liquor

Another high value-added evaluation method for oranges is the production of orange wine. Important researches about orange wine have been carried out by Çukurova University and Ege University researchers. (Arıcı & Yücel, 1994; Canbaş, 1983; Selli, 2007; Selli et al., 2003; Selli et al., 2008). Fruit winemaking is highly developed in European countries. Although there are attempts to produce orange wine from time to time in our country, it has not been continuous. The longest production was the orange wine production of Çukurova University under its own brand. However, this production has been interrupted recently. While 1 kg of orange is about

5.10 TL, the price of 1 bottle of orange wine can go up to 150-200 TL. In this sense, orange wine is a product with high economic returns.
In the studies on orange wine, it has been reported that Navel oranges grown in California give a wine that becomes bitter in a short time, but such a defect is not seen in the wines produced from the Valencia variety and positive results are obtained from all varieties grown in Florida (Amerine et al., 1972). In the production of orange wine in the Çukurova region, local varieties such as "kozan native" and "kozan musket" with high sugar content are used. In this respect, it is a very good product for the promotion of the region and the country. Orange wine is very sensitive to oxidation and is not suitable for aging. In the studies, it has been reported that the colors of the wines kept in the bottle start to darken after 1 year and the taste also changes. (Canbaş, 1983; Selli et al., 2002).
In addition to wine production, liquor production from oranges is a high value-added processing method.

3.3. Others

Orange peels also have various promising applications in areas such as bioethanol, composite production and packaging. Tasdemir et al. (2019) proposed orange peel waste usage in composite particleboard production as a filler to replace wood-based materials in the production of particleboard. This new material has been reported as having the better properties like a higher tensile strengths, higher water resistance and non-flammability than wood-based materials. Terzioğlu et al. (2021) studied biowaste orange peel incorporated chitosan/polyvinyl alcohol composite films for food packaging applications. According to study, the addition of orange peel increased the thickness, flexibility, thermal stability and water vapor permeability of the chitosan/PVA films. Also it improved the ultraviolet–visible light barrier characteristic of neat films by lowering the transparency value. It is reported that the presence of orange peel in the composite films resulted in decrease of hydrophobicity and oxygen transmission rate. Furthermore, orange peel notably improved the antioxidant activity of films. Consequently, chitosan/polyvinyl alcohol/orange peel composite films proposed as a potential ecofriendly bioactive packaging candidates for food preservation (Terzioğlu et al., 2021). Apart from these studies, another exciting production is the orange fiber. In 2015, the Italian company “Orange Fiber” won the Global Change Award, given annually by the H&M Foundation, with their patented product (patented in 2013). This patented product is a very luxurious fabric with silk-like properties (Anonymous, 2019). This and similar eco-friendly products are promising for a better future.

4. CONCLUSION

Türkiye is an important producer for fresh fruits and vegetables. The effective use of resources is a very important issue in today's world, which has begun to face the increasing population, climate changes and energy crisis. In this sense, the evaluation of wastes is very necessary for both our planet and our country. Apart from these, the production of products with high added value is especially important for Türkiye, which has many problems in economic and agricultural terms. In this context, orange, which is a very important product for our country and region, draws attention with its economic potential. In order to ensure standardization in orange production, a regular production policy should be developed, and production planning should be done. Production should be diversified in line with the plans made, and attention should be paid to effectively transforming wastes into products with high added value.

Conflict of interest

Authors declares that they have no conflict of interests.

Acknowledgment
This work is supported by the Scientific Research Project Fund of Adana Alparslan Türkeş Bilim ve Teknoloji Üniversitesi under the project number 18103022.

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ETLERİN PİŞİRİLMESİNDE SOUS VİDE PİŞİRME TEKNİĞİ KULLANIMIN DUYUSAL KALİTEYE ETKİSİ

Betül KARSLIOĞLU[1]

ÖZET

Antik Çağ'dan bu yana gıdalara farklı muhafaza ve pişirme yöntemleri uygulanmaktadır. Et ve et ürünlerinin prosesleri gereği kabul edilebilir bir duyusal kaliteye sahip olması, besinlerin sindirilebilirliğinin iyileştirilmesi ve de mikrobiyolojik olarak ürünün güvenli olabilmesi amacıyla uygulanan ısıl işlem kritik bir öneme sahiptir. Bu amaçla çoğunlukla tütsüleme, kavurma, kızartma, ızgarada, fırında, buharda pişirme gibi geleneksel pişirme yöntemleri uygulanmaktadır. Pişirme yöntemleri içerisinde "Sous-vide" tekniği çiğ ya da yarı pişmiş gıdaların, lezzet artırıcı malzemeler ilave edilerek veya edilmeksizin ısıya dayanıklı ambalaj içerisine konulması, vakumlandıktan sonra sıcaklık kontrolü sağlanabilen tankların içerisinde uygun sıcaklık-süre parametresine göre pişirilmesi veya pastörize edilmesi olarak tanımlanır. Bu yöntem ile etler daha düşük sıcaklık derecelerinde uzun süre pişirilebilmektedir. Sous- vide günümüzün popüler ısıl işlem tekniklerinden biri olup, gıdalarda besinsel, duyusal ve mikrobiyolojik kaliteyi artırmak, raf ömrünü uzatmak amacıyla kullanılmaktadır. Et ve et ürünlerinin geleneksel pişirme yöntemleri ile pişirilmeleri sırasında yapılarında bulunan su, suda çözünen besin bileşenlerinde ve aroma bileşenlerindeki vb. kayıplar nedeniyle duyusal kalitesinde kayıplara neden olmaktadır. Yapılan çalışmalar sous-vide pişirmenin üründe nem kaybını engellemesi yoluyla gevreklik, renk, sululuk ve lezzet kriterleri gibi duyusal beğeni düzeyini olumlu yönde etkilediğini ortaya koymuştur. Bu teknik ile et ve et ürünleri, bir yandan düşük sıcaklıkta pastörize edilirken bir yandan da uzun süre uygulaması ile pişirilmesi nedeniyle besin kayıpları azalmakta, daha homojen renkli ve duyusal beğeni düzeyinin daha iyi seviyelerde olmasına olanak sağlamıştır. Bu bildiri de, etlerin özellikle tekstür, renk, koku-lezzet ve tat gibi kalite karakteristiklerine sous-vide pişirme yönteminin etkisinin incelendiği mevcut çalışmalara genel bir bakış sağlamak amaçlanmaktadır.

Anahtar Kelimeler: *Sous-vide, et ve et ürünleri, pişirme yöntemleri, duyusal kalite.*

THE EFFECT OF USING SOUS VIDE COOKING TECHNIQUE ON SENSORY QUALITY IN COOKING MEATS

ABSTRACT

Different preservation and cooking methods have been applied to foods since ancient times. Thermal treatment is critical importance in order for meat and meat products to have an acceptable sensory quality due to their processes, to improve the digestibility of foods and to ensure that the product is microbiologically safe. For this purpose, traditional cooking methods such as smoking, roasting, frying, grilling, oven, steaming are mostly used. Among the cooking methods, the sous vide technique is defined as putting raw or half-cooked foods in heat-resistant packaging with or without adding flavor enhancing materials, cooking or pasteurizing them in tanks that can be temperature controlled after vacuuming, according to the appropriate temperature-time parameter. With this method, meat can be cooked at lower temperatures for a long time. Sous vide, a populer thermal treatment process, is used in foods on the purpose of extending the shelf life and increasing the nutritional, sensory and microbiological quality. During the cooking of meat and meat products with traditional cooking methods, the water in

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their structures causes losses in sensory quality due to losses in water soluble nutritional components and aroma components, etc. Studies have shown that sous vide cooking has a positive effect on the level of sensory taste such as firmness, color, juiciness and flavor criteria by preventing moisture loss in the product. With this technique, meat and meat products are pasteurized at low temperatures and, on the other hand, due to long-term cooking, nutrient losses are reduced, providing a more homogen color and a better level of sensory taste. In this paper, it is aimed to provide an overview of the existing studies examining the effect of sous vide cooking method on the quality characteristics of meat, especially texture, color, odor-flavor and taste.

Keywords: *Sous vide, meat and meat products, cooking methods, sensory quality.*

1. GİRİŞ

Günümüzde teknolojik gelişmeler ve yaşam tarzlarındaki değişiklikler, insanlarda bir yandan tüketim alışkanlıklarının değişmesine bir yandan da hızlı ve kolay hazırlanabilen, daha besleyici, daha lezzetli ve daha az işlem görmüş gıda ürünlerine ilgi duymaya başlamışlardır (Akoğlu vd., 2018).

İnsan beslenmesinde önemli bir yeri olan et ve et ürünleri mikrobiyolojik güvenilirliğinin sağlanması, organoleptik özelliklerinin geliştirmesi ve de depolanacak ürünlerin raf ömrünün uzatılması amacıyla ızgarada pişirme, kızartma, kavurma, haşlama, vb. çeşitli yöntemlerle pişirilmektedir (Nauta vd., 2018; Mologhoni vd., 2019; Mota vd., 2021). Pişirme işlemi ile birlikte, arzu edilen değişikliklerin yanısıra istenmeyen protein denatürasyonu, suda çözünür vitamin ve minerallerde kayıplar ve duyusal kalitesinde de değişiklikler meydana gelmektedir (Lund vd., 2011; Davies, 2016). Bununla birlite, pişirme işlemlerinde uygulanan pişirme yöntemi, pişirme sıcaklığı ve süresi vb. birçok faktöre bağlı olarak, insan sağlığına potansiyel olarak tehlikeli olan heterosiklik aminler, polisiklik aromatik hidrokarbonlar (PAH)'lar gibi kimyasal kontaminantlar da oluşmaktadır (Ghorbani vd., 2020; Kim vd. 2021; Karslıoğlu ve Kolsarıcı, 2022). Bu bağlamda diğer pişirme yöntemlerinin olumsuz etkileri ve tüketici talepleri dikkate alındığında, düşük sıcaklık uygulamalarına izin veren sous-vide pişirme yöntemi oldukça dikkat çekicidir.

Sous-vide pişirme yöntemi, çiğ ya da yarı pişmiş gıdaların, lezzet artırıcı malzemeler ilave edilerek veya edilmeksizin ısıya dayanıklı ambalaj içerisine konulması, vakumlandıktan sonra sıcaklık kontrollü su banyosunda veya buharlı fırınlarda tam olarak kontrol edilebilen sıcaklık ve sürede pişirilmesi veya literatürde uzun süreli pişirme işlemi olarak tanımlanmaktadır (Nyati vd., 2000; Wand vd., 2004). Bu teknik ilk olarak 1970'li yıllarda kullanılmış ve zamanla özellikle hastane, fabrika, okul, otel, hazır yemek sektöründe ve toplu tüketim alanlarında geniş bir kullanım alanı bulmuştur (Mol vd., 2009, Haskara ve Kolsarıcı vd., 2013). Günümüzde bu teknoloji birçok ürün grubuna uygulanmakla birlikte balık, sığır eti, kuzu eti, kanatlı etleri gibi çabuk bozulabilen ve protein değeri yüksek gıdaların soğukta depolanması ve bu ürünlerin mikrobiyolojik açıdan kontrol altına alınması amacıyla da kullanılmaktadır.

Et ve et ürünlerinin pişirilmesinde sous-vide uygulanmasının pek çok avantajı vardır. Bu teknoloji ile hazırlanan ürünlere vakum ambalaj içerisinde ısıl işlem uygulandığı için üründe nem ve aroma kaybı en aza indirgenerek daha sulu, lezzetli ve gevrek ürünler elde edilir. Bununla birlikte üründe daha homojen, daha tutarlı ve çekici renk sağlayabildiği de araştırmalarda gösterilmiştir (Sun vd. 2019). Sous-vide pisirme, ürünü tekstür ve kalite özelliklerine zarar vermeden, dıs yüzeyi asırı kurumadan, istenen sıcaklıkta ve istenen sürede hazırlamayı sağlamaktadır (Haskara ve Kolsarıcı vd., 2013). Sous-vide yönteminde kullanılan sıcaklık &süre parametresi ürün tipine göre değişmekle birlikte, kullanılacak olan sıcaklık &süre kombinasyonu, pişirilen etin nihai kalite özelliklerini belirleyecek en önemli kritik noktasıdır (Gomez vd., 2019). Et ve et ürünlerinin pişirilmesinde ürün türüne göre değişmekle

birlikte genellikle 50-80°C arası sıcaklıklar uygulanırken, pişirme süresi olarak 1,04 dakika ile 32 saat arasındaki değerlerin kullanıldığı görülmektedir (Gomez vd. 2019, Derin ve Serdaroğlu, 2020). Bu noktadan hareketle, bu çalışma kapsamında sous-vide pişirmenin et ve et ürünlerinin duyusal kalitesi üzerine etkisinin incelenmesi amaçlanmıştır.

2. SOUS-VIDE PİŞİRMENİN DUYUSAL KALİTEYE ETKİSİ

2.1. Tekstür

Et ve et ürünlerinde tekstür dolayısıyla etin gevrekliği ve sululuğu tüketici beğenisini etkileyen en önemli faktörlerdendir. Etlere özel işlevsellik kazandıran su tutma kapasitesi, jelleşme, emülsifikasyon, tekstür vb. özellikleri etin protein yapısı ile ilişkilidir (Baldwin vd., 2012). Etler çiğ haldeyken bağ doku proteinlerinden özellikle kolajenin varlığına bağlı olarak çiğ ette tekstür dirençli/sert iken, ısıl işlem uygulanmasıyla et kolaylıkla çiğnenebilir/tüketilebilir doku formuna dönüşmektedir (Derin ve Serdaroğlu, 2020). Pişirme işlemi ile miyofibriler ve bağ dokusu proteinleri (çoğunlukla kollajen) ısıtıldığında büzülürken, sarkoplazmik proteinler ısıtıldığında genişlemektedir. Pişirme işleminde uygulanan pişirme sıcaklığına ve süresine bağlı olarak kas lifleri arasındaki adhezyonun azalmasıyla ve kollajen doku çözünerek jelatin oluşturmak suretiyle etlerin gevrekliği artmaktadır (Roldán vd. 2015). Ancak pişirme sıcaklığı 60-90°C ulaştığında tam tersi etki yapıp, büzülme miktarı artmakta ve böylece tekstür olumsuz etkilenmektedir (Yang vd., 2020). Bu açıdan düşük sıcaklık uygulamalı sous-vide pişirme tekniği etin gevrekliği üzerinde pozitif etkilidir.

Aksoy ve Mete (2017), 63°, 65° ve 71° C'de sırasıyla 2,4 ve 6 saat sous-vide yöntemiyle pişirilen dana bonfile dilimleri, yüzey yapılarını inceledikleri çalışmada, en uygun dokunun 65°C'de ve 6 saatte olduğu saptanmıştır. Piliç göğüs etlerinin 60°C ve 70°C 1, 2 ve 3 saat sous-vide ve fırında pişirildiği bir çalışmada ise, en az pişme kaybının, Warner-Bratzler kesme kuvvetinin ve sertliğin 60°C'de 1 saat sous-vide pişirilen grupta olduğu bulgulanmıştır (Park vd., 2020). Yapılan başka bir çalışmada da sous-vide 60°C ve 65°C'de pişirilen balıkların, pişirme sıcaklığındaki artışın ürünün tekstüründe yumuşamaya neden olduğu belirlenmiştir (Cropotova vd., 2018). Sonuç olarak yapılan birçok çalışmada etin yüksek pişirme sıcaklığı ve uzun pişirme süresinin kolajen çözünürlüğüne neden olarak etin gevrekliği üzerinde olumsuz etkiye sahip olduğu bildirilmiştir (Caporaso ve Formisano, 2015, Yang vd., 2020).

2.2. Renk

Sous-vide pişirme yönteminin kullanımı ile etkilenen diğer duyusal parametresi rengidir. Araştırmalarda, antimikrobiyellerin kanatlı ürünlerinin yüzey renk özellikleri üzerine etkisi genellikle bir kolorimetre cihazı kullanarak enstrümental olarak değerlendirilmiştir. Kolorimetre cihazı ile etin rengini veren miyoglobin ve miyoglobinin farklı formlarının miktarlarının ölçülmesi prensibine dayanarak L^* (parlaklık), a^* (kırmızılık), b^* (sarılık) değerleri elde edilmektedir. Sous-vide yönteminde sıcaklık-süre parametrelerinin kontrol edilebilirliği ile istenilen düzeyde pişmişlik elde edilebilmekte, dolayısıyla üründe homojen bir renk dağılımı elde edilmektedir (Baldwin vd. 2012). Bu pişirme yönteminde, diğer yöntemlere kıyasla yüzeyde yüksek sıcaklıkların ve yüzey dehidrasyonunun olmaması, çok daha düşük maillard reaksiyonuna yol açarak daha açık renkli ve daha kırmızı bir et elde edilir. Bu yöntemde, et ve et ürünleri için istenen bir özellik olan maillard reaksiyonları ile oluşan arzu edilen kahverengi renk oluşmamaktadır. (Ruiz-Carrascal vd., 2019).

Yapılan çalışmalarda sous-vide yöntemiyle pişirilen etlerin L^* ve b^* değerlerinde artış ve a* değerinde azalma olduğu belirlenmiştir. Ayrıca sous-vide pişirmenin diğer geleneksel yöntemlere kıyasla a^* değerinin daha yüksek olduğu belirtilmektedir. Esen vd., (2022) fırın, ızgara ve sous-vide pişirme teknikleri ile pişirilen piliç bonfile dilimleri ile yaptıkları çalışmada, 7 gün depoladıkları ürünlerinde, depolama boyunca ise en yüksek L^* ve a^* değeri sous-vide

yöntemiyle elde etmişlerdir. Latoch (2020) ayran, kefir ve yoğurtla marine ettikleri domuz etlerini 60°C ve 80 °C'de sous-vide tekniği ile 6 saat pişirmişler ve bu tekniğin *L** ve *b** parametreleri üzerine herhangi bir etkisinin olmadığını, a* değerindeki artışında marinasyon sonucu olduğunu belirtmişlerdir. Yapılan başka bir çalışmada ise sous-vide 60°C ve 65°C'de pişirilen sığır etlerinin renginin kırmızımsı rengin daha fazla, kahvemsi-gri rengin daha az olduğu tespit edilmiştir (García-Segovia vd., 2007).

2.3. Lezzet

Sous-vide pişirme yönteminin duyusal kaliteyi etkileyen parametrelerinden biri de koku ve lezzetidir. Ette uçucu lezzet bileşenlerinin önemli bir kısmı 70°C üzeri sıcaklıklarda oluşmaktadır. Sous-vide pişirmede, düşük sıcaklık nedeniyle lezzet gelişimden lipid bozunma ürünleri ile birlikte uçucu olmayan bileşikler sorumludurlar (Ayub ve Ahmad 2019). Bu yöntemle pişirilen etlerin lezzetini artırmak amacıyla servis öncesi etlere kısa süreli ısıl işlem uygulanmasıyla yüksek sıcaklıklarda oluşan Maillard reaksiyonu ürünleri ile ette lezzetin artması sağlanmaktadır. Sous-vide yönteminde kullanılan düşük sıcaklıklar ile ette oluşan su kayıpları, protein denatürasyonu ile lipid oksidasyonu seviyeleri ve ısıya duyarlı protein, yağ gibi besin bileşenleri ile aromatik bileşiklerin kayıpları azalarak lezzet olumlu yönde etkilenmektedir. Ayrıca sous-vide yöntemiyle pişirilen etlerin uçucu lezzet bileşenlerini daha iyi koruduğu ve uygulanan vakum sayesinde okside lezzet oluşumunun engellendiği belirtilmektedir. Araştırmalarda, sous-vide pişmiş etin oluşan aroma bileşiklerinin de farklı olduğu gösterilmiştir (Ayub ve Ahmad 2019).

Roldan vd., (2015) kuzu filetolarında sous-vide ile farklı sıcaklık (60 ve 80 °C) ve süre (6 ve 24 saat) kombinasyonlarında pişirmenin uçucu bileşik profili üzerindeki etkiyi değerlendirdikleri çalışmalarında, lezzet profilinin sous-vide pişirmede daha iyi korunduğunu ve daha güçlü et aromalarının oluşmasına neden olduğunu saptamışlardır. Soğukta depolanan etlerde lezzet profilinin korunması ile ilgili başka bir araştırmada 80 °C'de sous-vide ile pişirilen tavuk etlerinde 7 güne kadar lezzet profilini korunduğu saptanmıştır (Church vd., 2001).

3. SONUÇ

Sous-vide teknolojisi son yıllarda besin ögeleri, duyusal ve mikrobiyal kalite bakımından sağladığı avantajlar bakımından ilgi çekmektedir. Sous-vide'ın duyusal parametreler üzerine bu olumlu değişiklikleri geleneksel pişirme tekniklerine kıyasla et ve et ürünlerindeki kalite kayıplarını azaltmak için büyük bir potansiyele sahiptir. Sous-vide tekniği raf ömrünü uzatma, besin öğesi kayıplarını engelleme, pişirme kayıplarını azaltma, etin gevrekliğini artırma, renk ve diğer kalite parametreleri gibi birçok olumlu etkisinin yanı sıra, genellikle düşük aroma oluşumu gibi tüketici açısından bir dezavantaja sahiptir. Bu sebeple etin lezzetin artırılması için pişirme öncesi bir ısıl işlem uygulaması, doğal katkı maddesi ilavesi, marine etme, yüksek basınç uygulamaları gibi kombine uygulamaların et kalitesini artırıcı etkisi olduğu anlaşılmaktadır. Sonuç olarak, sous-vide pişirme tekniği ile daha kaliteli, daha besleyici, daha lezzetli bir ürün elde edilmesine olanak tanımaktadır.

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KASTAMONU SİYEZ BULGURU

H. Guran UNAL[1]

ÖZET

Günümüz buğdaylarının atası kabul edilen siyez buğdayı tarihte tarımı yapılan ilk buğdaydır. Anadolu'da 10000 yılı aşkın süredir yetiştirilmekte olmasına karşın yüksek verimli modern buğdaylar karşısında ekim alanları hızla azalmaktadır. Fakat yüksek besin içeriği, düşük glisemik indeks değeri ve glüten oranı ile son yıllarda aranılan bir ürün olmaya başlamıştır. Yapılan akademik çalışmalar ile sağlık yönünden birçok avantajı olduğu ortaya konulmuştur. Kastamonu'da yüzyıllardır yetiştirilen siyez buğdayı lezzetinden dolayı siyez bulguru olarak işlenmektedir ve birçok yöresel yemeğe de ilham kaynağı olmuştur. Bu çalışmada coğrafi işaret sahibi Kastamonu siyez bulgurunun yapım aşamaları ve ayırt edici özellikleri incelenmiştir.

Anahtar Kelimeler: *Siyez, buğday, bulgur, Kastamonu.*

KASTAMONU EINKORN BULGUR

ABSTRACT

Einkorn wheat, which is accepted as the ancestor of today's wheat, is the first wheat cultivated in history. Although it has been grown in Anatolia for more than 10000 years, cultivation areas are rapidly decreasing in the face of high-yielding modern wheats. However, with its high nutritional content, low glycemic index value and gluten ratio, it has become a sought-after product in recent years. Academic studies have shown that it has many advantages in terms of health. Einkorn wheat, which has been grown for centuries in Kastamonu, is processed as einkorn bulgur due to its flavor and has inspired many local dishes. In this study, the production stages of Kastamonu einkorn bulgur with geographical indication and local dishes were examined.

Keywords: *Einkorn, wheat, bulgur, Kastamonu.*

1. GİRİŞ

Bulgur, insanoğlunun M.Ö. 2000 li yıllarda keşfettiği olağanüstü işlenme özelliklerine sahip bir gıdadır. Ülkemizde bulgur, özellikle kırsal kesimde ekmekten sonar ikinci derecede önem arzeden ve halkın günlük diyetinde büyük bir yere sahip olan besleyici bir gıda maddesidir.*(Bayram,2000)* İçerdiği folik asitten dolayı çocuk ve hamile kadınlar için çok önemli bir gıdadır. Kolestrol içermez. Posa lif bakımından zengin, karbonhidrat değeri düşük, protein oranı yüksektir. Pişirme ve kurutma işlemlerinden dolayı küf oluşumuna karşı dayanıklıdır ve raf ömrü uzundur.

Siyez (Triticum monococcum) 2n:14 kromozom yapısıyla genetik olarak en basit buğday çeşididir. Hidalgo ve Brandolini (2014) siyezin ekmeklik buğdaylara göre %50 fazla lipid içerdiğini, bu lipidlerin tromboz ve ateroskleroz riskini azaltması sebebiyle kardiyovasküler hastalıkların önlenmesine katkıda bulunduğunu, oksidasyonu yavaşlatarak daha uzun raf ömrü sağladığını tespit etmişlerdir. Dreher (2001), siyezin yüksek sindirilebilir lif oranıyla önemli bir besin olduğunu, prinç, durum buğdayı unu, arpa, yulaf, ıspanak, domates, şalgam, tam buğday ekmeği, soya fasulyesine göre sırasıyla 3.5, 6.8, 1.1, 1.8, 7.0, 15.3, 9.2, 2.3, 1.3 kat daha fazla lif içerdiğini belirtmiştir. Grausgruber ve ark. (2010) modern buğdaylar ile karşılaştırıldığında, siyezde iki katı karotenoidler bulunduğunu, Abdel-Aal ark (1995), Fregeau-Reid ve Abdel-Aal (2005), üç ya da dört kat fazla lutein, 4-5 kat daha fazla riboflavin ve yüksek piridoksin

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içerdiğini tespit etmişlerdir. Hidalgo ve Brandolini (2014) siyezin yüksek mikro element içerdiğini, mikro element eksikliğinin bağışıklık sistemini bozduğunu, fiziksel, zihinsel ve bilişsel gelişim bozukluklarına sebep olduğunu, birçok sağlık sorununu beraberinde getirdiğini vurgulamışlardır. Serpen ve ark. (2008), siyezin yüksek antioksidan, karotenoid ve lutein içeriğiyle sağlıklı beslenme ürünlerine dönüştürülebileceğini belirtmişlerdir.
Siyezin kavuzlu yapısı sebebiyle işlenmesi zordur. Yüzyıllarca sadece bulgur olarak işlenebilmiştir. Fazlası hayvan yemi olarak değerlendirilmiştir. Bu çalışmada coğrafi işaretli Kastamonu siyez bulgurunun yapım aşamaları ve ayırt edici özellikleri araştırılmıştır.

2. MATERYAL VE METOD

Kastamonu siyez bulguru 11.02.2019 tarihinde coğrafi işaret almıştır. Bu bölümde coğrafi işaret tescil onayındaki Kastamonu siyez bulguru yapım aşamaları ve ayırt edici özelliklerine yer verilmiştir.
Ürünün Tanımı ve Ayırt Edici Özellikleri: Kastamonu'da Triticum monococcum (einkorn) buğdayına Siyez buğdayı ve bu buğdaydan üretilen bulgura ise Siyez bulguru denilmektedir. Kastamonu Siyez Bulguru, başakçıkları tek taneli olan ve kavuzlu bir yapıya sahip olan siyez buğdayının kaynatıldıktan sonra kurutulması ve taş değirmenlerde yarılması sureti ile elde edilen bir üründür. Kastamonu Siyez Bulguruna kendine özgü niteliklerini kazandıran ayırt edici özellikleri aşağıda üç başlık altında verilmiştir;

2.1. Ayırt edici hammadde nitelikleri

Kastamonu Siyez Bulgurunun en önemli ayırt edici niteliği Kastamonu Siyez buğdayından üretilmiş olmasıdır. Siyez buğdayı (Triticum monococcum) en yaygın eski ata buğday türlerinden birisidir. Bunlar, hasat esnasında kabuklarını korudukları için kabuklu buğdaylar olarak bilinirler ve soyulmazlar. Siyez buğdayı ekmeklik buğday çeşitlerinin kültüre alınmaya başlandığı M.Ö. 4. yüzyıldan itibaren ekim alanlarından hızla kaybolurken, Kastamonu'da tarımsal hâkimiyetine ara vermemiştir. Siyez buğdayı Kastamonu'da İhsangazi başta olmak üzere Devrekâni, Seydiler ve Kastamonu'nun diğer ilçelerinde yetiştirilmektedir. Üretilen Siyez buğdayının bir kısmı hayvan yemi olarak kullanılmakta, diğer kısmı işlenerek Siyez bulguru elde edilmektedir. Kastamonu'da yetiştirilen Siyez buğdayı, bulgurundan insanların, buğday ve saplarından hayvanların yararlanabildiği, sıkı kavuz yapısı itibarı ile hastalık ve zararlılara karşı dayanıklı, kurak ya da besin maddelerince fakir şartlarda rekabet gücü yüksek bir türdür.

2.2. Ayırt edici üretim yöntemi nitelikleri

Günümüzde Antep ve Karaman (Mut) tipi olmak üzere iki tip bulgur üretimi modeli vardır. Bu üretim modellerinde bulgur prosesine temizlenmiş ve dış kavuzu soyulmuş buğday ile başlanır. Ancak Siyez buğdayı, dış kavuzu endospermine bitişik bir buğday olduğundan dolayı temizlenmiş buğday kavuzu ile birlikte kaynatma işlemine alınır. Kastamonu Siyez Bulguru üretimine kavuzlu buğdayın kaynatılması ileriki aşamada kavuzun buğday tanesinden kolay ayrılmasını sağladığından dolayı mekanik bir kazımaya gerek kalmamaktadır.
Son yıllarda müşteri talepleri doğrultusunda durum bulgurunda sarartma işlemi yapılmaktadır. Mekaniksel sarartma prosesinde (buğdayın parlatması) kırma aşaması öncesinde buğdayın kepek tabakası normalden daha fazla kazınarak özellikle renk pigmentlerinin bulunduğu dış tabaka uzaklaştırılmaktadır. Buğdayın daha alt tabakalarına inilmesi rengi daha sarı bulgur elde edilmesini sağlamaktadır. Bu durumda normalde %80-85 olan buğdayın bulgur verimi, %70-72'ye düşmektedir. Bunun yanı sıra buğdayın dış tabakasının normalden daha fazla uzaklaştırılmasıyla insan sağlığı için faydalı mineral maddeler ve selüloz miktarı da düşmektedir. Oysa Kastamonu Siyez Bulgurunda parlatma ve kepek alma aşaması yoktur. Başlangıçta kaynatma ile endosperminden gevşetilen dış kavuz çıkartıldıktan sonra buğday

doğal haliyle bulgur olarak kırılır. Bu da diğer bulgurlardan farklı olarak mineral madde ve selüloz içeriğinin daha zengin olmasını sağlar.

Kastamonu Siyez Bulguruna ayırt edici niteliğini katan diğer önemli özelliği de şeklidir. Taş değirmenlerde öğütülen Kastamonu Siyez Bulguru aynı değirmene 3 defa gönderilir ve her değirmen çıkışında eleklerden geçirilerek küçük parçalar ayrılır. 1. öğütme aşamasında değirmene dış kabuğunu uzaklaştırmak için gönderilir. Yöresel olarak "Kızıl iri" adı verilen henüz tam kırılmamış ama kabuğu uzaklaştırılmış buğday elde edilir. Bu haliyle durum buğdayından elde edilen iri pilavlık buğdaya benzemektedir ve pilavlık olarak da kullanılabilir. Kızıl iri değirmene kırılmak üzere tekrar verilir. Amaç dikey olarak buğdayı ikiye ayırmaktır. Kastamonu Siyez Bulguru olarak üretimde hedeflenen, ticari olarak tercih edilen ve geleneksel olan şekli "Sinek kanadı" olarak bilinen bu halidir. Tekrar elek sisteminden geçirilen buğdayların kırılmayanları yine değirmene verilerek son kırma aşaması da gerçekleştirilir. Bu 3'lü kırma metodu sırasında elek altına geçen bölümler de kendi arasında tasniflenerek Sinek kanadından daha küçük olanlar çorbalık, çok daha küçük olanlar da köftelik/kısırlık olarak ayrılır. Son iki sınıf değirmencilik yan ürünleridir.

2.3. Ayırt edici nihai ürün nitelikleri

Kastamonu Siyez Bulgurunu diğer bulgurlardan ayıran nihai ürün özellikleri Tablo 1'de verilmiştir.

Tablo 1. Kastamonu siyez bulgurunun bazı fizikokimya özellikleri

		Kastamonu Siyez Bulguru		
		Geleneksel	Modern	Ort.
Protein (%)(min)		% 11,50	Min % 11,50	11,50
Kül (%) (min)		% 1,30	Min % 1,30	1,30
Mineral maddeler				
Ca (ppm)		484,40±4,3	417,10±4,27	450,75±33,65
K (ppm)		3741,60±250	3959,70±150	3850,65±109,05
Fe (ppm)		25,23±0,10	27,53±0,13	26,38±1,15
Zn (ppm)		34,73±0,13	30,77±0,13	32,75±1,98
P (ppm)		2796,47±12,43	3070,50±18,40	2933,49±137,02
Mg (ppm)		938,10±3,23	1026,53±4,30	982,32±44,22
Al (ppm)		7,73±0,07	6,40±0,07	7,07±0,67
Si (ppm)		219,77±0,83	221,33±0,73	220,55±0,78
Yağ (%) (min)		% 1,5	% 1,5	% 1,5
Renk	*L*	53,24±0,01	51,98±0,01	52,61±0,63
	a	7,64±0,01	7,24±0,01	7,44±0,20
	b	20,71±0,15	18,06±0,02	19,39±1,33

Kastamonu Siyez Bulgurunun modern veya geleneksel yöntemlerle elde edilmesi büyük farklılıklar göstermemiştir. Geleneksel ve modern ürünler arasındaki farklılıklar işleme

yönteminden daha ziyade buğday tohum kalitesi, su alma, güneşlenme durumu, toprak mineral içeriği gibi direkt buğday içeriğine yansıyacak faktörlerden kaynaklanmaktadır. Siyez bulgurunun en belirgin niteliği protein oranının, kül içeriğinin ve buna bağlı mineral madde içeriğinin yüksek olmasıdır. Özellikle kalsiyum, demir, çinko, fosfor, magnezyum ve silisyum gibi makro elementler açısından yüksek içeriğe sahiptir. Ayrıca üretim yönteminde belirtildiği gibi modern bulgur üretimlerindeki parlatma amaçlı prosesler uygulanmadığından L* parlaklık değeri daha düşük, siyez buğdayının yapısına ve bulgurun işleme prosesine bağlı olarak daha koyu renkli (kahve/kızıl) yani a* değeri daha yüksek ve sarı olmaması nedeniyle klasik bulgura göre b* değeri daha düşüktür.

Kastamonu Siyez Bulgurunun şekil özelliği; Siyez bulgurunun taş değirmenlerde 3 aşamalı kırma yöntemi sırasında Türk Gıda Kodeksi (TGK) Bulgur tebliğindeki tasniflere karşılık gelebilecek 4 boy bulgur elde edilmektedir. Ancak Kastamonu Siyez Bulguru denildiğinde şekilsel olarak bilinen genel kabul görmüş ve ticari satışın da büyük kısmını oluşturan şekil "Sinek kanadı" olarak bilinen pilavlık çeşittir. Çorbalık ve köftelik/kısırlık ince bulgur çeşitleri değirmen yan ürünü olarak elde edilirler. Durum buğdayından elde edilen bulgura göre hazırlanmış TGK Bulgur tebliği ebat tasnifi ile Kastamonu Siyez Bulguru tasniflerinin karşılaştırması Tablo 2'de verilmiştir.

Tablo 2. Bulgur ebat tasnifleri

TGK Bulgur tebliğine göre boyut tasnifi	Kastamonu Siyez Bulguru ebat tasnifi
Pilavlık bulgur	
Tane Bulgur	Kızıl İri
İri Pilavlık	
Pilavlık	Sinek Kanadı
İnce Pilavlık	Çorbalık
Köftelik bulgur	
Köftelik	Pıs (Köftelik/Kısırlık)
İnce Köftelik	

1. Kızıl İri: "İri pilavlık" bulgur tasnifine karşılık gelebilir. Kırma yapılmamış kavuzundan ayrılmış bütün taneye yöresel olarak "Kızıl iri" adı verilir.
2. Sinek Kanadı: Yöresel olarak "Sinek kanadı" veya "Kavun dilimi" denilen çeşittir. Değirmende tanenin dik olarak ikiye ayrılması hedeflenir. Pilavlık çeşit olarak üretilir.
3. Çorbalık: Yöresel olarak "çorbalık" adı verilen çeşittir. Yöresel olarak Sinek kanadı tipin üretimi sırasında değirmende daha fazla parçaya ayrılan kısımdır. "İnce Pilavlık" tasnife karşılık gelir.
4. Pıs: Köftelik veya kısırlık çeşite karşılık gelir. Yöresel olarak "pıs" olarak adlandırılır. Değirmende elek altı olarak ayrılan en ince kısımdır.

2.4. Üretim metodu

2.4.1. Geleneksel yöntem

Kastamonu Siyez Bulguru üretiminde Siyez buğdayının kavuzlu bir buğday türü olması nedeniyle yabancı maddelerinden ayrılan Siyez buğdayı soğuk suya kavuzu ile birlikte dökülerek kazanlarda kaynatma işlemi yapılır. Bu işlem yapışık olan kavuzun ileriki aşamalarda taneden ayrılmasını kolaylaştırır. Ürünün pişip pişmediğini anlamak için kavuzlu bir buğday alınır. Kavuzları el ile ayrıldıktan sonra buğday el ile ortadan ikiye bölünür. Bölünen kısımda hafif bir beyazlık kalmış ise kaynatma işlemine son verilir. Kırılan buğdayda kalan bir miktar

beyazlık buğday kazandan alındıktan sonra buğdayın kendi sıcaklığı ile kaybolur. Pişen buğdayın kazandan un çuvallarına veya küçük sepetlere (çitlere) boşaltılırken sıcak kavuzlu buğdayın üzerine halk arasında 'paslı sarı su' denilen suyu akıtmak için buğdayın boşaltılması süresince soğuk su dökülmesidir. Boşaltma işlemi tamamen bittikten sonra buğdayın sıcaklığı buğdayın orta kısmına el sokulup kontrol edilerek soğuk su dökme işlemi sonlandırılır veya uygun sıcaklığa gelinceye kadar su dökmeye devam edilir. Uygun sıcaklığa getirilmiş olan buğdayın branda veya bez örtülerin üzerine yaklaşık 1 cm kalınlığında serilerek ve güneşte kurutularak başlangıçtaki koyu amber renginin kazandırılması diğer bir ayırt edici proses özelliğidir. Kurutma işlemi güneş altında 6 ile 9 saat süresince gerçekleşir. Kastamonu Siyez Bulguru üretiminde öğütme prosesi de kendine özgü nitelikler taşır. Değirmende ilk aşama olan eleme esnasında en üst eleğin üzerinde kalan siyeze halk arasında kızıl iri denir. Kızıl iri denilen ve %90 civarında kavuzsuz olan bu yarı mamul ürün ikinci bir defa değirmene verilir. Eleme aşamasından sonra işlem tekrar edilebilir. Eleme sonucunda kızıl iri haricinde pilavlık (sinek kanadı), çorbalık ve kısırlık/köftelik (pıs) olarak tabir edilen üç farklı kalınlıkta bulgur elde edilir.

2.4.2. Modern Yöntem

Kastamonu Siyez Bulguru üretiminde Siyez buğdayının kavuzlu bir buğday türü olması nedeniyle yabancı maddelerinden ayrılan Siyez buğdayı soğuk suya kavuzu ile birlikte dökülerek buharlı kazanlarda kaynatma işlemi yapılır. Bu işlem yapışık olan kavuzun ileriki aşamalarda taneden ayrılmasını kolaylaştırır. Bölünen kısımda hafif bir beyazlık kalmış ise kaynatma işlemine son verilir. Kırılan buğdayda kalan bir miktar beyazlık, buğday kazandan alındıktan sonra buğdayın kendi sıcaklığı ile kaybolur. Modern üretimde bu işlem basamağında ısıtma amacıyla buhar kullanılır. Pişen buğdayın kazandan un çuvallarına veya küçük sepetlere (çitlere) boşaltılırken sıcak kavuzlu buğdayın üzerine paslı sarı suyu akıtmak için buğdayın boşaltılması süresince soğuk su dökülür. Boşaltma işlemi tamamen bittikten sonra buğdayın sıcaklığı buğdayın orta kısmına el sokulup kontrol edilerek soğuk su dökme işlemi sonlandırılır veya uygun sıcaklığa gelinceye kadar su dökmeye devam edilir. Bu aşama Siyez buğdayı kavuzuyla işlendiğinden dolayı modern üretimde de uygulanmaktadır. Kurutma işlemi, uygun sıcaklığa getirilmiş olan buğdayın 5-10 m uzunluğunda çift cidarlı içine 100 °C'da kuru sıcak hava verilen tambur kurutma silindirlerinde buğdayın kavuzlu şekilde 2-3 saatte kurutulması ile gerçekleştirilir. Kastamonu Siyez Bulguru üretiminde öğütme prosesi de kendine özgü nitelikler taşır. Değirmende ilk aşama olan eleme esnasında en üst eleğin üzerinde kalan siyeze halk arasında kızıl iri denir. Kızıl iri denilen ve %90 civarında kavuzsuz olan bu yarı mamul ürün ikinci bir defa değirmene verilir. Eleme aşamasından sonra işlem tekrar edilebilir. Eleme sonucunda kızıl iri haricinde pilavlık (sinek kanadı), çorbalık ve kısırlık/köftelik (pıs) olarak tabir edilen üç farklı kalınlıkta bulgur elde edilir.

3. SONUÇ

Siyez buğdayı tarihte tarımı yapılan ilk buğday olmasına karşın, düşük tarla verimi ve kavuzlu yapısı sebebiyle işlenme zorluklarından dolayı son yüzyıllarda yerini modern buğdaylara bırakmıştır. Ekim alanları hızla daralmış ve kaybolmaya yüz tutmuştur. Fakat son on yılda düşük gluten, düşük glisemik indeks değeri, yüksek besin ve lif içeriği sebebiyle kıymeti anlaşılmış ve tekrar çoğalma trendine girmiştir. Süne, kımıl, buğday pası gibi hastalık ve zararlılara karşı dayanıklı olması sebebiyle tarım ilacı kullanılmayan, ince uzun sap yapısı sebebiyle gübre sevmeyip verimsiz toprakları tercih eden bu nadide bitki organik üretime de çok uygundur. Yüzyıllardır işlenme zorlukları sebebi ile sadece bulgura işlenen Siyez buğdayı geçtiğimiz on yıl içinde çiğken kavuzunun soyulabilmesi neticesinde una da işlenmeye başlamıştır. Bunun sonucunda makarna, erişte, büsküvi gibi bir çok unlu mamule dönüştürülmesinin önü açılmıştır. Sofralarımızda sağlıklı siyez buğdayının bir çok ürünü yer

almaya başlamış, tanınırlığı ve kullanımı hızla çoğalmıştır. Tüm orjinalliği ile 10000 yılı aşkın geçmişten gelen siyez buğdayı, gelecek nesillerimizin de sağlıklı beslenmesinde kilit rol oynayacaktır.

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KAZAKLARIN GELENEKSEL YEMEĞİ "BESHBARMAK"

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ÖZET

Dünyanın en büyük dokuzuncu ülkesi olan Kazakistan zengin tarihi, kültürü ve doğal güzelliklerinin yanısıra geçmişten günümüze kadar uzanan geleneksel mutfak kültüründeki zenginliği ile de dikkat çekmektedir. Ulusal kültürün ayrılmaz bir parçası olan "Kazak geleneksel mutfağı", halkın iç dünyasını, tarihini, geleneklerini ve inancını açıkça yansıtmaktadır. Günümüzde çeşitli bayramlar, düğünler, kutlamalar gibi geleneksel törenlerde eskiye nazaran bazı değişimler olmakla birlikte "Kazak yemek kültürü" ve "Kazak misavirperverliği" eski şeklini kaybetmemiş aksine, bugüne kadar geliştirilerek değerini korumuştur. Kazakistan'da Ruslar, Tatarlar, Ukraynalılar, Özbekler, Almanlar, Uygurlar, Dunganlar, Koreliler gibi çok çeşitli milliyet ve inanca sahip kişiler yaşamasına rağmen bu çeşitlilik Kazak halkının mutfak geleneklerini, yaşamlarını ve kültürünü etkilememiş bilakis "Geleneksel Kazak Mutfağı" bu değişik kültüre sahip insanlar tarafından tüm nesiller boyunca benimsenmiş ve sevilmiştir. Beshbarmak, bauyrsak, irimshik, kurt, kazı, shuzhık, kımız, shubat, sirne, kuyrdak, kattama, katık, zhent, talkan gibi geleneksel Kazak yemekleri eşsiz lezzetleri ile keşfedilmeye değer birer kültür sembolüdürler. Bu çalışmada; Kazakların bu geleneksel yemeklerinden biri olan, adını kaşık olmadığı zamanlarda el ile (beş parmak ile) yenmesinden alan ve Orta Asya'nın en eski tarihinden günümüze kadar gelmiş olan "Beshbarmak"'ın tanıtılması ve hazırlama teknolojisi hakkında bilgi verilmesi amaçlanmıştır. "Beshbarmak"'ın ana malzemeleri et, hamur ve soğandır. Yapımı oldukça kolay olamasına rağmen hazırlanma süresi oldukça uzundur. Çünkü etin yumuşaması ve tadının çorbaya verilmesi önemli noktalardan biridir. "Beshbarmak" yapımında tercihe göre sığır, koyun, at veya kaz eti kullanılmaktadır. Yemeklerin şahı olarak adlandırılan "Beshbarmak" kullanılan hamurunun yapılışı ve kesme şekliyle diğer hamur işi ürünlerinden farklıdır. Ayrıca bu yemek türü kazak masasına diğer halkların mutfaklarında bulunmayan eşsiz lezzeti ve orijinal çeşidi sağlar.

Anahtar Kelimeler: *Beshbarmak, Kazakistan, gelenek, Kazak mutfağı, kültürel*

TRADITIONAL FOOD OF THE KAZAKH'S "BESHBARMAK"

ABSTRACT

Kazakhstan, the ninth largest country in the world, draws attention with its rich history, culture and natural beauties, as well as its richness in traditional cuisine from past to present. "Kazakh traditional cuisine", which is an integral part of the national culture, clearly reflects the inner world, history, traditions and faith of the people. Today, although there are some changes in traditional ceremonies such as various religious holidays, weddings, celebrations compared to the past, "Kazakh food culture" and "Kazakh hospitality" have not lost their old form, on the contrary, they have been developed and preserved until today. Although people of various nationalities and religions such as Russians, Tatars, Ukrainians, Uzbeks, Germans, Uyghurs, Dungans and Koreans live in Kazakhstan, this diversity has not affected the culinary traditions, lives and culture of the Kazakh people. In fact, "Traditional Kazakh Cuisine" has been adopted and loved by all generations of these people. Traditional Kazakh dishes such as beshbarmak,

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bauyrsak, irimshik, kurt, goose, shuzhik, kumiss, shubat, sirne, kuyrdak, katama, katik, zhent, talkan are cultural symbols worth exploring with their unique flavors. In this study; It is aimed to introduce and give information about the preparation technology of "Beshbarmak", which is one of these traditional dishes of the Kazakhs, which takes its name from being eaten by hand (with five fingers) when there is no spoon and has survived from the oldest history of Central Asia. The main ingredients of “Beshbarmak” are meat, dough and onions. Although it is very easy to make, the preparation time is quite long. Because the softening of the meat and giving its taste to the soup is one of the important points. Preferably, beef, sheep, horse or goose meat is used in the production of “Beshbarmak”. “Beshbarmak”, which is called the king of dishes, differs from other traditional products in the way its dough is used and the way it is cut. In addition, this type of food provides the Kazakh table with a unique flavor and original variety not found in other peoples' kitchens.

Keywords: *Beshbarmak, Kazakhstan, tradition, Kazakh cuisine, culture.*

1. GİRİŞ

İnsanın varlığını sürdürebilmesinin ana koşullarından biri beslenmedir. Gıda miktarı, gıdaların kalitesi, tüketilen yiyeceklerin çeşitliliği, hazırlığın zamanlaması ve yiyecek alımının düzenliliği, organizmanın hayati aktivitesini özel bir şekilde etkilemektedir. Bu nedenle yemek pişirme sanatı önde gelen insan faaliyetlerinin en eski alanlarından biridir (Temerbayeva., 2019).

Antik çağlardan beri süregelen Kazak yemekleri kendine özgü orijinal teknolojileriyle diğer yemeklere göre farklılık göstermektedir. Kazakistan’ın yüzölçümü (2.729.900 km^2) Orta Asya ve Doğu Avrupa’daki ülkelerden daha fazladır ve bu yönüyle dünyanın en büyük dokuzuncu ülkesidir. Bütün Türk devletleri arasında yüzölçümü bakımından en büyüğü, doğal kaynaklar bakımından ise en zenginidir. Komşuları - Rusya, Türkmenistan, Özbekistan, Kırgızistan ve Çindir, 17 bölgesi olup cumhuriyet için öneme sahip Nur-Sultan, Almaty ve Shymkent olmak üzere 3 şehri vardır.

Kazak halkının kendilerine has yaşam tarzları yemek hazırlama yöntemine de damgasını vurmuştur. Kazak yemekleri çoğunlukla et, hamur işi ve sütle hazırlanır. Bunun nedeni Kazakların çok eski zamanlardan bu yana daha çok hayvancılık ve tarım ile uğraşmasıdır. Geleneksel Kazak mutfağında yaygın olarak yer alan ürünler; yoğurt, kımıs, şubat, kefir, tereyağı, peynir, peynir altı suyu, beşbarmak, kazak mantısı, nevruz çorbası, sirne, kuırdak, kazak pilavı, bauırsak, süt ürünleri, tarı, talkan, kazı ve et çeşitleridir (Alimardanova, 2003). Bu yemekler arasında Kazak halkı daha çok “Beşbarmağı” sevmişlerdir çünkü yemekleri kaynatarak pişirmeye her zaman özen gösterilmektedir. Kaynar suya etin, sebzelerin, baharatların ve hamurun özel koku vermesi sonucu eşsiz bir lezzet kazanan bu Kazak geleneksel yemeği Orta Asya ülkelerinde meşhur bir yemek çeşididir. Eski zamanlarda elle yenilen bir yemek olduğu ve adeta yiyenler lezzetinden beş parmağını yiyecek kadar zevk aldığı için bu adı almıştır (Bekova ve Shadrin, 2018).

Beşparmak yemeğinin farklı bölümleri misafirin yaşına ve akrabalık ilişkilerine bağlı olarak tabaklara konulur ve uygun hürmetle sunulur. Örneğin misafirler arasında yaşça en büyük olan kişiye koyunun baş ve but kısımlarını içeren yemek bölümü sunulurken orta yaştaki kişiye etin omurga ve göğüs bölümleri ikram edilir. Yemek tadımına önce şerefli misafirler tarafından başlanır. Yemek yedikten sonra evin misafirleri tarafından dua okunur ve misafiri ağırlayan kişinin evine bolluk, bereket vb gibi iyi dilekler dilenerek sofradan kalkılır (Pokhlebkin, 1983; Asrandin ve Shadrin, 2018).

Geleneksel Kazak yemekleri eşsiz lezzetleri ile keşfedilmeye değer birer kültür sembolüdürler. Bu çalışmada; Orta Asya’nın en eski tarihinden günümüze kadar gelmiş olan Kazakların

geleneksel yemeği "Beshbarmak"' tanıtılmış ve hazırlama teknolojisi hakkında bilgi verilmiştir.

2. MATERYAL VE METOD

2.1. Materyal

Beshbarmak yemeği hazırlanmasında kullanılan malzemeler; kemikli kuzu eti, at etinden yapılmış kazı, patates (soyulmuş, orta boy doğranmamış), havuç (soyulmuş, orta boy doğranmamış), tuz, kuru soğan (piyazlık doğranmış sos için) ve karabiber (arzuya göre). Kazı; taze kesilmiş atın bağırsakları yıkandıktan sonra içerisine tuz ve çeşitli baharatlarla (genellikle karabiber, sarımsak) karıştırılan at eti konularak hazırlanır. Uzun bağırsağın iki ucu kapatılır ve rüzgarda asılır ve bir aydan fazla bir süre kurutulur. Kuru üzüm gibi olan bu doğal ortamda kurutulmuş kazılara "füme kazılar" denir. Beshbarmak yemeğinin hamuru için: birinci sınıf buğday unu (GOST 26574-85), içme suyu (GOST 2874-82), yumurta ve ½ çay kaşığı tuz kullanılmıştır.

2.2. Metod

Beshbarmak yemeği yapımında öncelikle etlerin çok iyi bir şekilde kaynatılması gerekir. Bu çalışmada; kuzu eti ve at eti soğuk suyla iyice yıkandıktan sonra büyük bir tencereye yerleştirilmiş ve tüm tencere su ile dolacak kadar su eklenmiştir. Etler kısa bir süre kaynatıldıktan sonra su yüzeyine çıkan köpük atılmış ve düşük ateşte yaklaşık 2 saat pişirilmeye bırakılmıştır.

Diğer taraftan etler pişene kadar Beshbarmak'ın hamuru hazırlanmıştır. Hamur hazırlama aşamasında; elenmiş una az miktarda su, ½ çay kaşığı tuz ve 1 adet yumurta ilave edildikten sonra hamur iyice yoğrulmuş ve yoğurma işlemi tamamlanan hamur oda sıcaklığında üzeri örtülerek 20 dakika dinlendirilmiştir. Dinlendirilen hamur 1-1.5 mm inceliğinde açılarak 8x8 santimetrelik dikdörtgenler halinde kesilmiştir.

1.5–2 saat sonra etler pişmeye yaklaşınca havuç ve patatesler eklenmiş ve yumuşayana kadar pişirilmiştir. Yumuşayan havuç, patates ve etler kevgir yardımıyla tencereden çıkarılmıştır. Kaynayan et suyunun üzerindeki yağ alınmış ve bu yağ içerinde doğranmış soğanlar yumuşayana kadar yaklaşık 5 dakika kavrularak sos hazırlanmıştır. Kaynamış et suyuna hamur parçaları atılarak 5 dakika pişirilmiştir (eğer su miktarı azalmışsa biraz daha su eklenir ve kaynadıktan sonra hamurlar tekrar pişirilir).

Beshbarmak yemeği; pişmiş hamurlar servis edilecek tabağın en altına yerleştirilip üzerine et ve patatesleri, en üste de soğandan yapılan karabiber eklenmiş sosu yerleştirilerek servise sunulur.

Şekil 1'de Beshbarmak yemeğinin farklı sunum şekilleri gösterilmiştir.

Şekil 1. Kazakların geleneksel yemeği "Beshbarmak"

3. SONUÇ

Günümüzde de olduğu gibi eski zamanlardan beri Kazakların en belirgin özelliği konuksever olmalarıdır. Konuklar saygın bir şekilde ağırlanır ve evlerde (eskiden yurtlarda) şeref köşelerine oturtulur. "Beshbarmak" bu değerli konuklara ikram edilen en popüler geleneksel Kazak yemeğidir. "Beshbarmak" düğün, nişan, sünnet gibi özel günlerde yapılır. Adını eski zamanlarda elle (beş parmak ile) yenilmesinden almıştır. İri parçalar halinde haşlanan etler konuklara yaş ve önem sırasına göre ev sahibi tarafından kesilir ve servis edilir. "Beshbarmak" yemeğinin yanında etlerin haşlanmasında kullanılan et suyu geleneksel olarak kese adı verilen Kazak kaselerinde sunulur.

Kazakistan Orta Asya ülkeleri arasında çok zengin bir mutfak kültürüne sahiptir. Pek çok gelenek çoğu Türk toplumu tarafından terk edilmişken Kazakistan Türkleri tarihsel süreç boyunca güçlü ulusal aidiyet duyguları ile gelenek- göreneklerine ve mutfak kültürlerine çok sıkı bir şekilde sahip çıkmışlar ve bu kültürün değişmeden günümüze kadar ulaşmasını sağlamışlardır.

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