A DISSERTATION ON

Development of Gluten Free pizza base fortified with Elephant foot yam flour

SUBMITTED TO THE
DEPARTMENT OF BIOENGINEERING
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FOR THE
DEGREE OF MASTER OF TECHNOLOGY
IN FOOD TECHNOLOGY

BY
Sheereen Samar
B. Tech-M.Tech Dual Degree Food Technology (X Semester)
Roll No: 1801087033

UNDER THE SUPERVISION OF

Mrs. Poonam Sharma
Assistant Professor
Department of Bioengineering

INTEGRAL UNIVERSITY, DASAULI, KURSI ROAD
LUCKNOW- 226026

<u>DECLARATION FORM</u>

I, **Sheereen Samar**, a student of **B.Tech.-M.Tech. Dual Degree Food Technology** (V Year/ X Semester), Integral University have completed my six months dissertation work entitled **"Development of Gluten free pizza base fortified with Elephant foot yam flour"** successfully from **Integral University, Lucknow** under the able guidance of **Mrs. Poonam Sharma.**

I, hereby, affirm that the work has been done by me in all aspects. I have sincerely prepared this project report and the results reported in this study are genuine and authentic.

Sheereen Samar

Dr. Rahul Singh
Assistant Professor
Department of Bioengineering

INTEGRAL UNIVERSITY
LUCKNOW - INDIA
Phone No.: +91(0522) 2890812, 2890730, 3296117, 6451039, Fax No.: 0522-2890809
Kursi Road, Lucknow-226026 Uttar Pradesh (INDIA)

CERTIFICATE

Certificate that Ms **Sheereen Samar** (Enrollment Number 1800100594) has carried out the research work presented in this thesis entitled **"Development of Gluten free pizza base fortified with Elephant foot yam flour"** for the award of **B.Tech.-M.Tech. Dual Degree Food Technology** from Integral University, Lucknow under my supervision. The thesis embodies results of original work and studies carried out by the student himself and the contents of the thesis do not form the basis for the award of any other degree to the candidate or to anybody else from this or any other University/Institution. The dissertation was a compulsory part of her **B.Tech.-M.Tech. Dual Degree Food Technology** degree.

I wish her good luck and bright future.

Mrs. Poonam Sharma
(Supervisor)
Assistant Professor
Department of Bioengineering

INTEGRAL UNIVERSITY
LUCKNOW - INDIA
Phone No.: +91(0522) 2890812, 2890730, 3296117, 6451039, Fax No.: 0522-2890809
Kursi Road, Lucknow-226026 Uttar Pradesh (INDIA)

CERTIFICATE BY INTERNAL ADVISOR

This is to certify that **Sheereen Samar,** a student of **B.Tech.-M.Tech. Dual Degree Food Technology** (V year/ X Semester), Integral University has completed her six months dissertation work entitled **"Development of Gluten free pizza base fortified with Elephant foot yam flour"** successfully. She has completed this work from Integral University, Lucknow under the guidance of Mrs.Poonam Sharma, Assistant professor, Department of Bioengineering. The dissertation was a compulsory part of her **B.Tech.-M.Tech. Dual Degree Food Technology**.

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Mrs. Poonam Sharma
Assistant Professor
Department of Bioengineering
Faculty of Engineering & Information Technology

INTEGRAL UNIVERSITY
LUCKNOW - INDIA
Phone No.: +91(0522) 2890812, 2890730, 3296117, 6451039, Fax No.: 0522-2890809
Kursi Road, Lucknow-226026 Uttar Pradesh (INDIA)

TO WHOM IT MAY CONCERN

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I wish her good luck and bright future.

Dr. Alvina Farooqui
Professor and Head
Department of Bioengineering
Faculty of Engineering & Information Technology

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Place: Lucknow **Sheereen Samar**

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ABSTRACT

Pizza is one of the most frequently consumed food product. It has been marketed in America, Europe, Asia and other continents and has boosted the trend towards convenience foods. However it is composed of wheat flour which contains gluten that cannot be consumed by people suffering from celiac disease. Therefore in this study a gluten free millet based pizza base fortified with Elephant foot yam flour was developed and its physicochemical analysis was conducted. The result showed that the moisture content of pizza base with blend of sorghum flour and oats flour (50:50) had highest moisture content of (38.55%), total ash content (5.52%) and fat content (8.13%) while pizza base made with the blend of sorghum flour, oats flour and elephant foot yam flour (40:30:30) had highest protein content (13.01%) and antioxidant (16.38%). The sensory analysis showed that pizza base made with the flour blend (50:25:25) had the maximum rating (9) on hedonic scale while pizza base with flour blend (40:30:30) had minimum rating (7).The thickness and spread ratio of the pizza base reduced with the increase in concentration of elephant foot yam. It was observed that with increase in concentration of elephant foot yam, protein content and antioxidants increased while there was decrease in the moisture content and fat content with the increase in yam concentration.Therefore it can be concluded that Elephant foot yam incorporated pizza base is nutritionally rich and suitable for reducing high cholesterol and prevention of diseases such as diabetes.

Keywords: Gluten free pizza base, Elephant foot yam, Millet

CHAPTER 1
INTRODUCTION

Development of different types of gluten-free products and their implementation on current enterprises are one of the recent trends in modern food industry. The growing gluten intolerance related consciousness has driven the food industry to discover alternatives to provide suitable products to the consumers with gluten intake related disorders. gluten-free production is required for specialized nutrition for individuals having celiac disease (gluten enteropathy) or gluten intolerance. In addition, it can also be added in diet for consumers who stick to a gluten-free diet by choice. Celiac disease is an immune system disorder where an individual cannot tolerate gluten, leading to damage to the inner lining of the small intestine and preventing the absorption of essential nutrients. This condition is triggered by the consumption of gluten in those who are intolerant to it. Gluten is a complex protein primarily found in wheat, as well as in other grains like barley and rye, and it is soluble in alcohol. When genetically susceptible individuals consume gluten, it triggers an improper immune response in the small intestine, characterized by villous atrophy and crypt hyperplasia. This immune response results in poor absorption of proteins, fats, carbohydrates, soluble vitamins, folate, and minerals, particularly iron and calcium. Currently, the only effective treatment is to completely eliminate gluten from the person's diet.Gluten-Free alternatives are also in demand due to their contribution in weight management. Gluten-free products need special condition for production since they are made in the absence of gluten which provides texture and binding to the processed food products.

Pizza is one of the most frequently purchased products and has gained popularity with time.it is one of the most popular food items. It has been marketed in America, Europe, Asia and other continents and has boosted the trend towards convenience foods. As a result, production of pizza has increased extensively and is expected to expand further in the next decade with the growing world population. As pizza is widely consumed by a significant portion of the global population, there is a pressing need for its reformulation due to its classification as fast food, which can potentially have adverse effects on health. According to Michael Jacobson, who serves as the President of the Center for Science in the Public Interest in Washington, D.C., junk food is characterized by its high caloric content and low nutritional value. It typically contains elevated levels of refined wheat flour (commonly known as Maida), refined sugar, fats, and various food additives.Besides, it lacks valuable nutrients required by the body such as proteins, vitamins and fiber. The junk food production in india is increasing at a rate of 40% a year. Unfortunately, this adaptation to junk food has caused numerous adverse health effects. Some of which comprise childhood obesity epidemic (which later in life leads to life threatening diseases), allergies and cancer.

To manage these issues, we speculated a new product based on the fusion of Elephant foot yam, Sorghum and Oats that are gluten free as well as an excellent source of vitamins, minerals, protein, dietary fibers with functional properties.

Elephant Foot Yam or Amorphophallus paeoniifolius also known as Jimmikand is cultivated in several parts of South Asian Countries. The plant is also grown throughout the India. Its main producing regions in india are Bengal, Sikkim, Kerala, Maharashtra, Tamil Nadu, Uttar Pradesh, Punjab, Bihar, Assam and Odisha. Elephant Yam has been regarded as a famine food and is an essential part of small rural communities during food scarcity. It has also been ranked fourth most significant tuber after sweet potato, cassava and potatoes. This crop is superior to other tuber crops in terms of nutrients it contains high amount of protein, vital amino acids in balanced form and also a variety of dietary minerals. There are more than 600 species of elephant yam that are found in the world. Due to the presence of some anti-nutritional factors such as oxalates it is not much utilized hence it is also called underutilized crop These antinutritional factors can be removed by various methods such as sulphiting before consumption and can be utilized as a functional food.

Sorghum millets or jowar is one of the most popular millet cultivated in tropical semi-arid regions of the world. Sorghum is a gluten free cereal rich in protein, Polyphenols, iron, calcium, dietary fiber hence it is unique among all millets. It has different varieties such as red and white sorghum. Sorghum is a staple food for millions of people and is primarily grown for its seeds, fodder, sugar, and fibre or for the generation of bioenergy. Its expected production for the world and Africa in 2020 was 58.7 and 27.5 million tonnes over 40.3 and 27.3 million hectares, respectively.

Processing methods such as milling, malting, blanching, acid treatment, dry heating, and fermentation play a vital role in decreasing antinutritional components and improving the digestibility and shelf life of various alternative food items, including unleavened flatbread (roti/chapatti), porridges, noodles, bakery goods, and extruded food items. Consequently, through the application of value-added approaches and appropriate processing techniques, millet grains can find their way into numerous value-added and nutritious food products, potentially leading to substantial demand among large urban populations.

Oats, scientifically known as Avena sativa, are abundant in beneficial natural substances, including soluble fibers, proteins, vitamins, minerals, and unsaturated fatty acids. The key feature of oat flour is its elevated fiber content, notably glucan, which effectively reduces cholesterol levels in the bloodstream by enhancing the secretion of bile within the body. Addition of oat products to blended mixtures in baking increases the biological value of the new product. The consumption of oats is recognized for its potential health advantages, such as its ability to lower cholesterol levels and potentially have anti-cancer properties. Recently, oats have also been deemed suitable for inclusion in the diets of individuals with celiac disease. Because of their rich nutritional profile, food items made from oats, including bread, biscuits, cookies, probiotic beverages, breakfast cereals, flakes, and infant food, are gaining more attention. European Commission Regulation (EC) No. 41/2009 has permitted the use of oats as ingredients, as long as their gluten content remains below 20 ppm (mg/kg).(European Commission 2009).

The objectives of this study are:

1.Collection and Processing of Elephant Foot yam.

2.Incorporation of Elephant Foot Yam flour in the millet pizza base.

3.Physiochemical and shelf life analysis of Elephant foot yam pizza base.

CHAPTER 2

REVIEW OF LITERATURE

Pizza is a widely consumed and significant food product. Pizza consumption has increased by over thrice since the 1970s, and it is most likely responsible for the vast majority of sauce and cheese consumption and purchases at fast food establishments. Wheat flour is typically used to make the bread dough that is flattened into the pizza crust. Aside from bread and pasta, wheat is also frequently used to make other baked goods including morning cereals and pasta. Wheat is a popular component in baked goods because it forms a cohesive dough that can trap gas and allow for mechanical sheeting, which is necessary for leavened breads and pizza bread. The creation of gas pockets and the ability for sheeting are both due to wheat gluten. Wheat is necessary for the industrial manufacture of leavened, light goods like bread and pastries due to the special property of gluten. Due to a sensitivity to the dietary ingredient gluten, celiac disease is an autoimmune genetic condition of the small intestine. The small intestine's lining typically has a fluffy, velvety feel, but in those with celiac disease, it becomes smooth and flat. This lessens its capacity to absorb nutrients from diet, such as carbohydrates, proteins, essential minerals, and vitamins. When people with celiac disease consume gluten-containing foods, their immune systems react by destroying the lining of the small intestine. A lifetime commitment to a gluten-free diet is the only effective treatment for celiac disease. The harmful component of wheat in celiac disease patients is the prolamin fraction of wheat gluten, which contains α-gliadin. Gluten protein intolerance is a lifelong symptom of celiac disease. Prior to ten years ago, celiac disease was regarded as a rare ailment with prevalence rates of 1 in 1000 or below (Feighery, 1999). However, more recent population studies have revealed a significantly greater prevalence, and it is now thought that both adults and children may be affected by celiac disease, which is thought to afflict one in 100 people overall (Mendoza and McGough, 2005). Pizza is unsuitable for consumption by people with diabetes and cardiovascular disease due to its high calorie and low fibre content; however, replacing the wheat flour in the pizza base with millet flour and a functional tuber like Elephant foot yam may improve its nutritional quality and make it suitable for those with the aforementioned diseases. Additionally, due to their negative effects on humans, the dietary guidelines recommend consuming composite flour instead of refined flour (Devi and Haripriya 2014).

2.1 Elephant foot yam as nutritional substitute

2.1.1 Therapeutic properties of Elephant foot yam

There have been claims that certain Dioscorea species have antibacterial, antifungal, antimutagenic, hypoglycemic, and other characteristics (Kumar et al.). Dioscorea bulbiferous and Dioscorea alata Botryodiploidia theobromae extracts have been reported to have antifungal effects. By describing the antifungal and antimicrobial properties of D. pentaphylla, a wild yam, against a variety of gram-positive and gram-negative bacteria, such as Salmonella enteric-typhi, Vibrio cholera, Pseudomonas aeruginosa, Streptococcus mutans, Shigella flexneri, and Streptococcus pyogenes. Similar to this, it has been demonstrated that D. hamiltonii leaf extract exhibits antibacterial and antifungal properties on gram-positive bacteria and fungi. It has been demonstrated that D. bulbifera's bulbils contain analgesic and anti-inflammatory properties that can treat paw oedema. Additionally, it has anthelmintic effects on Pheritima posthuman and Fasciola gigantica. The cytotoxicity of D. alata extract against human cancer cell lines has shown the presence of anticancer components. The yam species D. oppositifolia tested on adult Wister rats demonstrated anti-ulcer effectiveness. The methanolic and ethanolic extract of D. oppositifolia apparently prevented castor oil-induced diarrhoea and intestinal transit in rats. The anti-diabetic effects of D. alata and D. bulbifera have been demonstrated for the treatment of type II diabetes.

Wild cultivars are frequently utilized to make vegetables, pickles, and regional ayurvedic treatments for various ailments in India's northern and eastern provinces (Srikanth et al., 2019). This starch-rich tuber is often used to make chips and other foods. Considering that EFY is a gluten-free tuber, adding EFY flour to wheat caused a considerable reduction in both wet and dry gluten. The protein and baking qualities of the flour are revealed by the wet gluten yield. This species has a reputation for enhancing gut microflora and preventing the formation of infections including Salmonella, Escherichia coli, and Staphylococcus. Scientific evidence indicates that EFY contains significant amounts of nutritive fibre, carbs, glucose, protein, and sugars. It also contains significant amounts of calcium, salt, potassium, and vitamin C (Sheela Immanuel et al., 2020). These EFY tubers are rich in minerals but deficient in protein (Peetabas et al., 2015). The tuber's protein content was 1.126%, falling within the acceptable range of 0.85%-2.7% for EFY tubers derived from Indian cultivars. Compared to EFY cultivars in India, Nigerian yams had a crude fat level that was greater (0.01%–0.4%), Iron (0.6 mg/100 g), phosphorus (934 mg/100 g), and calcium (950 mg/100 g) are all present in high concentrations in EFY (Chattopadhyay et al., 2009). EFY is a product with a high nutritional value that might supply a substantial portion of a person's daily mineral needs through diet or feed. The body requires large levels of the important nutrients phosphorus and calcium. Minerals play a part in the regulation of enzymes, acid-base reactions, bone formation, and stimulation of muscles, among other things (Jogi & Lahre, 2020). The leaves are utilized as a vegetable by native tribes in India because they contain high concentrations of vitamin A, and the corms are typically consumed as vegetables after boiling or baking (Rajyalakshmi et al., 2001). Elephant foot yam plants thrive in soils that are medium to light in weight (coarse-textured sandy soils), as they prefer well-aerated soils. The crop can withstand brief floods, but anaerobic waterlogging leads to corm rot. Elephant yam consumption is uncommon, and storing fresh yam is a challenging task with a quick rate of deterioration (Afoakwa and Sefa-Dedeh 2001). Studies have shown that drying techniques combined with the blanching process have significantly improved the feasibility and viability of using yam in food formulations (Suriyaet al. 2016). Fresh tubers frequently exhibit the discoloration phenomena, which is mostly caused by enzymatic browning. The browning processes are caused by the activity of the enzymes polyphenol-oxidase and peroxidase (Asemota et al. 1992). the blanching process stops the browning response By inactivating the enzyme Therefore, preserving A. paeoniifolius would be a crucial step in unlocking its potential as a nutraceutical.

2.1.2 Cultivation of Elephant foot yam

Elephant yam is also called suran or jimikand in local dialects. Amorphophallus paeoniifolius sometimes known as elephant foot yam (EFY), is a very nutritious but underutilized tropical tuber crop. In the wild, 50 species are used as staples or as famine food. Dioscorea villosa L., a native to North America and generally referred to as wild yam, is the most well-known species of yam (Avula et al., 2014). The common species Dioscorea esculenta (Lour.) Burk is well known for having originated in China. Research indicates that D. alata L., which is widely distributed throughout the Pacific and tropical Asia, is the species with the greatest commercial significance. D. pubera Blume, a different wild species, can be found in humid regions of the Himalayas, China, Bhutan, Western Malaysia, and Central Nepal, as well as temperate northern Australia and tropical Americas. It comes from the Indo-Chinese region. As opposed to D. pentaphylla L., which is indigenous to Tropical Asia and Eastern Polynesia and is widespread there as well as in South-Eastern Asia and North America (Kumar et al., 2017). Assam has the most yam species out of the 50 that have been identified, followed by Tamilnadu, Darjeeling & Sikkim, and Tamilnadu. The most popular variety in the nation is "Gajendra," a local variety from Kovuur in the Andhra Pradesh region. This crop also has significant export potential from India because it is rarely economically farmed in other countries. There are currently no statistics on elephant foot yam production, area, or yield, and for some states where it is produced commercially, the only information accessible is unpublished data. The economics of this crop in India hasn't yet been studied or documented in any literature. As a result, studies have been done to find out how much it costs to grow the crop, how much it brings in for farmers, and how efficiently it uses resources in the states where it is grown for commercial purposes.

Scientific Classification	
Kingdom	Plantae
Division	Angiosperm
Class	Monocots
Order	Alisma tales
Family	Araceae
Genus	Amorphophallus
Species	Paeoniifolius
Synonyms	A campanulatus

Table 2.1 Scientific Classification of Amorphophallus Paeoniifolius (Dey et al.)

Fig. 2.1 Amorphophallus paeniifolius

According to Behera and Ray(2016) The tuber is a good source of minerals, protein, nutrients, and starch and is abundant in nutrients. The tuber crop is primarily eaten by rural and tribal populations either raw, cooked, or baked. (Di Cagno et al. 2013). The elephant yam tuber is primarily nutrient-rich. In India, ginger and elephant foot yam have been grown together as an intercrop under coconut or banana trees. The elephant foot yam has a production yield of 50–80 t ha, as a result, this plant produces at a low rate and is not widely used as a crop in Indonesia. Since it is not economically grown in other nations, this crop also has the potential to be exported (Misra and Shivalingaswamy, 1999; Misra et al., 2001). For the next 20 years, more than 2 million people in developing nations will depend on yam for food and energy. In Malaysia, the Philippines, Bangladesh, Indonesia, and India, the tubers have been used as traditional food sources, traditional medicines, and animal feed. The yam tubers are a good source of essential nutrients like lipids, proteins, carbohydrates, minerals, and vitamins, according to research. Elephant foot yam tubers contain P (34 mg/100 g), calcium (50 mg/100 g), vitamin A (434 IU/100 g), crude protein (2.14%), fat (0.46%), and crude fibre (1.68%). Due to the presence of starch and resistant starch, which has several physiological health benefits for humans, especially for those with degenerative disorders like obesity, diabetes, and hyperlipidemia, the tuber can serve as a functional food (Reddy et al. 2014).

Table 2.2 Nutritional Components of Elephant foot yam (Chattopadhyay et al.)

Nutrient	Unit	Composition
Calories	Calories	71-135
Moisture	%	65-81
Protein	Gm	1.4 - 3.5
Fat	Gm	0.2 – 0.4
Carbohydrate	Gm	16.4 – 31.8
Ash	Gm	0.6 – 1.7
Calcium	Mg	12 – 61
Phosphorus	Mg	17 – 61
Iron	Mg	0.7 – 5.2
Sodium	Mg	8 – 12

2.1.3 Anti-nutritional Factors present in Elephant foot yam

Antinutrient components like oxalate and phytate are also present in the tuber. Anti-nutritional factors are naturally occurring chemicals created by healthy metabolism that make it harder for the body to absorb nutrients. These factors reduce the meal's nutritional value and also reduce the bioavailability of dietary elements, including protein, minerals, and vitamins. Due to a number of anti-nutritional elements, the bitter tubers of yam species can irritate the skin and inflame the throat and buccal cavities after consumption (Kumar et al., 2017). Elephant foot yams have a 1.3% oxalic acid content. Due to their high calcium oxalate content, elephant yam tubers are extremely acidic and can irritate the mouth and throat. The amount of oxalate in plants is influenced by a number of factors, such as the soil's quality, seasonal fluctuations, meteorological conditions, water availability, and the plant's location (Kurniawati et al., 2016). Because of the oxalate and acridity, EFY has been significantly underutilised. Oxalates combine with calcium to generate calcium oxalate, which is insoluble and prevents the absorption of calcium (Singh et al., 2022; Suresh Kumar et al., 2020). Because calcium oxalate accumulates in kidney clusters, oxalate in food may cause hypocalcemia (Singh et al., 2011). Consuming oxalic acid causes renal failure, oral and gastrointestinal tract corrosion, and stomach haemorrhaging (Makkar et al., 2007). It may be okay to consume less than 2% soluble oxalate in ruminants and less than 0.5% soluble oxalate in non-ruminants (Jogi & Lahre, 2020). The oxalate content of yam and yam products may be decreased through cooking and fermentation. Sun drying techniques could reduce the oxalate content in yam tubers by 26%–35% (Ridla et al., 2016). The soil, season, water, and climate conditions of where elephant foot yams are grown all affect the nutrients that the tubers contain.

2.2 Sorghum as wheat flour replacement

Awika and Rooney, Dicko et al. and Taylor and Emmambux demonstrated the potential use of sorghum for maintaining human health and preventing disease. They have pushed for a paradigm shift away from viewing sorghum as a low-value cereal grain and towards seeing it as a food that promotes human health and is environmentally sustainable. According to (ICRISAT, 2006) The United States is the world's top producer, accounting for over 17% of all output, with yields that are obviously considerably greater. India, Nigeria, China, Mexico, Sudan, and Argentina are the next greatest producers. Sorghum, often known as the camel plant, is more drought-tolerant than other cereal crops. As a result, this cereal is a crucial staple food in many semi-arid developing countries. Grain products hold considerable importance in the diets of people in Senegal, as they do in many semi-arid countries across Asia and Africa. Among these individuals, especially among farmers, sorghum grains are a common dietary choice because they often lack the means to access food that is rich in protein, vitamins, and minerals. Sorghum grains are a good source of both energy-producing and non-energy-producing elements.They are meant to be consumed in these places as pasta, cooked foods, and conventional drinks (Kayode,2006).

2.2.1 Sorghum a gluten free flour

Sorghum has gained popularity recently as a gluten-free cereal to replace grains high in gluten in the diets of those with celiac disease (Elkhalifa et al., 2005). When determining how flour proteins can be utilised to complement or swap out more toxic protein sources (like wheat), one can use the functional characteristics of sorghum proteins. Due to a unique intestinal absorption condition called celiac disease, a small but significant portion of the population cannot tolerate wheat gluten (Gallagher, 2009). Sorghum would be an excellent food option because rigorous adherence to a gluten-free diet is the recommended course of treatment (O'Neill, 2010). Therefore, attempts have been undertaken to completely or partially replace sorghum in the preparation of starch pizza dough. In order to increase the nutritional content of vegetarian or celiac disease diets, sorghum flour can be added to, partially substituted for, or totally replaced by wheat flour. Sorghum grains have the potential to reduce the incidence of cardiovascular disease, certain types of cancer, and type II diabetes when consistently taken since they have potent antioxidant activity, cholesterol-lowering, anti-inflammatory, and anti-cancer properties. It is a particularly fascinating cuisine for people who are gluten intolerant because of its minimal gluten content. Many conventional food preparation techniques, such as heating and malting, improve the nutritional value of whole grains by removing some antinutrients such phytic acids, polyphenols, and oxalic acids.

Fig.2.2 Sorghum

2.2.2 Nutritional Components of sorghum

Alkaline and acid hydrolysis of polyphenols and carotenoids was followed by quantitative analysis utilising an ultra-performance liquid chromatograph coupled with a photodiode array detector (UPLC-PDA). On the basis of the investigations, it was determined that sorghum grain is a rich source of bioactive chemicals that have antioxidant effects; as a result, it may be categorised as a functional food. Since phytic acid has a high affinity for binding, it can combine with proteins and multivalent cations to form complexes. The majority of complex phytate metals are insoluble at physiological pH, making them more inaccessible to animals and people biologically (FAO,1995). Phytic phosphorus appears to range between 170 and 380 mg per 100 g and accounts for more than 85% of the total phosphorus in the whole grain after examination of numerous sorghum cultivars (white and red). (Hadbaoui Zineb, 2007). According to the results of the necessary amino acids, the protein content of grain sorghum is between 7 and 17%, the starch content is between 60 and 75%, and the weight of 1000 grains is between 25 and 30 g. White sorghum has 126.72 mg/g of amino acids compared to red sorghum's 168.42 mg/g (A-M. LINKO et al, 2005). Istianah et al. found that dehusked sorghum contained 1.64% ash. However, it appears that different types' micronutrient contents vary significantly from one another. Tasie and Gebreyes (2020) determined that the dry matter of various Ethiopian whole grain sorghum flours had ash concentrations ranging from 1.1-2.3%. Regarding the micronutrients, phosphorus concentrations ranged from 112.5 to 327.7 mg/100 g, salt concentrations were 2.2 to 6.2 mg/100 g, magnesium concentrations were 62.0 to 207.5 mg/100 g, and calcium concentrations were 9.5 to 67.2 mg/100 g.

2.2.3 Pasting properties and rheology of Sorghum flour

It is generally understood that adding non-gluten flours to wheat doughs alters the final dough qualities mostly as a result of the dilution of gluten or the reduction of the final gluten content, respectively. Ragaee and Abdel-Aal used an RVA to investigate the starch pasting capabilities of soft wheat and whole grain sorghum. Generally speaking, soft wheat had greater peak and ultimate viscosities than sorghum. The pasting temperature for sorghum, in contrast, was 94.9°C, a value similar to that of wheat. Hugo et al. found that wheat flour exhibited higher RVA values than sorghum flour. However, they made an intriguing discovery that sourdough fermentation and re-drying of sorghum flour led to an increase in RVA results, bringing them closer to those of wheat flour. In order to attain optimal rheological characteristics, preconditioning of sorghum may be required.these findings imply that adding sorghum flour to wheat flour will reduce the resulting qualities, although other research trials have revealed the contrary. According to Ragaee and Abdel-Aal, when 15% sorghum was added to wheat flour, the ultimate viscosity was substantially higher than it would have been with only 100% soft wheat. wheat-sorghum blends with such high final viscosities highlight the hardness of the final product in wheat-sorghum breads. The highest viscosity of sorghum flour was 310 B.U degree celcius , with a pasting temperature of 79 C.When sorghum flour was blended with wheat flour, the peak viscosity dropped with increased sorghum addition. This was also determined using a Brabender Amylogram. Adding 15% whole grain sorghum flour reduced the peak viscosity of the mixture from 100% wheat flour to 585 B.U. to

500 B.U. and 30% whole grain sorghum flour to 430 B.U. Istianah et al After their analysis noted that poor final viscosity is related to low amylose levels.

According to Srichuwong et al., non-starch components can affect the way starch gelatinizes. The pasting properties of whole grain sorghum flour were found to be less than those of isolated starch when the thermal starch properties of the two types of starch were compared. These authors suggested that proteins might be involved, and additional research has demonstrated that phenolic chemicals and the texture of the endosperm influence the starch pasting abilities of sorghum. There have already been initiatives to comprehend the behaviour of sorghum in (leavened) dough. Using a Brabender Farinograph, various studies have assessed the mechanical stress and water absorption of wheat-sorghum mixtures. They have all demonstrated that the farinograph water absorption reduced as sorghum was added to wheat in greater amounts. Only one study discovered the opposite outcomes, although it did not state if they were statistically significant. Researchers discovered that the degree of flour fineness and starch degradation affected how much water sorghum-wheat flour mixes absorbed. However, it may be expected that sorghum requires less water than wheat for dough production based on the results of the water absorption tests. While two studies found that the amount of sorghum added decreased the amount of time needed to generate dough, other researchers discovered that the amount of sorghum added to wheat increased the amount of time needed to develop dough. Therefore, it is unclear whether longer kneading times are necessary for the development of dough structure when using sorghum. Yousif et al. drew attention to the fact that The dough development time for 30% whole grain sorghum flour mixed with wheat was notably extended when using a white sorghum variety compared to a red sorghum variety. This suggests that the rheological characteristics were influenced by the specific type of sorghum used.

Given that sorghum lacks the gluten that wheat has, it is reasonable to assume that the extensibility will decrease if sorghum is added. This anticipation was validated in the investigations of Rizk et al. and Seelem and Omran, who both used a Brabender Extensograph. However, this confirmation required the inclusion of 15% or more sorghum. In comparison to 100% wheat, the extensibility of the dough was unaffected by lesser quantities of 5% or 10%. Dube et al. discovered a lesser extensibility with a 10% sorghum addition to wheat. In order to improve the bread quality, Akin et al. looked into adding zein to sorghum bread. For this experiment, many sorghum cultivars were used. The use of a white, non-tannin sorghum flour produced the best bread quality. The use of a white, non-tannin sorghum flour produced the best bread quality. Therefore, discovering suitable sorghum varieties that offer enhanced baking qualities may be required to make it easier to include sorghum into Western-style bread.

2.3 Oats as a fiber rich flour

2.3.1 Cultivation of Oats

In terms of global cereal production figures, oats come in roughly sixth place after wheat, maize, rice, barley, and sorghum. Despite being a good source of protein, fibre, and minerals, global oat grain production fell between 1930 and 1950 as farm mechanisation rose. Oat crops are still primarily used for livestock grain feed, which in 1991 to 1992 accounted for an average of almost 74% of global utilization (Welch, 1995). They are often produced in cold, wet environments, and from the time the head first appears until it reaches maturity, they might be vulnerable to hot, dry weather. Due to these factors, the majority of the world's oat production occurs between latitudes 20 to 46°S and latitudes 35 to 65°N, which includes Finland and Norway. Quality oat production should be promoted because it benefits the farming community economically as well. To alleviate poverty and improve both human and animal nutrition, residents in Pakistan, Afghanistan, and China could experience significant advantages by gaining access to more effective crop varieties, as exemplified by a case study in Nepal. (Stevens et al., 2000) that covers oats dating back to the 1950s. For individuals in marginal ecologies all throughout the developing globe, as well as in industrialised economies for specialised needs, oats continue to be a significant grain crop. About 75% of the world's supply of grain, seed, and industrial grade oats comes from Russia, former Soviet Union nations, the US, Canada, Germany, and Poland. Muesli, oat flour, oat bran and oat flakes are all edible forms of oats that are used as breakfast cereals and as ingredients in other foods. Oats are more adaptable in India than other grains, especially in the western and northwestern parts of the country due to their superior growing environments, quick regrowth, and higher nutritional value. Oats can only be grown in a few different kinds, and under ideal management, their grain yields range from 15 to 25 q ha-1. Therefore, the creation of high-yielding oat variants has more significance for human consumption (Ahmad and Zaffar, 2014).

Fig. 2.3 Oats

2.3.2 Nutritional Components of Oats

One of the healthiest grain cereals, oats are rich in protein and fibre. The overall amount of dietary fibre and -glucan content play a major role in the health benefits of oats (Kerckhoffs et al., 2003). Oats are an abundant source of soluble fibre, balanced proteins, and a number of vitamins and minerals vital to human health (Esposito et al., 2005). Because of the dietary advantages and nutritional worth of oats, the amount used for human consumption has gradually increased. With a significant amount of essential linoleic acid, oats have a higher lipid content than other cereal grains (Mattila et al., 2005). In general, the protein content of rolled (flakes) oats is higher than that of other cereal grains. Oat protein is almost as high-quality as soy protein, which the World Health Organisation has determined to be comparable to the proteins in meat, milk, and eggs. The oat kernel (groat) without the hull has the greatest protein level of any cereal, ranging from 12 to 24% (Lasztity, 1999). The bran and germ of oats contain a large number of the vitamins and minerals that are present in them. Oats are considered a healthy cereal grain mainly due to the fact that most oat-based food products utilize the whole groat. Furthermore, oats stand out as a distinctive source of avenanthramides (N-cinnamoylanthranilate alkaloids) and avenalumic acids (ethylenic counterparts of cinnamic acids), compounds that are absent in other types of cereal grains.These natural antioxidants include tocopherols alk(en)ylresorcinols alk(en)ylresorcinols, and phenolic acids and their derivatives (Mattila et al., 2005).

Table 2.3 Nutritional Components of Oats (Sterna et al.)

Energy	1,628Kj (389)
Carbohydrate	66.3 g
Dietary Fibre	10.6 g
Fat	6.9 g
Protein	1.3 mg (26%)
Folate	56 µg (14%)
Calcium	54 µg (5%)
Iron	5 mg (38%)
Potassium	429 mg (9%)
β- glucan	4 g

Oat grains contain soluble fibre called β-glucan, which has a number of useful functions and bioactive qualities. Its advantageous effects on insulin resistance, dyslipidemia, hypertension, and obesity are constantly being reported. The basis of their health advantages may lie in their capacity to ferment in the human stomach and their capacity to create extremely viscous solutions. In order to increase the fibre content of food items and improve their health attributes, β-glucan's suitability as a food additive is therefore being heavily examined. The bakery industry can leverage the viscosity properties of β-glucan in the production of pasta and cookies. Additionally, it may be used in canned soups, frozen desserts, breakfast items, drinks, meats, and non-dairy creamers, particularly as a fat substitute. This has been demonstrated to be a very effective dietary source of soluble β-glucan fibre and has been linked to a decreased risk for numerous diseases. Due to their high levels of β-glucan, some microorganisms, including yeast and mushrooms, as well as cereals like oats and barley, are of commercial interest. These compounds have a positive impact in battling infections (bacterial, viral, fungal, and parasitic), as they boost the immune system and modulate cellular and humoral immunity. Research indicates that the consumption of oats has been linked to various health benefits, including reductions in cholesterol levels (Braaten et al., 1994; Bae et al., 2010; Drozdowski et al., 2010; Tiwari and Cummins, 2011), improved control of postprandial blood sugar (Wood et al., 2000; Hooda et al., 2010; Regand et al., 2011; Dong et al., 2011; Tiwari and Cummins, 2011), enhanced immune responses, and a decreased risk of developing colon cancer (Mälkki, 2001; Yang et al., 2008). The cholesterol-lowering effects of rolled oats in humans were initially observed as early as the 1960s by Groot et al., and subsequent research has consistently supported this health benefit.Oats' hypocholesterolemic qualities were first proven in 1963. Incorporating oat products into the diet was discovered to generate a modest decrease in blood cholesterol levels from the meta-analysis of 20 trials, and considerable decreases were seen in hypercholesterolemic participants, especially when a dose of 3 g or more of soluble oat fibre was used.

According to Behall et al. (1997), daily intake of 2.1 g of β-glucan decreased total cholesterol levels by 9.5%. Since LDL cholesterol tends to infiltrate and build up within arterial walls and has the largest concentration of cholesterol, it harms blood vessels. Oats had a 2 to 23% reduction in total and LDL cholesterol, making them significantly hypocholesterolemic foods. While two recent investigations propose that oats might have the potential to decrease the oxidation of LDL cholesterol due to the presence of different phenolic compounds, it is likely that the way oat-soluble fiber reduces blood lipid levels is connected to its capacity to either inhibit the absorption of cholesterol and bile acids or slow down the digestion of lipids.Consumption of oats substantially raises blood levels of HDL cholesterol and apolipoprotein A-I, a crucial component of HDL, to enhance lipid profiles. (Glore et al., 1994). Oat bran, which is high in dietary fibres, has been found to have various other physiological impacts in addition to the well-known effects of lowering blood cholesterol and influencing glucose level. As per findings by Anderson (1990), Malkki, and Virtanen (2001), a diet rich in soluble fiber can impact the sensation of fullness (satiety) and promote weight loss through several mechanisms. These include a reduced pace of meal consumption, a delay in the emptying of the stomach, an elevation in cholecystokinin levels (a gut hormone associated with prolonged satiety), as well as the generation of gas and short-chain fatty acids resulting from the fermentation of fiber in the colon.In recent studies, it has been demonstrated that a gelling β-glucan from (Glucagel) can have a variety of effects on the mammalian immune system, including changes to wound healing and an increase in the secretion of gut mucin. Gliadin is absent from oats, and its substitute is avenin. Without having a detrimental impact on nutritional status, oats increase the nutritious value of the gluten-free diet and are well-liked by the patients.

Oats are a beneficial addition to the gluten-free diet since they are a strong source of dietary fibre and a number of vitamins and minerals (Huttner and Arendt, 2010).

The American Dietetic Association (ADA) has formally endorsed the advantages of oats. Oat eating does enhance glucose control by reducing the significant blood glucose spikes that lead to metabolic disturbances in diabetics, according to an ADA paper from 1996. Its viscosity qualities as a soluble fibre have an impact on gut motility, nutritional absorption, and stomach emptying, which are reflected in decreased postprandial glycemic and insulin responses. A study demonstrated the effectiveness of oat beta-glucans in lowering blood sugar levels. This study compared dietary oats to mixed-food diets that also included other water-soluble Fibres. The findings demonstrated that the mixed food diet fell short of the daily servings of plain whole oats in terms of managing blood sugar levels after meals. Another research looked at the effects of two oat products-boiled flakes of oats (oat porridge) and flaked oats (muesli) on healthy volunteers after eating. Although the consumption of cooked oat kernels at the same time led to reduced glucose and insulin responses, both products had a similar glycemic impact as white bread. Tappy et al (1996). Increased short-chain fatty acid levels in the caecal contents are a direct result of higher quantities of fermentable material in the caecum. Dietary fibre may have this "bulking" effect because fiber-rich diets have a higher water-holding capacity, which lowers postprandial hyperglycemia and insulin release. This offers type-2 diabetics health advantages and lowers their risk of getting the condition as well as insulin sensitivity.

This review-article serves as an overview, including medical applications of Elephant foot yam, sorghum and oats providing a basic description of involved disease, as well as mechanism of action and application. Elephant yam has numerous health benefits including functional , anti-cancerous, anti-inflammatory and therapeutic properties. Oats is a suitable source of dietary fibre and helps in controlling blood cholesterol levels. Whereas sorghum incorporated bakery products have a good stability and a good alternative for gluten free diets.

CHAPTER 3

MATERIAL AND METHODS

The current study was performed in the Departmental of Bioengineering, Integral University Kursi road Dasauli, Lucknow.

3.1 Procurement of materials

Elephant foot yam was procured from local vegetable market of Tehdi pulia Lucknow, Uttar Pradesh. Sorghum flour, Oats flour and other raw materials were procured from local market.

3.2 Raw Materials

Table 3.1 List of raw materials used

S.NO.	INGREDIENTS	COMPANY
1.	Elephant Foot Yam flour	-
2.	Sorghum flour	Organic Tattva
3.	Oats	Saffola
4.	Sugar	GMC
5.	Olive oil	Figaro
6.	Psyllium husk	Dabur
7.	Baking powder	Weikfield
8.	Salt	Tata
9.	Yeast	Puramate

Table 3.2 List of Equipments used

S.NO.	EQUIPMENT	MODEL NO.	COMPANY
1.	Weighing Balance	AB 600	KERRO
2.	Baking Oven	OTG 28 RSS	Morphy Richards
3.	Sieve	-	-
4.	Tray Dryer	-	-

5.	Hot air oven	Asiannoven14	ASIAN
6.	Grinder	GX 15	Bajaj
7.	Desicator	-	-
8.	Incubator	CI-10 PLUS	Remi
9.	Dough mixer	-	INALSA
10	Muffle Furnace	-	-
11.	Fat Analyser	(ST-243)	FOSS

Table 3.3 Lists of Glassware/Tools used

S.NO	GLASSWARES	SPECIFICATIONS	QUANTITY	COMPANY
1.	Petri plates	7.5cm diameter	10	Borosil
2.	Conical flasks	500ml	2	Borosil
3.	Beaker	50ml 250ml	5 3	Borosil
4.	Measuring cylinder	10ml 100ml	1 1	Borosil
5.	Dropper	3ml	1	SPYLX
6.	Knife	Stainless steel	1	Agaro
7.	Kneading board	Wooden	1	Flora ware
8.	Rolling pin	Wooden	1	-
9.	Stainless- steel utensils	Cook and serve big bowl Table spoons Laddel	1 3 1	Hawkins
10.	Test tubes	Glassware	40	Borosil

3.3 Equipments used

3.3.1 Digital Weighing Balance

An electronic balance (model no. # AB 600) of KERRO company was used to weigh all the ingredients required for the development of pizza base. The maximum limit of the balance was 600g.

Fig 3.1 Digital weighing balance

3.3.2 Hot Air Oven

A Hot air oven was used for drying of spoons and also for determining the percent moisture content in Elephant foot yam and base samples and in material used. The oven used in the study had a chamber size of 30cm x 30cm x 30cm (L x W x 11). The input power required for the oven was 650 watts. This was made up of a double wall, with an inner and outer chamber made of mild steel sheets. Mineral glass wool was used for insulation, in-between the two-chamber walls. The door is insulated front door was provided with brass hinges and a ball lock. Heating elements, made of nichrome 80/20, are been provided at the bottom of the chamber. Temperature is generally controlled with the help of a capillary thermostat. A 3-heat switch is also given for power saving.

Fig 3.2 Hot air oven

3.3.3 Hand Sealing Machine

The sealing machine is used to seal products, like plastic pouch or aluminium pouch by using heat.

Fig 3.3 Hand Sealing machine

3.3.4 Baking Oven

A baking oven (OTG 28 RSS) of morphy Richards company was used for baking the pizza base.

Fig 3.4 Baking Oven

3.3.5 Dough Mixer

A Dough mixer of INALSA company was used for kneading the dough for pizza base.

Fig 3.5 Dough Mixer

3.3.6 Muffle Furnace

Muffle furnace is designed to heat the materials to significantly high temperatures. It is fully packed enclose that keep material isolated from external contaminants, substances, and chemicals. It is used for ashing and determining ash content.

Fig 3.6 Muffle Furnace

3.3.7 Tray Dryer

A Tray dryer is an equipment that uses hot air to remove moisture from the materials being dried. In this study it was used for drying sliced Elephant foot yam.

Fig 3.7 Tray Dryer

3.3.8 Fat Analyser

A Soxhlet fat analyser (ST-243) of FOSS company was used to determine fat content in the base.

Fig 3.8 Fat Analyzer

3.3.9 Incubator

An incubator is an enclosed, insulated device that offers the ideal levels of humidity, temperature, and other environmental variables needed for the growth of organisms. It was used for incubation of the samples in microbial analysis and protein estimation of the base.

Fig 3.9 Incubator

3.3.10 Autoclave

The items are sterilized in an autoclave by being heated to a set temperature for a predetermined amount of time. Another name for the autoclave is a steam sterilizer. it was used for the sterilization of glasswares and the media used for microbial analysis of base samples.

Fig 3.10 Autoclave

3.3.11 Spectrophotometer

A Visible basic spectrophotometer of LABMAN company was used for taking O.D. in protein and antioxidant analysis. A spectrophotometer is based on the Beer-Lambert law.

Fig 3.11 Spectrophotometer

3.3.12 pH meter

A digital pH meter of EUTECH company of pH 700 was used for the determination of ph in the samples.

Fig 3.12 pH meter

3.4 Methodology of preparing Elephant foot yam flour

After procurement the yam corms were properly cleaned with water, peeled, and trimmed to remove any damaged areas before being cut into slices using a slicer. Slices of yam were then blanched for 5 minutes in a 0.1% sodium metabisulphite solution at 70 C to reduce the oxalate content present in it. Yam slice

s that had been blanched were cooled in tap water, drained, and dried with paper towels to remove external moisture. After that slices of yam were then dried in a tray drier for 24 hours at 55ºC. To create yam flour, dried yam slices were ground in a lab grinder and then first sieved through a 300 mesh screen then with 150 mesh size screen in order to obtain a fine flour. Following that, the prepared Elephant foot yam flour was kept at room temperature in an air tight plastic containers in a cool, dark, and dry environment.

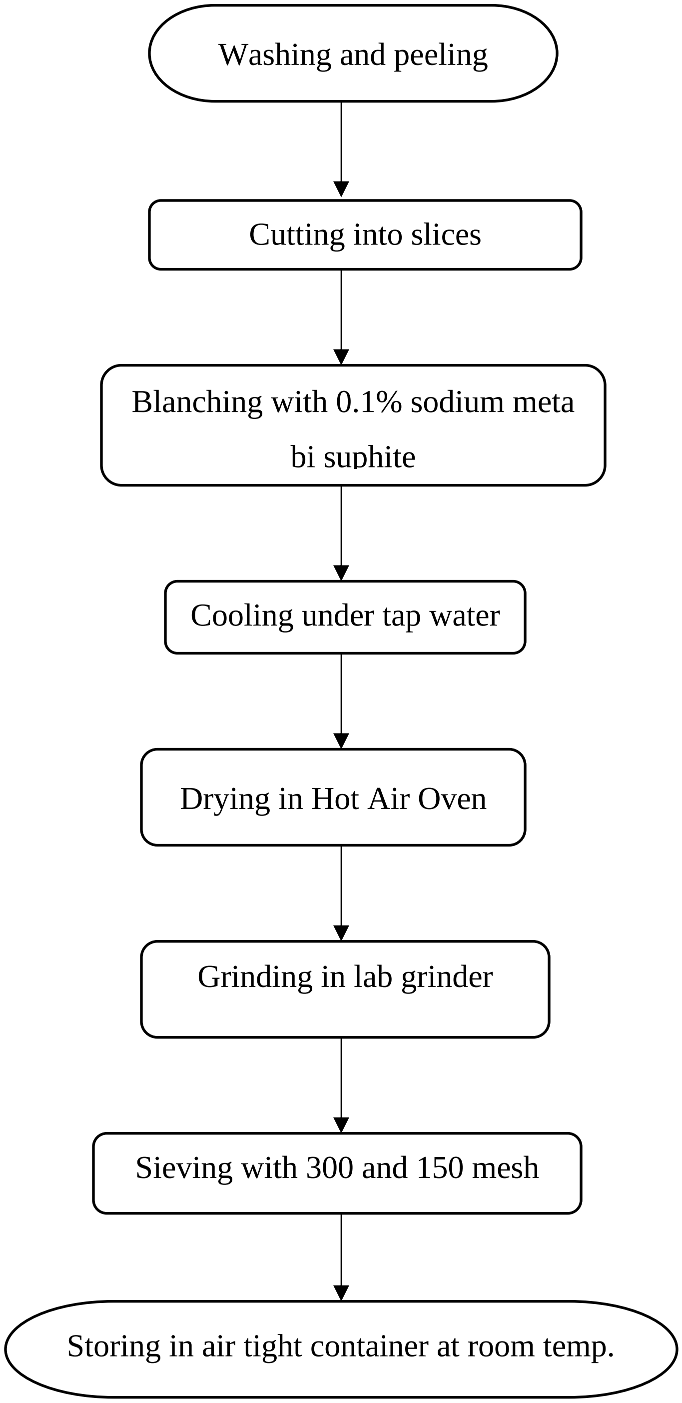


Fig 3.12 Flow chart for Elephant foot yam preparation

Fig 3.12 Preparation of Elephant yam flour

3.5 Methodology of preparing Elephant foot yam pizza base

Weighing of all the three flours used in each sample was done according to the proportions needed in making the pizza base. Total 3 samples were prepared in which S1 was control without the incorporation of elephant foot yam flour with 50:50 ratio of sorghum and oats flour, S2 was prepared with incorporation of yam flour with 50:25:25 ratio of sorghum flour, oats flour and yam flour respectively while S3 was prepared with the proportion of 40:30:30 of sorghum flour, oats flour and yam flour respectively. Along with the flours other dry ingredients were also weighed by digital weighing balance. All the dry ingredients were wisked with the help of a wisker to mix them uniformly. Oil and water were measured using a measuring cylinder. A smooth and soft dough was prepared by adding oil and warm water in a dough mixer. The dough was covered with cling wrap and kept in a warm environment for 2 hrs to rise.After the dough was doubled in its size it was then rolled into a flattened bread and was pricked all over to avoid the hot air bubbles from forming. The rolled pizza base was then brushed with olive oil and baked in an oven at 200 degree Celsius for 25mins. The base sample was then cooled in a desiccator and packed in a cling crap before refrigerating it.

3.4 Ratio takes in pizza preparation

Sample	Sample 1	Sample 2	Sample 3
Sorghum flour	50gm	50gm	40gm
Oats flour	50gm	25gm	30gm
Elephant Foot Yam flour	0gm	25gm	30gm
Psyllium husk	3gm	3gm	3gm
Yeast	1gm	1gm	1gm
Baking powder	3gm	3gm	3gm
Sugar	4gm	4gm	4gm
Salt	1gm	1gm	1gm
Water	70ml	70ml	70ml
Olive oil	5ml	5ml	5ml

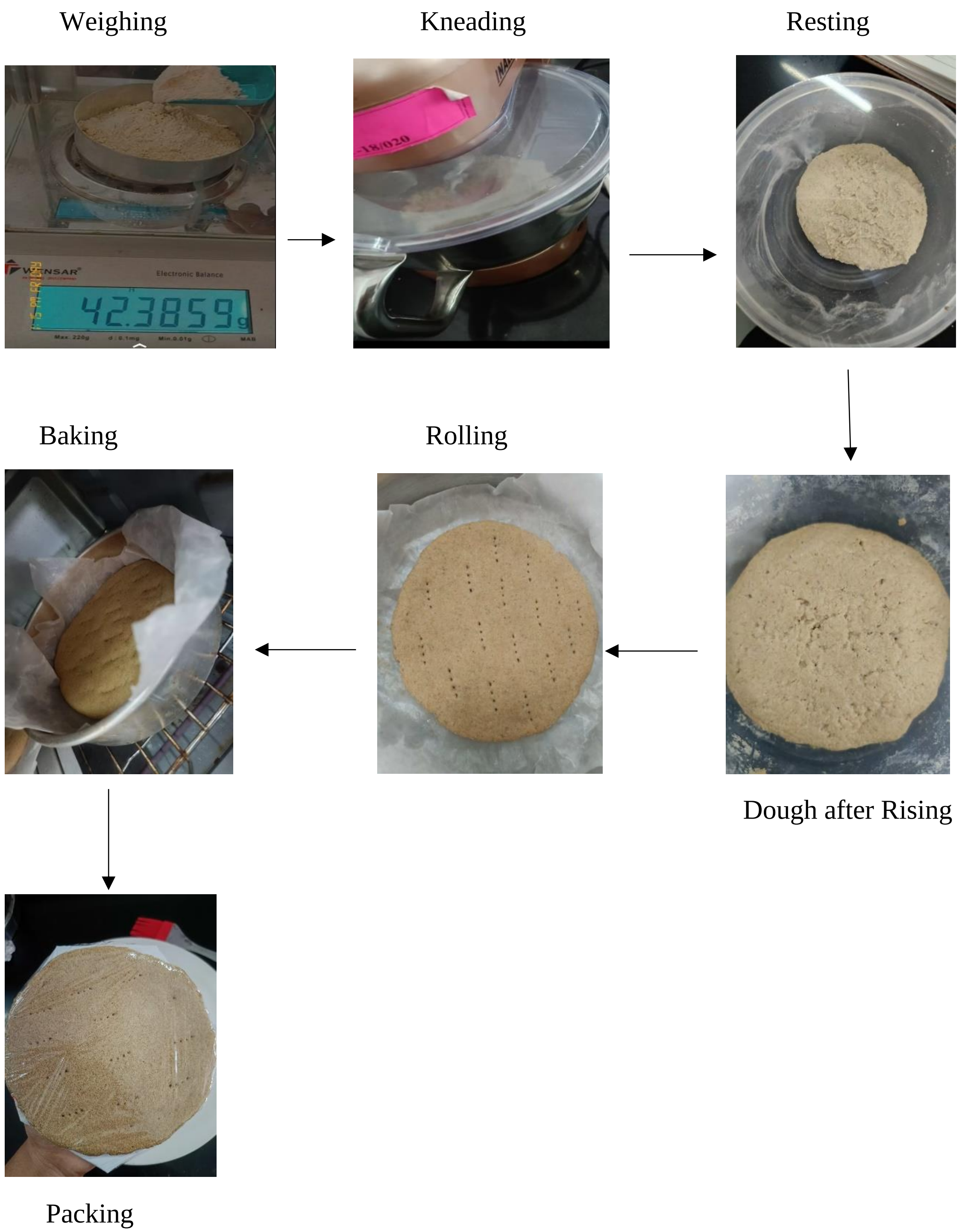


Fig. 3.4.2 Development of pizza base using Elephant foot yam

4

SAMPLE 1

SAMPLE 2

SAMPLE 3

Fig 3.12 Pizza base samples

3.5 Physicochemical Analysis

Raw materials, as well as the final product, were evaluated for chemical as well as nutritional constituents by using standard methods.

3.5.1 Moisture Content

Moisture content determination was essential to control the quality as well as the shelf-life of the food (Zambrano et al., 2019). The aim was to determine the amount of moisture present in the sample. It was done by comparing dry weight of the sample to the weight taken before drying. The procedure for determination of moisture content was carried out by taking 2 gram from each sample in a Petri dish. Place the samples in a hot air oven at 135°C for two hours. After drying, allow them to cool in a desiccator and be weighed.

Calculation:

$$\textbf{Moisture content (MC)} = \frac{w-d}{w} \times 100$$

Where,

W = weight of the sample

D = weight after drying

3.5.2 Ash Content

The main aim of the Ash content determination is to measure the inorganic substance in food. It was done by burning away organic substances, leaving inorganic minerals. It is important for determining the amount minerals present in food. Dry ashing require heating the sample in a muffle furnace at 500-600°C (Park, 1996). The procedure takes place by taking 2g sample from each in a tared crucible. Place crucible in a cool muffle furnace. Burn the samples for 4 hours at temperature 550°C. After 4 hours turn off the furnace and allow it cool to at least 250°C. Transfer crucibles in a desiccator by using tongs. Close the desiccator and cool to room temperature and then weigh the samples.

Calculation:

$$\textbf{Ash Content} = \frac{z-x}{y-x} \times 100$$

Where,

x = Weight of the crucible

y = Sample + crucible weight

z = crucible weight after ashing

3.5.3 Fat Analysis

The total fat cortent present in a food is generally by its organic solvent extract. Solvents that are used commonly for fat analysis are ethyl ``ether, petroleum ether, petroleum benzene, hexane, etc. Generally, lipids are fuse with proteins and polysaccharides, thus for a successful extraction lipids should be freed by alkaline or acid hydrolysis and then extracted into the organic solvents (Jiang et al., 2014). Fat analysis was done by the Soxhlet method by FOSS ST 243 Soxtec extraction system. 2gm of sample was taken in a tared thimble and was covered with cotton before attaching to the fat analyzer. The extraction cups were weighed and filled with 50ml of solvent that was Di ethyl ether. The cups were then attached to the setup along with the cup stand. The system was then set to boiling for 20mins. After boiling for 20 mins it was set to rinsing for 40 mins. Once the rinsing was over recovery mode was on for 10 mins and then the extraction cups were removed from the system and dried for 30mins at 103ºC in an hot air oven and weighed.

Calculation:

$$\frac{w2 - w1}{s} \times 100$$

Where,

W2 = weight of empty cup

W2 = weight of cup with extracted fat

S = Sample

3.5.4 Protein Analysis

For protein analysis of the base sample , Lowry method was used as described below :

0.2 , 0.3 , 0.4 , 0.5 , 0.6 , 0.7 , 0.8 , 0.9 and 1 ml of standard working solution were pipette out in different test tubes. Then the volume was made up to 1ml with 1N sodium hydroxide. 1 ml distilled water was pipette out in the blank test tube and 1 ml of sample was pipette out in the test sample tube. 5 ml of Alkaline copper solution was added to all the test tubes including the test sample and blank test tube. The test tubes were then kept for 10mins before adding the follin ciocalteu reagent. After 10 mins, 1 ml of follin reagent was added to each test tube. Mix well and incubate at rppm temp (25 degree Celsius). Blue color was developed. O.D was taken at 660nm. Graph was drawn versus concentration.

3.5.5 Antioxidants

The antioxidant activity of analyzed samples was estimated using a 2.2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging assay described by Brand-Williams et al. In 50 ml of methanol 0.002 gm of of DPPH was added. Then for sample preparation 2 mg of base sample was added in 1 ml of methanol. Then 3 ml of DPPH solution, 1 ml of distilled water, and 3 ml of methanol was mixed with the sample in test tubes. The tubes were kept in the dark for 45 min, and afterward, the absorbance was measured at 517 nm in a spectrophotometer. The DPPH scavenging activity was expressed as a percentage of inhibition and calculated using the following formula:

$$\textbf{Inhibition (\%)} = \frac{\textbf{A control} - \textbf{A sample}}{\textbf{A control}} \times \mathbf{100}$$

3.5.6 Spread Ratio

Spread Ratio is the ratio of average diameter to the average thickness of the pizza base. The spread ratio is calculated by the following formula:

$$\frac{D}{T}$$

Where,

D = Diameter of the base

T = Thickness of the base

3.5.7 Shelf life estimation

The shelf life of a food can be defined as the time period within which the food is safe to consume and has anacceptable quality to consumers. The shelf life of the pizza base was observed for five consecutive fdays it was estimated on the basis of following parameters:

3.5.7.1 Moisture Content

Moisture content determination was essential to control the quality as well as the shelf-life of the food (Zambrano et al., 2019). The aim was to determine the amount of moisture present in the sample. It was done by comparing dry weight of the sample to the weight taken before drying. The procedure for determination of moisture content was carried out by taking 2 gram from each sample in a Petri dish. Place the samples in a hot air oven at 135°C for two hours. After drying, allow them to cool in a desiccator and be weighed.

3.5.7.2 pH analysis

The higher pH products have greater microbial counts and a decrease in shelf-life. (Rousset & Renerre, 1991). The Ph was determined using digital Ph meter by the following steps-

1. Sample was prepared by dissolving 2 gm of base into 10 ml of distilled water.

2.Meter was put into calibration.

3.Buffer was collected.

4. The buffer was decanted into a beaker.

5.The electrode was dipped into the buffer solution till "ready" was indicated on the screen.

6. The electrode was then rinsed with distilled water.

7. It was then dipped in the sample and ph was noted.

8. Electrode was rinsed again after the noting down the ph.

3.5.8 Sensory Analysis

The sensory attributes were analyzed by Hedonic Rating Test was used to evaluate Pizza base. sensory attributes such as colour, flavour, texture, taste, size etc. The Hedonic Ratting test was used to evaluate sensory characteristics. This test is used to assess consumer acceptance of a product. The methodology is presented in detail below. A panel of five judges of varying ages and eating habits was chosen, and the samples were served to them. The panelists were asked to rate the acceptability of the product based on their sense of organs on a scale of 9 points ranging from extremely like to extremely dislike. At the time of the evaluation, a test Performa was prepared and provided to them.

Table 3.2 Hedonic Rating Scale

Grade	Score
Like Extremely	9
Like very much	8
Like moderately	7
Like slightly	6
Neither like nor dislike	5
Dislike slightly	4
Dislike moderately	3
Dislike very much	2
Dislike extremely	1

CHAPTER 4

RESULTS AND DISCUSSION

This chapter present the experimental results conducted to enhance the nutritional components of pizza base with the incorporation of Elephant foot yam under ambient condition.

During the analysis 3 different samples were taken and their comparative study is done in order to get the best results.

Sample 1(S1) – Base made with Sorghum flour and Oats flour

Sample 2 (S2) – Base made with incorporation of 25% of Elephant foot yam flour

Sample 3 (S3)- Base made with incorporation of 30% of Elephant foot yam flour

The experiments were carried out to determine various analysis of the pizza base. The result of this investigation was discussed under the following ahead :-

4.1 Physical characteristics of Elephant foot yam

S.No	Morphological Characteristics	Parameters of Elephant foot yam
1	Shape	Tapered, oblong and round
2	Color	Dark-brown
3	Diameter	28cm
4	Length	15cm
5	Weight	1.6 kg
6	Shelf life	2 months

4.2 Thickness and spread Ratio of the pizza base

Thickness

The thickness of the samples varied with the change in concentration. The thickness of S1, S2, and S3 were found to be 3.5mm, 2.8mm and 1.5mm respectively. It was observed that with increase in yam concentration from 25% to 30% the thickness of the base drastically changed in S3 while there was less difference in the thickness of S1 and S2.

Diameter

The diameter of S1, S2 and S3 were determined to be 150mm, 141mm and 120 mm respectively. There was a little difference found in between the diameter of S1 and S2 while there was much variation in the diameter of S3. S1 had the highest value of diameter while S3 had the lowest value.

Spread ratio – The spread ratio of S1, S2 and S3 were calculated to be 10.5, 9.3 and 7.

4.2 Moisture Content

The moisture content of all the base samples has been shown below in table 4.1. Initial moisture content observed in controls S1, S2 and S3 was 39.5 % and 31.5 % and 34.3% respectively. Sample S1 had the highest amount of moisture in which there was 0 % concentration of Elephant foot yam flour. Least amount of moisture was determined in Sample S2 which had 25% concentration of Elephant foot yam flour. So it proves that S2 was the ideal sample of the pizza base regards to moisture content because the higher moisture amount is not for the base to sustain the shelf-life.it was also observed that with increase in days the moisture content of the base reduced. The moisture content of pizza base made with wheat flour was 14.67% (Agrawal and Verma, 2016).

Fig. 4.1 Moisture content of pizza base

Table 4.2 Moisture Content (%) of Pizza base

Sample	Moisture Content
S1	38.55%
S2	31.5%
S3	34.3%

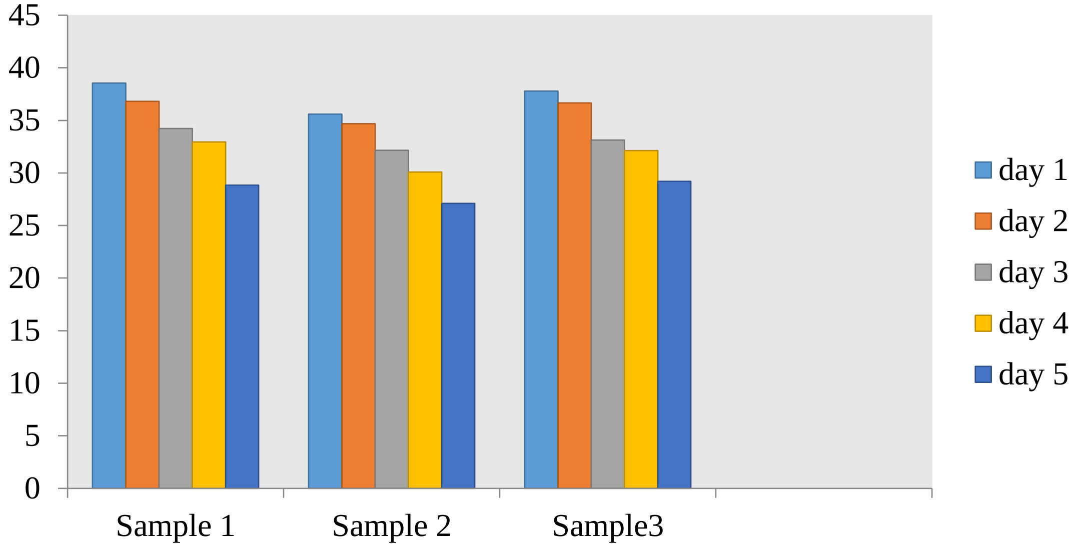


Fig. 4.2 Graphical Representation of Moisture Content

4.3 Ash Content

Ash content is used to measure the inorganic substance present in food. It is done by incineration of organic matter, leaving inorganic minerals (Park, 1996). Percent Ash of all the base samples is in table The amount of ash determined in S1, S2 and S3 was 5.52%, 2.19% and 1.69% reduction was seen in ash content with increase in yam concentration. Ash content was highest in control sample S1 without incorporation of yam flour and highest in the S3 with highest concentration of yam flour.it was also observed that the ash content increased with time .The ash content of pizza base made with wheat flour was 15.30 (Saini Manju et al.).

Fig. 4.3 Ash content of pizza base

Table 4.3 Ash Content (%) of Base

Samples	Ash Content
S1	5.52%
S2	2.19%
S3	1.84%

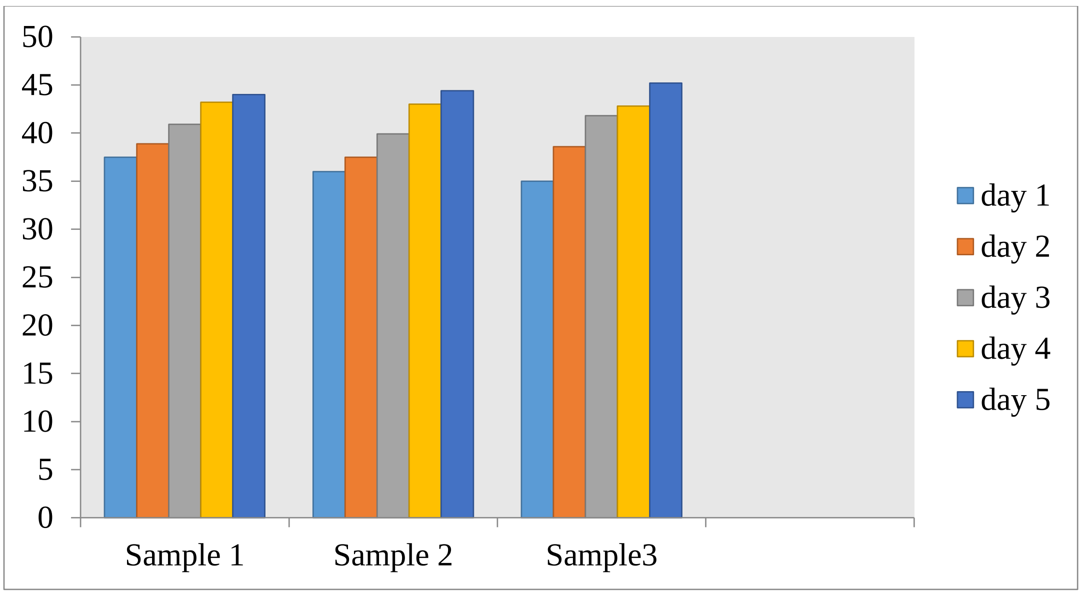


Fig. 4.4 Graphical Representation of Ash Content

4.4 Fat Content

It was done to determine the total fat content of a food. The fat percentage varies in the results S1, S2 and S3. The fat percentage of S1, S2 and S3 was 8.13%, 7.2% , 6.10%. lowest amount of fat was found in S3 in which yam concentration was the highest (30%) while S1 had the highest fat percentage with 0% of yam concentration this must be because Elephant foot yam flour has less amount of fat content in comparison with other flours. The fat content of pizza base made up of wheat flour was 4.24% (Agrawal and Verma, 2016). The amount of fat content of all the three base samples has been shown in table 4.4.the fat content was observed for 5 consecutive days and it was found that there was reduction in fat content of all the samples from day 1 to day 5

Table 4.4 Fat Content (%) of pizza base

Sample	Fat Content
S1	8.13%
S2	7.2%
S3	6.10%

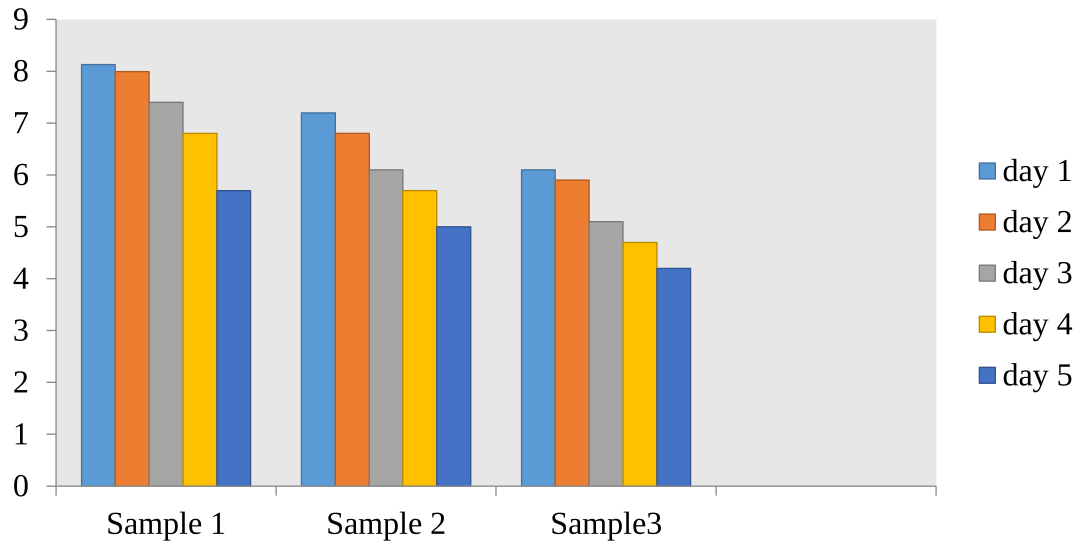


Fig.4.5 Graphical Representation of Fat Content

4.4 Protein Content

It was done to determine the total protein content present in the sample. The protein content of S1, S2 and S3 was 10.05 %, 12.23 %, 13.01 %. Highest amount of protein was found in S3 in which yam concentration was the highest (30%) while S1 had the lowest of protein content with 0% of yam concentration this must be because Elephant foot yam flour has higher amount of protein than sorghum and oats.The total crude protein in wheat pizza base was 8.87% (Saini Manju, et al). The amount of protein content of all the base samples has been shown in table 4.6. the protein content of pizza base was observed for 5 consecutive days and reduction of protein was found from day 1 to day 5.

Fig. 4.6 Protein content of pizza base

Table 4.5 Protein Content (%) of pizza base

Sample	Protein Content
S1	10.5%
S2	12.23%
S3	13.01%

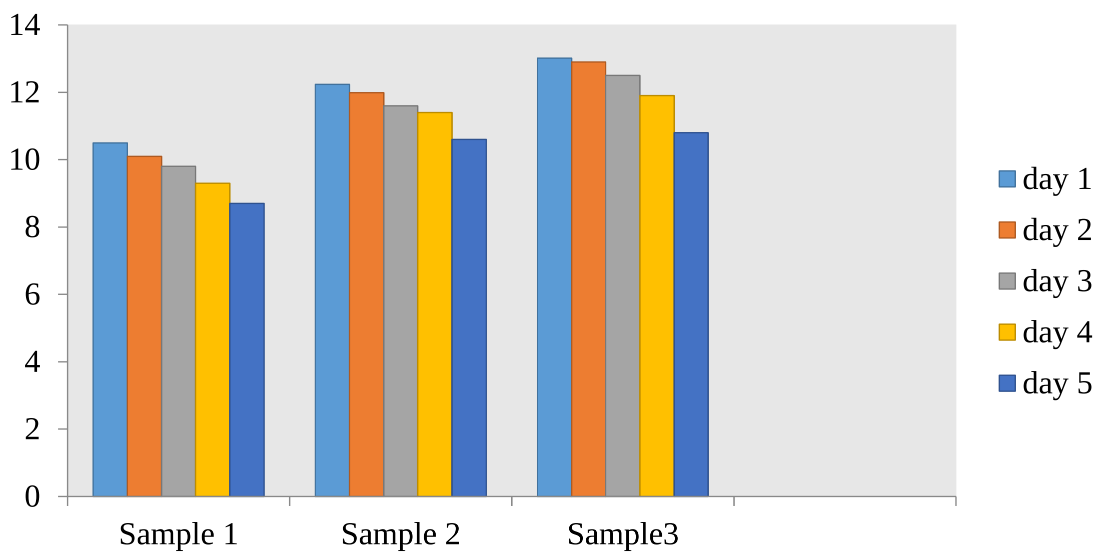
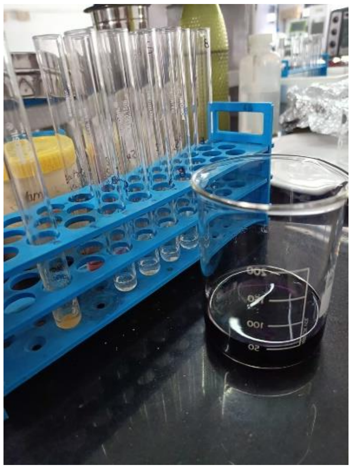


Fig.4.7 Graphical Representation of Protein Content

4.5 Antioxidants

It was done to estimate the amount of antioxidants present in the base samples. The amount of antioxidants determined in yam flour was 83.84% and the level of antioxidants present in S1, S2 and S3 was 3.305 % , 14.05% and 16.387 % reduction was seen in ash content with increase in yam concentration. The percentage of antioxidant was highest in S3 with highest incorporation of yam flour and lowest in S3 with lowest concentration of yam flour. The amount of antioxidants in each sample is given in the table 4.6.



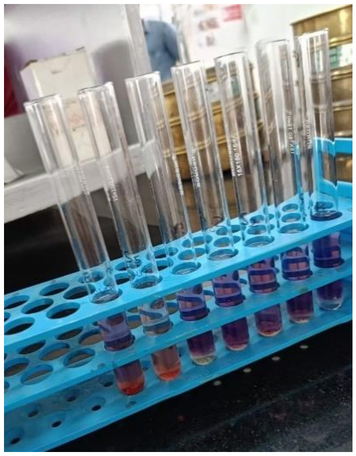


Fig 4.8 Antioxidants in pizza base

Table 4.6 Antioxidants (%) in the pizza base

Sample	Antioxidants
Yam Flour	83.84%
S1	3.305%
S2	14.05%
S3	16.38%

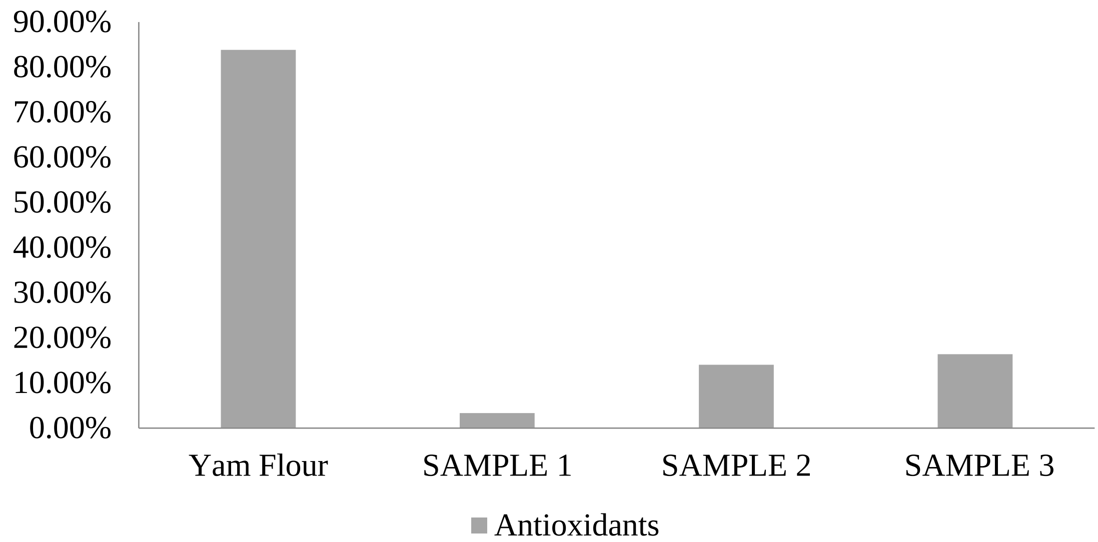


Fig.4.9 Graphical representation of Antioxidant

3.6 Shelf Life

The shelf life of the base samples was observed for 5 consecutive days and was found that there was no significant changes in the shelf life of S1, S2 and S3. And all the three samples shown to have shelf life of 4 days on the basis of the following parameters-

3.6.1 Moisture Content

The moisture content of the samples S1, S2 and S3 decreased with the number of days. There was slight reduction in moisture till 4^{th} day. The reduction in moisture content calculated on the 5^{th} day was highest amongst all the days. The moisture content of S1, S2 and S3 on Day 1 was 48.5 %, 35.60 % and 43.80 % respectively while moisture content of S1, S2, and S3 on Day 5 was 35.83, 27.11 and 29.57 respectively. There was a drastic reduction in the moisture content of samples from Day 1 to Day 5

Table 4.7 Shelf life (Moisture Content)

DAY	SAMPLE 1	SAMPLE 2	SAMPLE 3
Day 1	38.55%	35.60 %	37.80 %
Day 2	36.81 %	34.68 %	36.66 %
Day 3	34.24 %	32.15 %	33.12 %
Day 4	32.95 %	30.08 %	32.13 %
Day 5	28.83 %	27.11 %	29.2 %

3.6.2 pH

The pH of the samples were observed for 5 days and with increasing number of days the pH of the samples was found to be increasing. The pH of S1, S2 and S3 on the Day 1 was 6.4, 6.75 and 6.75 respectively. While on Day 5, the pH of S1, S2, and S3 was found were observed 7.09, 7.3 and 7.27 respectively. With increase in the pH the shelf life decreases. Table shows the increase in the pH from Day 1 to Day 5.

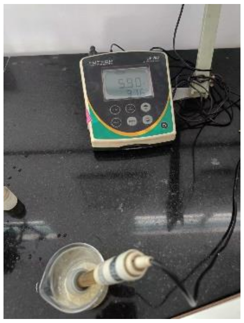


Fig 4.9 pH of pizza base

Table 4.8 Shelf life (pH)

DAY	SAMPLE 1	SAMPLE 2	SAMPLE 3
Day 1	6.2	6.57	6.62
Day 2	6.5	6.63	6.71
Day 3	6.7	6.79	6.88
Day 4	6.91	6.83	6.99
Day 5	7.5	7.3	7.29

3.7 Sensory Analysis

The three samples were rated on the hedonic rating scale by the semi trained panel members and it was observed that S1 had 8.5, S2 had 9 rating and S3 had 7 rating. It was also observed that with increase in the number of days the ratings were decreasing.

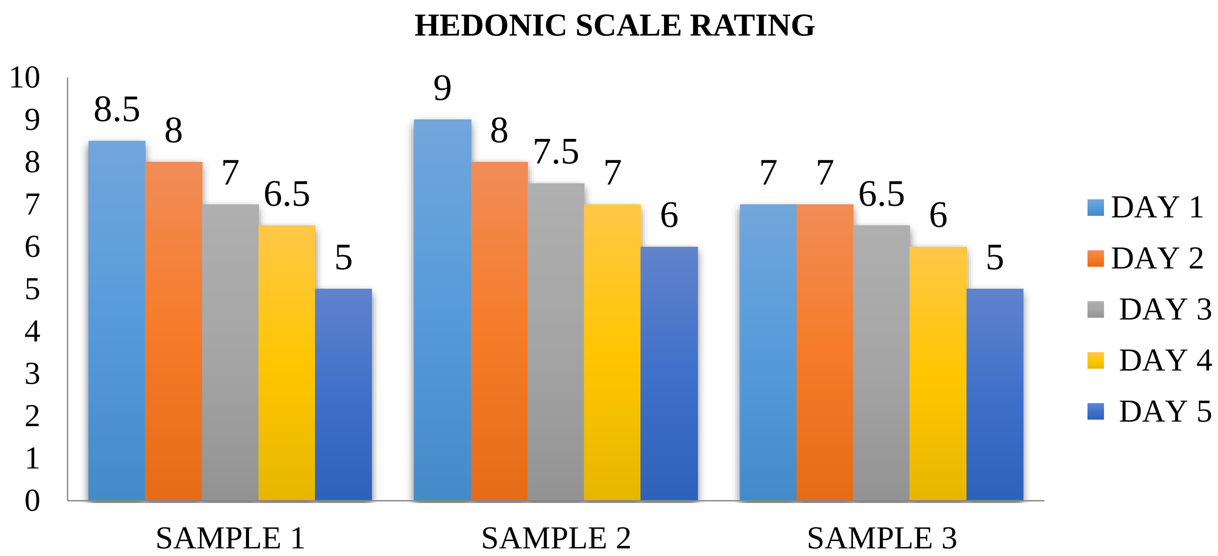


Fig 4.11 Graphical Representation of Hedonic scale rating

CHAPTER 5

SUMMARY AND CONCLUSION

During this project it was observed that when Elephant foot yam flour was incorporated with sorghum and oats flour there was increase in protein content and antioxidants. Fat content was decreased with incorporation of elephant foot yam flour. It was obtained that as we increased the content of Elephant foot yam there was a increase in protein content and decrease in fat content developed product was ready to be served as proteinatious. It was also concluded that the product can be stored till 5 days for better sensory characteristics.The developed product is rich in protein and antioxidants which can be consumed on daily basis and The sensory analysis showed that with increase in the addition of elephant foot yam the taste ratings increased. However the product can be modified in a certain manner.

Future aspects of the research-

The value added pizza base can be further modified and tastier by certain modifications. It could be served as the healthiest pizza base which can be served on daily basis and can be stored in refrigerator for about 5 days. After reducing the anti-nutritional factors are in elephant foot yam flour to a safe level it can be used as a **functional food.**

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