DEVELOPMENT OF PROTEIN RICH CHOCO RAGI ROLLS FROM FINGER MILLET (ELEUSINE CORACANA) AS A HEALTHY SNACK FOR CHILDREN

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B. Voc Food Processing Technology

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DECLARATION

We **Anjitha L (Reg.No. VB21FPT002), Gouri Gopinath (Reg.No. VB21FPT007) and Sneha S (Reg.No. VB21FPT019)** hereby declare that the project entitled "Development of Protein Rich Choco Ragi Rolls From Finger Millet (*Eleusine coracana*) As a Healthy Snack For Children" is bonafide record of the project work done by us during the course of study and the report has note previously formed on the basis for the award to us for any degree, diploma, fellowship or other title of any university or society.

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CERTIFICATE

This is to certify that the project entitled " Development of Protein Rich Choco Ragi Rolls From Finger Millet (*Eleusine coracana*) As a Healthy Snack For Children" submitted in partial fullfilment of the requirements for the Award of the degree of B.Voc Food Processing Technology to St.Teresa's College, Ernakulam is a record of bonafied research work carried by Ms. Anjitha L, Gouri Gopinath and Sneha S under my guidance and supervision and that no part of the project has been submitted for the award of any other degree, diploma, fellowship or other similar titles or prize and that the work has not been published in part or full in any scientific or popular journel or magazine.

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ABSTRACT

This project explores the development of protein-rich choco rolls using Eleusine Coracana (finger millet) as a nutritious alternative snack for children, conducted at St. Teresa's College. In addition to finger millet, ingredients such as cocoa powder and a nut-seed mix comprising almonds, peanuts, hazelnuts, pumpkin seeds, flaxseeds, and jackfruit seeds were utilized. The nuts and seeds were roasted or dried using various methods before being powdered and incorporated into the filling mixture, along with cocoa powder, milk, and cornstarch.

Two batter samples were prepared for the choco rolls. The control sample contained all-purpose flour, sugar, cocoa powder, vanilla essence, and milk, while the experimental sample replaced a portion of the all-purpose flour with finger millet in a 1:1 ratio, along with the other ingredients.

The experiment aimed to optimize the recipe for taste, texture, and nutritional content. Through a series of baking trials and sensory evaluations, the protein-rich choco rolls were refined to meet the desired criteria for a delicious and wholesome snack. Nutritional analysis revealed that the final product offered a significant source of protein, fiber, and essential nutrients, making it a viable healthy alternative to conventional snacks for children.

This case study highlights the feasibility of incorporating Eleusine Coracana into snack adds both flavor and nutritional value to the choco rolls, catering to the growing demand for healthier snack options among children.

Keywords: Eleusine Coracana, finger millet, protein-rich snack, healthy alternative, children's nutrition, food product development, St. Teresa's College, nut-seed filling, cocoa rolls

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CHAPTER 1

1. INTRODUCTION

Over the past several decades, dietary habits and eating patterns have changed considerably around the world (Vlismas et al., 2009). Diet is considered a public health necessity for developing strong immunity and protecting the body from viruses and other diseases (Muscogiuri et al., 2020). Snacks are mostly smaller than a regular meal and usually eaten between meals.

Snacking and healthy eating habits have been suggested to have various health benefits, such as appetite control, body weight regulation and enhanced blood glucose control in adults and people who have diabetes. (Morris et al., 2020). On the other hand, if consumed excessively and prepared with unhealthy ingredients, it can result in obesity, diabetes, heart diseases, and hypertension. Determining the proper place of snacks and snacking products in the human diet thus requires an understanding of the role of snacks as well as the development of healthy snacks. (Mehak, 2020) The prevalence of young adults eating snacks instead of meals varies globally. Skipping meals and increased snacking behaviors are reported in a high percentage of children, adolescents, and college students in developing countries (Jayawardhana et al., 2017). A study conducted among children aged 2 to 5 years found that snacks constituted 26% to 27% of children's daily energy and the nutrients provided were deficient (kachurak et al., 2019). Excessive energy intake in children leads to excessive weight gain and obesity. This may be linked to snacking. Evidence has shown that eating snacks causes an increase in energy density and lower nutrients, as well as the development of other obesity-related diseases in children (Piernas et al., 2006). The growth of the market for healthy food in general and healthy snacks in particular has also been the subject of scientific interest.

Finger millet (Eleusine coracana) belongs to the Poaceae family and is generally known as Mandua or Ragi in India. Ragi grains have a high calcium content of 300-400 mg, which is approximately 10 times higher than that of conventional grains like wheat and rice. It comprises several micronutrients such as thiamine, iron, magnesium, manganese, zinc and iodine (Patil et al., 2023). Ragi is considered to be one of the most nutritious, easily digestible and least allergenic grains among the grains. (Burgard et al., 2013). Due to its health benefits for humans, it is considered a model plant for nutraceuticals. Numerous epidemiological studies have shown that regular consumption of whole ragi grains and its derivatives can help to reduce type II diabetes, cardiovascular disease, gastrointestinal cancer, and a number of other diseases. Whole ragi grains are rich in minerals, fiber, vitamins, and phenols that help fight high blood sugar and oxidative stress (Akhtar et al., 2020). The seed coat, high in dietary fibre and phenolic compounds, has been shown to reduce blood glucose and cholesterol levels, protect the kidneys, and prevent cataracts and finger millet extracts have been shown to have free radical scavenging, anti-protein glycation, anti-cataractogenic, and antibacterial activities (Gupta, 2014).

Peanut (Arachis hypogaea) belongs to the family of Fabaceae, genus Arachis. Peanuts are a legume which is considered as a vital source of nutrients. Peanuts contain approximately 6-9% of protein (Koppelman et al., 2001). Peanuts also supply B vitamin, niacin (B3), a necessary coenzyme in metabolic respiratory pathways within the mitochondria with an approximate quantity of 13.525 mg/100 g of dry roasted peanuts (Settaluri et al., 2012). Vitamin B5, pantothenic acid is accountable for the formation of Coenzyme A, which is responsible for quintessential reactions in electricity metabolism, synthesis of cholesterol, and synthesis of heme. Vitamin B5 is present in peanuts at approximate quantities of 1.395 mg/100 g of dry roasted peanuts (Settaluri et al., 2012). Peanuts are an excellent dietary supply of the macro minerals (Derise et al., 1974; Settaluri et al., 2012), which are the minerals needed daily in a volume higher than a 100 mg/day. Settaluri et al. (2012) also confirmed that peanuts supply the macro minerals magnesium (175 mg), calcium (54 mg), and phosphorus (358 mg) per one hundred g of dry roasted peanuts.

Hazelnuts are typically classified under the Betulaceae family, the Fegales order, and more specifically under the Corylus species (Dobhal et al., 2018). Hazelnuts are a good source of both micronutrients like vitamins and minerals and significant amounts of macronutrients like fat, protein, and fibre. They help reduce blood pressure because they are low in sodium and high in calcium, magnesium, and potassium. (Talebi et al., 2023).

The massive, tropical fruit that grows on trees, the jackfruit (Artocarpus heterophyllus), belongs to the Moraceae family. Jackfruit seed provide a good dose of protein, potassium, carbohydrate, fat, fiber, minerals (Theivasanthi and Alagar, 2011). Additionally, lignans, isoflavones, and saponins—also referred to as phytonutrients—found in jackfruit seeds possess plenty of health advantages, including antioxidant, anti-cancer, and anti-aging properties (Noor, 2014). Given their high fiber content, the seeds are also a good source of B-complex vitamins and dietary fiber. They aid in promoting weight loss, preventing constipation, and lowering the risk of heart disease.

The pumpkin seeds (Cucurbita sp.) from Cucurbitaceae family are normally considered as industrial waste merchandise and thrown out. As they are prosperous in protein, fibers, minerals like iron, zinc, calcium, magnesium, manganese, copper and sodium, PUFA (polyunsaturated fatty acids), phytosterol and vitamins, they would possibly be considered essential for the meals industries. Health promotion impacts of pumpkin seeds on the stage of blood glucose, cholesterol, immunity, liver functioning, gallbladder, disabilities of leaning, prostate gland, depression, inflammation, cancer management and inhibition of parasites are established. 25.4% protein, 25.19% carbohydrates, 5.34% fiber, and 2.49% total ash. (Qamar Abbas Syed et al., 2019).

Almonds (Prunus dulcis; Gradziel 2009) are a nutrient-dense food that have been the subject of extensive research over the past ten years regarding their potential health benefits. This research has linked almond consumption patterns to a lower risk of chronic diseases like type 2 diabetes and coronary heart disease (CHD), as well as to weight maintenance and control. Since before agriculture was developed, tree nuts like almonds have been a staple of human diets.

The flax plant, an annual herb belonging to the Linaceae family, yields flaxseed. It grows best in deeply damp, clay-, silt-, and sand-rich soils. The species is indigenous to the area bounded by the Middle East and the Eastern Mediterranean, via Western Asia and India (Bernacchia R et al., 2014). The entire flaxseed is round, flat, and has pointed tips. It is composed of two embryos, an embryo axis, a thin endosperm, and the seed coat, also known as the real hull (sometimes called testa (Morris DH, 2007). All parts of the linseed plant are used for commercial purposes, either unprocessed or processed. The seed produces oil rich in omega-3, digestible proteins, and lignans; it is also used to make paints, varnishes, linoleum, oilcloths, printing inks, soaps, and many other items. The shell yields high-quality fiber with low density and good mechanical qualities (Bernacchia R et al., 2014).

Theobroma cacao L. seeds are used to make cocoa powder, which has become more popular in the world's food and confectionery industries.(Joel et al., 2013).Rich in fibre (26–40%), proteins (15–20%), carbohydrates (around 15%), and lipids (10–24%; most, 10–12%%), cocoa powder also contains minerals (such calcium, magnesium, and potassium) and vitamins (A, E, B, and folic acid).(Puig and Castell ,2009).The antioxidant properties of cocoa may have a direct impact on insulin resistance, which lowers the chance of developing diabetes. Procyanidins, epicatechins, and catechins are the main flavonoids that exhibit antioxidant activity. (Katz et al.,2011).

1.1 Rationale and scope of study

Current study was planned to explore physical, textural and sensory attributes of Finger millet and nut mixed choco rolls.

1.2 Objectives

- Development of finger millet, nuts and seeds based choco rolls.
- Sensory evaluation and analysis of nutritional composition.
- Storage study of the developed product.

CHAPTER 2

REVIEW OF LITERATURE

2.1 RAGI

Among the Poaceae family of grasses, millets are minor cereals. They are small seeded, annual cereal grasses, many of which are tailored to tropical and arid climates and are characterized by their potential to live to tell the tale in less fertile soil (Hulse, Laing, & Pearson, 1980). Ragi or finger millet (Eleusine coracana L.) is one of the common millets in countless regions of India. It is also commonly known as Koracan in Srilanka and through exclusive names in Africa and has historically been an essential millet staple meal in the components of eastern and central Africa and India (FAO, 1995).

Traditionally in India, finger millet used to be processed by techniques such as grinding, malting, and fermentation for products like beverages, porridges, idli (Indian fermented steamed cake), dosa (Indian fermented pan cake), and roti (unleavened flat bread). (Malathi & Nirmalakumari, 2007). The distinctiveness of finger millet grain imparts an attribute of permitting the pericarp to be easily removed upon rubbing the grains with mortar and pestle.

Another unique structural characteristic of finger millet grain is its five (5) layered-testa which has been implicated as one of the probably motives for the presence of an excessive dietary fibre content in the grain (Shobana et al., 2013).

The major anatomical parts of the finger millet grains are pericarp, germ and the endosperm. The pericarp is an outer skinny layer which covers the grain and it is known as the glume. The grain pericarp consists of three (3) layers with various thickness: the epicarp (outermost layer), mesocarp (middle layer) and endocarp (inner layer) (Siwela, 2009; Wrigley).

Table 1. Composition of ragi

S.No	Particulars	Ragi millet
1	Carbohydrates(g)	72.6
2	Protein(g)	7.7
3	Fat(g)	1.5
4	Crude fibre (g)	3.6
5	Ash (g)	2.7
6	Calcium(mg)	344
7	Phosphorus(mg)	250
8	Iron(mg)	6.3
9	Manganese(mg)	3.5
10	Magnesium(mg)	130

***Source: USDA Nutrient database**

Fig 1

Finger millet grain has a carbohydrate content of 81.5%, protein 9.8%, crude fiber 4.3%, and mineral 2.7% which is similar to different cereals like rice, wheat, maize and millets. Its crude fiber and mineral content is remarkably higher than these of wheat (1.2% fiber, 1.5% minerals) and rice (0.2% fiber, 0.6% minerals); its protein profile is surprisingly well balanced; as it includes more lysine, threonine, and valine than other millets. In addition to this black finger millet incorporates 8.71 mg/g dry weight fatty acid and 8.47 g/g dry weight protein. Finger millet types comprise calcium (220–450) and iron (3–20%) respectively10. The finger millet consists of important amino acids viz., isoleucine (4.4 g), leucine (9.5 g), methionine (3.1 g) and phenyl alanine (5.2 g) which are poor in different starchy meals. Millets also includes B vitamins, mainly niacin, B6 and folic acid calcium, iron, potassium, magnesium and zinc.

Consumption of finger millet on a regular foundation will heals procedures degenerative ailments and slows down the early ageing. It is beneficial for the sufferers these have coronary heart problem, liver disorder, blood pressure and asthma. Finger millets are enormously enriched with nutrients and proven recommended to maintain right health.

Antidiabetic:

Consuming meals high in fibre and complex carbohydrates helps prevent subsequent blood glucose spikes, which is essential for managing diabetes and lowers chronic vascular issues. According to studies, finger millet's carbohydrates have been absorbed and processed far greater slowly. The advantages of cereal grains were associated to its dietary fibre and polyphenols contents which were recognized to lowers the incidence of diabetes mellitus and gastrointestinal tract diseases.

Antioxidant:

Antioxidant resources are becoming greater and extra common as lipid stabilizer and inhibitors of extreme oxidation. The seed coat of millet consists of polyphenols and its constituents, flavonoids and tannins which have multiple uses. They can act as chelators of metals, these both of singlet oxygen and reductants. The potential of phenolic compounds to donate hydrogen atoms to free radicals that lack an electron with the aid of the hydroxyl corporations on benzene rings effects in the formation of a resonance-stabilized but a lot less reactive phenoxyl radical.

Antimicrobial:

According to the phenolics in finger millet, in most cases the tannins, might also provide resistance to fungus infection. A structural impediment in the direction of fungal contamination is created with the aid of phenolic compounds, particularly tannins in the grain's outermost layer. Because of the excessive polyphenol content of the seed coat, acidic methanol extracts of the seed coat exhibit increased antifungal and antibacterial houses than whole wheat extracts (Patil et, al. 2023)

2.2 PEANUT

It is believed that peanuts are originated in Central American region and from where they spread to other parts of the world. Peanuts are widely cultivated in India, South America, China, United States, Africa and a few other countries. In United States they are the most frequently eaten nuts but they are actually legumes. They are enriched with health benefiting nutrients that are beneficial to human health. (VS Settaluri et al., 2012). In developing countries, peanuts are utilised in worldwide to address the nutritional needs since it contains protein and energy rich contents. Currently, took attention among consumer groups and within the scientific community for heart health diet. (Ondulla T Toomer, 2018).

The botanical name of Peanut is Arachis hypogaea which belongs to the family of Fabaceae, genus Arachis. It can be consumed in many forms such as boiled peanuts, roasted peanuts, peanut butter, peanut oil, and added peanut meal in snack food, candies and energy bars. Peanuts are a legume which is considered as a vital source of nutrients. Nutrition plays an important role in growth and energy gain of living organisms. They are rich in calories and contain many nutrients, antioxidants, vitamins and minerals that are essential for optimum human health. All these biomolecules are essential for sustaining normal human body health. (VS Settaluri et al., 2012).

There are more than 300 varieties of Peanuts grown worldwide (Settaluri et al., 2012). In United States, there are four market types of peanuts grown commercially are runner, Virginia, Spanish, and Valencia. The 80% of the United States predominates the runner peanut in peanut market and is primarily used for peanut butter, and it has an attractive uniform kernel size (American Peanut Council, 2014). They are predominately grown in Georgia, Texas, Oklahoma, Alabama and Florida. The Virginia type peanuts are mainly grown in Virginia and North Carolina for gourmet snacks.

They have largest kernel size and processed in shell, and comprises approximately 15% of the United States peanut market (American Peanut Council, 2014). The third type is Spanish peanuts which has a smaller kernel size. Comparatively they have higher oil content than other peanut types and are often used in peanut snacks and candies. Spanish type peanuts are grown in Texas and Oklahoma. They compromise approximately 4% of the United States peanut market (American Peanut Council, 2014). The Valencia type peanuts are primarily produced in New Mexico and they comprise approximately 1% of the United States peanut market (American Peanut Council, 2014). This type of peanuts have three or more small kernels to a pod, and they are very sweet in taste, therefore usually roasted and sold in the shell.

Peanuts can be eaten in many ways, either raw, boiled, or roasted. They are widely used to prepare peanut butter, candies, confections, and snack products and other packaged foods.

Broad Composition of Dry-Roasted Peanuts, without Salt

The basic composition of peanuts per 100 g of nuts is as below:

• Water 1.55 g

• Carbohydrates 21.51 g

• Fiber 8.0 g

• Lipids (Fats) 49.66 g

• Proteins 23.68 g Energy (Total Calories) 2448 kJ (585 kcal) (VS Settaluri et al., 2012)

Protein

The chiefly cultivated species of peanut is Arachis hypogaea L. They are annually grown species. Peanut has mainly three types of proteins, arachin, conarachin I and conarachin II. They are an important but cheap source of protein. In human beings, it can also cause allergic reactions. The peanut protein contains two components, Ara h 1 and Ara h 2. These two are mainly responsible to cause allergy. There are some remedial measures proposed to fight with this allergenic property of peanut protein such as treatment with activate charcoal, peroxidase, phytic acid, and various enzymes are also used to minimize allergenic effect. The growth of a fungal organism that releases aflatoxin are causing due to improper storage, which is a carcinogen to mammals. (Sumanta Kumar Ghatak, Kamalika Sen, 2013).

Globulin proteins

A glycoprotein, Ara ha 1 is belonging to the vicilin (7S) legume globulin family. This protein compromises approximately 12–16% of peanut proteins (deJong et al., 1998) and the percentage of affecting peanut allergic population is about 35–95% (Mari et al., 2006).

Albumin proteins

The glycoprotein Ara h 2, accounts for approximately 6-9% of total peanut protein (Koppelman et al., 2001). It's molecular weight is approximately about 17 kDa (Saiz et al., 2013). A 2S albumin Ara h 2, also called conglutin, and it functions as a trypsin inhibitor. The biological activity of digestive enzyme trypsin are reduced by the protein. (Maleki et al., 2003).

Carbohydrates

Oil or dry roasted peanuts contain about 21.51 g of carbohydrates per a hundred g (USDA, Food Composition Database, 2017) with starch as the foremost carbohydrate. However, peanut research has established that peanut carbohydrate content material is structured upon cultivar, maturation, and geographic region (Pattee and Young, 1982) and may incorporate the following carbohydrates in varying portions (major to minor): sucrose, fructose, glucose, inositol, raffinose, stachyose. Pattee and Young, (1982) said that upon thermal processing (roasting), sucrose undergoes hydrolysis releasing fructose and glucose, which in turn react with free amino acids to structure the characteristic flavor of roasted peanuts (Pattee and Young, 1982). Defatted peanut flour has been proven to include about 38% total carbohydrates of which account for oligosaccharides 18%, starch, 12.5%, hemicellulose A 0.5%, hemicellulose B 3.5%, and cellulose (fiber) 4.5% (Tharanathan et al., 1975) of the oligosaccharide fraction, approximately 13.90% sucrose, 0.89% raffinose, 1.56% stachyose, and 0.41% verbascose in unprocessed peanut flour (Tharanathan et al., 1975).

Fig 2

Vitamins

Peanuts provide a valuable source of water-soluble B vitamins and Vitamin E (tocopherol). Vitamin E (tocopherol) is a fat-soluble diet that is an antioxidant. Tocols (fundamental unit of the tocopherol family) are naturally occurring antioxidants found in plant oils like peanuts and encompass four tocopherol and four tocotrienol (members of the Vitamin E family) isomers, distinct as alpha, beta, gamma, and delta. Peanuts can provide a dietary supply of vitamin E vital to human nutrition. It a suitable source of water-soluble diet thiamine (B1), which functions as a coenzyme in carbohydrate and amino acid metabolic pathways. Studies via Dougherty and Cobb (1970a) suggested thiamine content material in the peanut seed to be about 1.0 mg/100 g, whilst thiamine content material in peanut testa (skin) to be considerably greater at approximately 3.8 mg/100 g (Dougherty and Cobb, 1970b). Peanuts are additionally an efficient source of riboflavin (B2), which functions as a coenzyme in carbohydrate, lipid, and protein metabolic pathways and is about 0.098 mg riboflavin/100 g of dry roasted peanuts (Settaluri et al., 2012).

Peanuts also supply B vitamin, niacin (B3) a necessary coenzyme in metabolic respiratory pathways within the mitochondria with an approximate quantity of 13.525 mg/100 g of dry roasted peanuts (Settaluri et al., 2012). Vitamin B5, pantothenic acid is accountable for the formation of Coenzyme A, which is responsible for quintessential reactions in electricity metabolism, synthesis of cholesterol, and synthesis of heme. Vitamin B5 is present in peanuts at approximate quantities of 1.395 mg/100 g of dry roasted peanuts (Settaluri et al., 2012).

Additionally, in smaller amounts diet B6 (pyridoxine) and diet B9 (folic acid) can be found in peanuts with approximate amounts of 0.256 mg and one hundred forty-five mg per a hundred g of dry roasted peanuts, respectively (Settaluri et al., 2012). Vitamin B6 (pyridoxine) functions biologically as a vital coenzyme in amino acid, glucose, and lipid metabolism pathways. (Ondulla T Toomer, 2017).

Table 2. Micronutrients content of whole conventional peanuts.

Vitamins	Class	Name	Peanut content	Main biological function	References
	Fat soluble	Tocopherol	8.2 mg/ 100 g raw, 4.1 mg/ 100 g roasted	Antioxidant	Chun, 2002
	Water soluble	Thiamine (B1),	1.0 mg/100 g peanut seed	coenzyme in carbohydrate and amino acid metabolic pathways	Dougherty and Cobb, 1970a
		Riboflavin (B2)	0.098 mg/100 g of dry roasted peanuts	coenzyme in carbohydrate, lipid, and protein metabolic pathways	Settaluri et al., 2012
		Niacin (B3)	13.525 mg/100 g of dry roasted peanuts	coenzyme in metabolic respiratory pathways	Settaluri et al., 2012
		Pantothenic acid (B5)	1.395 mg/100 g of dry roasted peanuts	formation of Coenzyme A	Settaluri et al., 2012
		Pyridoxine (B6)	0.256 mg/100 g of dry roasted peanuts	coenzyme in amino acid, glucose, and lipid metabolism pathways	Settaluri et al., 2012
		Folic acid (B9)	145 μg/100 g of dry roasted peanuts	nucleic acid synthesis, amino acid metabolism, early development	Settaluri et al., 2012
Minerals	Macro minerals	Potassium	658 mg/ 100 g of dry roasted peanuts	electrolyte balance, and muscle and neurological function	Settaluri et al., 2012
		Magnesium	175 mg/ 100 g of dry roasted peanuts	muscle and nerve function and maintenance of blood pressure	Settaluri et al., 2012
		Sodium	≈5.56 mg/ 100 g of roasted peanuts	electrolyte balance, hydration, function nerves and muscles	Derise et al., 1974
		Calcium	54 mg/ 100 g of dry roasted peanuts	normal bone and tooth development and muscle function	Settaluri et al., 2012
		Phosphorus	358 mg/ 100 g of dry roasted peanuts	bone and teeth formation, tissue growth and repair	Settaluri et al., 2012
	Trace minerals	Zinc	3.31 mg/100 g of dry roasted peanuts	immune system function, wound healing, cell division, and growth	Settaluri et al., 2012
		Iron	2.26 mg/ 100 g of dry roasted peanuts	essential element for blood production and oxygen transfer	Settaluri et al., 2012
		Manganese	≈2.06 mg/ 100 g of roasted peanuts	formation connective tissues, blood clotting factors, sex hormones, nerve function	Derise et al., 1974
		Copper	0.671 mg/ 100 g of dry roasted peanuts	red blood cells, healthy blood vessels, nerves, bones, immune support	Settaluri et al., 2012
		Selenium	7.5 μg/ 100 g of dry roasted peanuts	antioxidant, prevent cell damage	Settaluri et al., 2012

Table 2

Minerals

Peanuts are a excellent dietary supply of the macro minerals (Derise et al., 1974; Settaluri et al., 2012), which are the minerals needed daily in a volume higher than a 100 mg/day. Settaluri et al. (2012) also confirmed that peanuts supply the macro minerals magnesium (175 mg), calcium (54 mg), and phosphorus (358 mg) per one hundred g of dry roasted peanuts. Magnesium is needed for regular muscle and nerve feature and upkeep of blood pressure, whilst calcium is required for regular bone and tooth development and muscle function. Phosphorus (358 mg) along with calcium is required for bone and tooth formation, and protein synthesis in tissue increase and repair. Peanuts contain about 5.56 mg of sodium per a hundred g of roasted peanuts (Derise et al., 1974). Settaluri et al. (2012) stated that peanuts supply the trace minerals zinc (3.31 mg), iron (2.26 mg), copper (0.671 mg), and selenium (7.5 mg) per 100g of dry roasted peanuts (Derise et al.,1974) reported that peanuts grant about 2.06 mg of manganese per 100 g of roasted peanuts.

2.3 HAZELNUTS

Hazelnuts are typically classified under the Betulaceae family, the Fegales order, and more specifically under the Corylus species (Dobhal et al., 2018). Species-wise, they are also referred to as cobnuts or filberts. Hazelnuts are grown in Turkey, primarily in the Black Sea region to the east. Western Asia and Europe are home to Corylus avellana (Ulus et al., 2017). With 430,000 tonnes of dry, in-shell hazelnuts produced annually, Turkey leads the globe in production followed by Italy (128,940 tons), USA (34,927 tons). After cashew, walnut, almond, and pistachio, hazelnut production is rated fifth in the world, with 1 million tons produced in 2017(FAO Statistics, FAO 2017). At altitudes of 0.700 mm, hazelnuts grow best in sub-temperate and Mediterranean climate zones influenced by the sea, when summers are cold and winters are moderate. It is resistant to frost and can endure -8°C temperatures (Özenc et al, 2014). In the important hazelnut-producing regions of Europe and the USA, the annual rainfall typically falls between 800 and 1200 mm. Although hazelnuts can grow in a variety of soil types; deep, well-drained soils with a medium texture are ideal (Martin et al,2013). After roasting, the hazelnut skin is separated from the kernel and makes up around 2.5% of the weight of the entire hazelnut kernel. Whole or chopped raw kernels are used in a variety of food products, including cereals, snacks, meals, and desserts (Lin.T, 2013). Many dishes include blanched kernels that have had their skins removed through heating; gelati, for instance, calls for varieties that blanch well. Bakery goods and confections contain roasted kernels. Hazelnut is frequently used in desserts such as chocolates, ice cream, cakes, cookies, and breads (Maleki et al, 2013). When hazelnuts are ground, chopped, or roasted, they become hazelnut meal, which is used as a food ingredient in baked goods (Jiang. J et al., 2021). Additionally, hazelnut meal is used to manufacture praline, a paste or powder that is used to flavour goods like candy. Belgian chocolates, or praline belge, are one well-liked product. Additionally, chocolate and hazelnut are combined to make chocolate truffles and products like Nutella (Lin.T.,2017). Hazelnut oil is a clear, yellow, and highly flavoured cooking oil which is rich in Vitamin E and monounsaturated fatty acids. It is made from cold-pressed raw hazelnut kernels. It is also used in baking and salad dressing. (Raparelli et al., 2020). Hazelnuts can also be processed into vodka-based hazelnut liquors, as the well-known Frangelico in the US and Eastern Europe, and used as a plant milk (Lin.T., 2017). Because of their exceptional nutritional value, hazelnuts are important to human nutrition and health. Malic acid is the most abundant organic acid in hazelnut kernels, although it is also present in minor amounts. Hazelnuts contain 1-30% of available celluloses and pectins (Alawan et al, 2022). Hazelnuts are a good source of both micronutrients like vitamins and minerals and significant amounts of macronutrients like fat, protein, and fibre.

S. No	Phytoconstituent	Weight
1	Protein	14.95 g
2	Total lipid	60.75 g
3	Carbohydrate	16.70 g
4	Fiber (Total dietary)	9.70 g
5	Iron	4.70 mg
6	Magnesium	163 mg
7	Zinc	2.45 mg
8	Copper	1.72 mg
9	Selenium	4 µg
10	Vitamin E	15.18 g
11	Lysine	0.42 g
12	Arginine	2.21 g
13	Saturated	4.46 g
14	MUFA	45.67 g
15	PUFA	7.92 g
16	Phytosterol	96 mg

Table 3: composition of phytoconstituents in 100 gm of edible part of hazelnuts

Proteins:

Since hazelnuts appear to be a decent source of both protein and amino acids, including them in a person's diet should be taken into consideration. Protein comment of hazelnut range from 14.95 g /100 g. Hazelnut skin has 8% protein. (Allegrini et al., 2022).

Carbohydrate:

The carbohydrate content ranges from approximately 16.70 g/100 g.

Vitamins:

Vitamin E content ranges from approximately 15.18 g /100 g. Vitamin E (α-tocopherol, or αTOH), which is present in the maximum quantity up to 40.6 mg/100 g, and minerals including magnesium, calcium, potassium, copper, and iron are also important components. Since not all nuts have the same amounts of essential components, it is recommended to consume up to 42.5 g of nuts daily in a variety of forms (Jiyang. J et al ,2021).

Minerals:

Minerals like magnesium, calcium, potassium, copper, and iron, as well as vitamin E (α-tocopherol, or αTOH), which can be found in the highest concentration up to 40.6 mg/100 g, are also significant constituents. It is advised to consume a mixture of different nuts and to consume up to 42.5 g of them daily, as not all nuts have the same amounts of these elements. (Navaz et al,2022). 100 g of hazelnuts supplied approximately, Mg 163 mg, 1.72mg Cu, 4.70 mg Fe, 2.45 mg Zn, selenium 4 µg of the suggested dietary limits based on the daily mineral element requirements (Kröl et al, 2020).

Fatty acid:

Saturated fatty acids (SFA) are found in very tiny amounts in hazelnuts, whereas monounsaturated fatty acids (MUFA) are abundant. With up to 60.75% of total fatty acids (FA) in hazelnuts, oleic acid is the most abundant fatty acid in the nut, followed by linolic and palmitic acids. Hazelnut skin has 9% fat. It contains 55–65% oil. (Zhao et al, 2023).

Dietary fiber:

Hazelnut nuts contains good natural source of dietary fibre, as seen by the reported 8.7% fibre levels for hazelnuts. It's been suggested that this high fibre content contributes to the negative correlation between nut consumption and weight gain. It is incredibly high in fiber and a variety of polyphenolic substances, including procyanidins, phenolic acids, and flavan-3-ols. Hazelnut skin has 65% dietary fiber (Fan liying et al, 2020).

Micronutrients:

The micronutrients like folic acid (vitamin B9) and antioxidants like tocopherols and polyphenols are found in hazelnuts. The amount of micronutrients like folic acid (vitamin B9) and antioxidants like tocopherols and polyphenols, as well as the mineral salt composition of these nutrients, is also very relevant to human health (Allegrini et al.,2022). They help reduce blood pressure because they are low in sodium and high in calcium, magnesium, and potassium. Hazelnut oil manages the negative consequences of hypertension (Islam Ali.,2018).

Hazelnuts contain MUFA and PUFA, which are beneficial for a healthy heart. A daily hazelnut diet satisfactorily raises low density lipoprotein (LDL) and decreases high density lipoprotein (HDL) in plasma. Hazelnut's phenolic components increased plasma antioxidant activity and decreased MDA levels. The body's plasma lipid profile is changed directly by these factors (Di Renzo L et al, 2019).

More research on hazelnuts' potential to treat and prevent heart disease is possible. Hazelnuts are a great way to keep your nervous system and other bodily systems in balance. They are full of nutrients including potassium, phosphorus, calcium, magnesium, copper, manganese, and selenium (Ulus et al.,2019). Because of its venotonic properties, this plant is used to treat edema brought on by insufficient venous flow and varicose veins.

Fresh hazelnuts were found to have substantial antimutageneity and anticancer activity when compared to the carcinogenic substance sodium azide, however dried hazelnut potential was found to be moderate. In the future, hazelnut may be used into anticancer medications (Allegrini et al.,2022). Evidence suggests that it lowers the risk of type 2 diabetes. A-Tocopherol may also guard against Alzheimer's disease and intellectual decline (Talebi et al.,2023).

Hazelnuts have been used in pharmaceuticals and cosmetic products. Oil from hazelnuts is also used for cooking and massaging (Zhao et al, 2023). Hazelnuts can be added to a wide range of foods, including cereals and breads, yoghurts, soups, salads, main courses, and confections. They are commonly used in the food industry in chocolate, confectionery, baking, ice cream, and dairy goods (Di Caro et al., 2010).

The hazelnut lipase enzyme exhibits remarkable stability when stored for four months at elevated temperatures and alkaline pH levels. For a variety of biotechnological studies, this enzyme may be more efficient (Müller et al.,2020). Because hazelnut kernels have a high oil content, they can be utilised to boost nutritional intake of oleic acid for individuals deficient in monounsaturated fats. The primary flavouring component of hazelnuts is called filbert one. Since it is widely accepted to be safe (GRAS) for use in food, it is utilised in perfumery (Dobhal et al., 2018).

Fig 3

2.4 ALMONDS

Almonds (Prunus dulcis; Gradziel 2009) are a nutrient-dense food that have been the subject of extensive research over the past ten years regarding their potential health benefits. This research has linked almond consumption patterns to a lower risk of chronic diseases like type 2 diabetes and coronary heart disease (CHD), as well as to weight maintenance and control. Since before agriculture was developed, tree nuts like almonds have been a staple of human diets. In the present era, their ubiquity has only increased, whether they are consumed as snacks or as a whole meal. Almonds can be utilized in a variety of culinary goods and dishes, as well as consumed whole (either raw or roasted) and in spreads like almond butter. Almonds have clearly evolved from the Spiraeoideae family in recent time. There are three types of almonds that bear nuts; some of the nuts are edible, while others are not. There are three types of almonds: one that yields sweet, edible nuts, another that yields bitter, poisonous, and non-edible nuts, and a third type that combines bitter and sweet almonds. Almonds are grown for their commercial purposes in two main varieties: bitter almonds (Prunus amygdalus amara) and sweet almonds (Prunus amygdalus dulcis). The color of the flowers on plants that produce sweet and bitter almonds can be used to distinguish between them. Pinkish-colored flowers are produced by bitter almonds, whilst white blooms are produced by sweet almonds (D. Potter et al., 2007). Countries in western and central Asia are the original home of almonds. It has been grown in China since the 10th century B.C. Greece has been growing it since the fifth century B.C. Almonds are mostly grown in the Kashmir area of India, where they are regarded as one of the main crops (M.K. Abdullah et al., 2017).The little deciduous almond tree typically reaches a height of 4–10 m and a trunk diameter of 30 cm. When exposed to sunshine during the first year of cultivation, immature or young branches turn green; in the second year, the purple tint turns gray. The lanceolate leaves are 4–13 cm long, 3–5 cm broad, and have serrated tips. Early spring brings with it the production of single or clustered flowers with a diameter of 3–5 cm that are pale pink or white. Fruit is a drupe with a delicate outer shell that is 3.5 to 6.0 cm long. The hull, or leathery green-grey coat, is all that remains of the exocarp in other Prunus members, such as cherries and plums. There is edible fruit (nut) inside the husk. Hydrogen cyanide is produced when the glycoside amygdalin in wild almond fruit is chewed or crushed. On the other hand, grown almonds are not toxic (M.K. Verma etal., 2014).

Fig 4

Composition of macronutrients in almonds

Nutrient	Value per g/100 g
Water	4.4
Energy	579 kcal / 2423 kJ
Protein	21.2
Total lipid	49.9
Ash	3.0
Carbohydrate, by difference	21.6
Fiber, total diet	12.5
Sugars, total	4.4
Sucrose	4.0
Glucose	0.2
Fructose	0.1
Lactose	0.0
Maltose	0.0
Galactose	0.1
Starch	0.7

Source: USDA (2019a).

Table 4

Micronutrients:

One of the foods that is highest in nutrients is almonds. Almonds stand out from other tree nuts due to their high protein and vitamin E (a-tocopherol) content. Fat makes up the majority of almonds, and studies on human volunteers have shown that either a sizable amount of lipid is either fully undigested or digested slowly (Blomhoff et al. 2006).

Sodium and potassium content:

Almonds are rich in potassium and practically free of salt. Almonds are naturally high in potassium, naturally sodium free, and a good fit for low-sodium/high-potassium diets based on the EU nutrition claim standards (David P. Richardson et al., 2009).

Phytosterols and antioxidants:

Almonds and other tree nuts have no cholesterol in the diet, but they are high in a class of chemicals called phytosterols, which act as a block to the absorption of cholesterol, so assisting in the maintenance of normal blood cholesterol levels. 5-avenasterol, stigmasterol, campesterol, and b-sitosterol. Nuts have a phytosterol concentration. Because of their high MUFA content and fatty acid exchange, nuts have frequently shown more cholesterol-lowering efficacy in human studies than expected (Griel and KrisEtherton 2006). The distinct amalgamation of monounsaturated fatty acids, phytosterols, and antioxidants, in conjunction with the elevated nutritional density of almonds concerning vitamin E, folate, calcium, magnesium, and potassium, along with minimal sodium content, could plausibly account for the well-being noted in both human trials and epidemiological investigations. (Griel et al., 2006)

Lipids, proteins, carbohydrates (metabolizable sugars), minerals, fibers, and secondary metabolites—which are present in small amounts but have the potential to affect the quality of almonds—are the key ingredients of almond seeds (Roncero et al., 2016). The overall makeup of almonds is displayed in Table 1. The genotype, environmental factors, cultivation region, cultivation techniques, climatic conditions that change between harvest years, variations in production factors (such as soil type, irrigation technique, and temperature), or the interactions of these factors all affect this nut's nutrient composition (Yada et al., 2011)

The majority of the lipids in almonds are storage lipids, which are found in the cotyledon tissues of the kernel as intracellular oil droplets. Since the intake of these fatty acids is typically inversely correlated with serum cholesterol levels, the lipid fraction in this oilseed is primarily composed of monounsaturated and polyunsaturated fatty acids, which are an important source of calories but do not contribute to the formation of cholesterol in humans (Kodad & Company, 2008; Yada et al., 2011).

Almonds are naturally high in fibre:

Almonds have a lot of fiber by nature. As per Table 1, whole natural almonds provide about 12 g of dietary fiber per 100 g, which is adequate to qualify them as "naturally high in fiber" under the recently implemented European rule. Based on epidemiological and human intervention research, there is broad agreement that dietary fiber from plant cell walls of foods such whole grain cereals, fruits, vegetables, legumes, and nuts is linked to a number of health advantages. These advantages include a lower chance of diabetes and coronary heart disease as well as advantageous effects on the digestive system, such as prebiotic actions. Various forms of dietary fiber can reduce plasma cholesterol concentrations and moderate the rise in postprandial glycaemia. Over time, consuming more dietary fiber can also decrease weight gain and improve satiety (Chen et al. 2006).

Almond consumption and reduced risk of cardiovascular disease

The favorable benefits on lowered risk of coronary heart disease (CHD) that have been noted may be partially explained by the healthy fatty acid profiles and abundance of nutrients found in tree nuts like walnuts, hazelnuts, and almonds, which are popular in the Mediterranean diet. Results of a randomised study conducted in Spain were published by (Estruch et al. in 2006). One of two Mediterranean diets or a low-fat diet (n = 257) was given to the participants. During three months (n = 258), those who were assigned to Mediterranean diets received nutrition instruction and either free virgin olive oil (1 L/week) or free nuts (15 g/day walnuts, 7.5 g/day hazelnuts, and 7.5 g/day almonds). A 99.6% completion rate was achieved. The two Mediterranean diets supplemented with nuts or olive oil had positive effects on cardiovascular risk factors, such as blood pressure, systolic blood pressure, total cholesterol, and the ratio of high-density lipoprotein (HDL) to low fat. These results were in comparison with the low-fat diet.

Almonds, satiety, weight maintenance and type 2 diabetes

Almonds are high in fibre and protein and have a low glycaemic index, all of which are dietary factors shown to increase satiety and suppress appetite (Holt et al. 1995). In the first, the satiety value of nuts is examined, and it is hypothesised that including nuts in the diet causes a natural decrease in energy intake during other times of the day to balance out a significant amount of the energy the nuts give. Second, it is hypothesised that eating nuts could lead to higher energy expenditure and the dissipation of some of the energy they contain. Third, it is proposed that the energy absorbed from nuts is diminished, lowering their potential contribution to energy intake (David P. Richardson et al., 2009). The almonds have a powerful satiating impact, with 74% of the energy from almonds being countered by less energy from other sources. A non-significant increase in daily energy expenditure would account for approximately 14% of the energy in almonds, whereas there was a large increase in faecal energy loss, which would account for approximately 7% of the energy in almonds. As a result, the results indicated that eating almonds had no effect on body weight.

These mechanisms contribute to the explanation of the findings of clinical and epidemiological investigations, which indicate that moderate nut consumption does not increase the risk of weight gain. For instance, a study conducted in southern California revealed that 81 participants' diets containing a modest amount of almonds (65 g) for six months increased the amount of unsaturated fat and did not significantly affect their body weight (Fraser et al. 2002).

Almonds in the diet

Due to mounting proof of their positive health effects, nuts like almonds are now a staple of many countries' diet plans. On their intake profiles and the qualitative and quantitative variations in their consumption patterns within and between populations and geographical areas, there are, nevertheless, surprisingly few data available. Information on consumption habits and nutritional status is available from the European Prospective Investigation into Cancer and Nutrition (EPIC), a cohort study comprising 520 000 participants from 23 centers across ten western European nations normal serving sizes (Frecka et al. 2008; Jenab et al. 2006).

2.5 JACKFRUIT SEED

The massive, tropical fruit that grows on trees, the jackfruit (Artocarpus heterophyllus), belongs to the Moraceae family. Though believed to have originated in the Indian Western Ghats, it is currently most often grown in Bangladesh, Burma, Malaysia, Indonesia, Thailand, and, to a lesser extent, Brazil and Australia (Hossain, 2014). Strong, sweet-flavored golden yellow bulbs, which make about 30–35% of the fruit weight, are present in the ripe, edible fruits (Kamal et al, 2023). Up to 70% of the jackfruit's byproducts are made up of seeds, which make up about 8–15% of the fruit's overall weight (Kamal et al,2023). The jackfruit seed consist of two lectins namely jacalin and artocarpin. The thin brown spermoderm that envelops the fleshy white cotyledon is encased in a white aril and encircled by the surrounding flesh (Ranasinghe et.al, 2019). The round, light brown seeds of jackfruit measure 2-3 cm in length and 1-1.5 cm in diameter, (Hossain,2014) each jackfruit contains 100 to 500 seeds (Noor,2014). The seeds can be eaten cooked, roasted, or fried, and their flour can be used to make a variety of baked goods, including cakes and bread. Jackfruit seeds are a healthy source of both starch and protein. (Noor,2014).

The seeds are collected, dried, and stored in South India, but are often discarded due to processing and storage difficulties. They can be used as a perishable food ingredient, as an alternative flour in bakery and confectionery products, and as a supplement to potatoes (Hossain,2014). Additionally, lignans, isoflavones, and saponins—also referred to as phytonutrients—found in jackfruit seeds possess plenty of health advantages, including antioxidant, anti-cancer, and anti-aging properties (Noor,2014). The demand for jackfruit seeds has increased due to increased consumer awareness about the diet-disease relationship.

Jackfruit seeds are less widely known but have important nutritional value. Jackfruit seed provide a good dose of protein, potassium, carbohydrate, fat, fiber, minerals (Braz.Food Tech,2019), (T. Theivasanthi and M. Alagar,2011).

Table 5: Composition of jackfruit seed; (100 g of edible portion)

Parameters	Amount
Moisture	21.10%-71.92%
Protein	10.09%-18.12%
Carbohydrate content	7.89%-30.84%
Crude Fat	1.5%
Fiber	0.94%-3.96%
Ash	0.89%-3.16%
Starch	12.86- 17.90%

(Kushwaha et al., 2023; Thatsanasuwan et al., 2023, Bemmo et al.,2023)

Protein:

An isolation of jackfruit seeds was made in an attempt to find a new and helpful source of proteins with emulsifying qualities (Zhang et al. 2019a, 2019b, 2019c). The amount of protein present in seed range from 10.09%-18.12%. Researchers have studied jackfruit seed protein isolates and found preservation characteristics (Chai et al. 2021a, 2021b). Jackfruit seeds have a high concentration of highly soluble protein that helps reduce mental tension and anxiety. (Waghmare et al. 2019), (Brahma et.al,2023).

Lectin:

Jacalin and artocarpin are the two lectins found in jackfruit seeds (Shedge et al. 2022). Natural proteins called lectins have remarkable antibacterial effects because they bind to carbohydrates on microbial surfaces (Brahma et.al,2023).

Starch:

There is a specific quantity of starch in jackfruit seeds.

Starch content present in seed range from 12.86-17.90%.

There are many advantages to starch; after it is gelatinized, it can be cooked and cooled to mak e resistant starch (Birkett & Brown, 2007). When a starch is digested in the colon to form short chain fatty acids, it is referred to be resistant starch (RS) because human digestive enzymes cannot access it.

Minerals:

The major minerals identified in the concentrate are Ca, Mg, P, K, Na, and Fe, with estimated concentrations of 202.20 mg, 230.01 mg, 193.51 mg, 2820.60 mg, 478.42 mg, and 132.51 mg per 100 g of concentrate sample, respectively (Braz.Food Tech,2019). Jackfruit seeds possess vital minerals such as magnesium, potassium, phosphorus, calcium, sodium, iron, copper, zinc, and manganese (Thirugnanasambandan,2011). However, different species of jackfruit have different mineral compositions according to literary works (Brahma et.al,2023).

Fatty acid:

The two main fatty acids identified are linoleic and linolenic acids (Kumoro et al. 2020). According to their research, jackfruit is a good source of essential fatty acids (EFAs) and has co nsiderable antioxidant activity. The amount of crude fat in the seed is 1.5%.

Fiber:

When it comes to fibre, jackfruit seed is higher than jackfruit pulp (Amadi et al. 2018). The amount of fibre present in the seed range from 0.94%-3.96%. The jackfruit seed had 3.19% (Ocloo et al. 2010) fibre content. Dietary fibre is abundant in jackfruit seeds. (Babu et al. 2017). Dietary fibre has been associated with a decreased mortality and cardiovascular disease risk (Brahma et.al,2023).

Phytonutrients:

Jackfruit seeds include lignans, flavones, and saponins that have been found to have antiaging, anticancer, antiulcer, and antihypertensive properties (Shedge et al. 2022).

Bioactive constituents:

Following microwave extraction, the composition of the jackfruit seeds was examined using chromatography-mass spectrometry analysis. It was discovered that the sample had 90 and 148 bioactive constituents at positive and negative electrospray ionisation modes, respectively, indicating its medicinal and nutritional value (Brahma et.al ,2023).

Given their high fiber content, the seeds are also a good source of B-complex vitamins and dietary fiber. They aid in promoting weight loss, preventing constipation, and lowering the risk of heart disease.

Resistance starch, which lowers blood sugar and maintains intestinal health, is another ingredient found in jackfruit seeds. Antimicrobial activity found in jackfruit seeds helps to prevent foodborne illnesses (Maurya & Mogra, 2016). Moreover, the seeds contain jacalin, a significant lectin that is utilized to assess an HIV-positive person's immune system.

Magnesium, which is abundant in the seeds, is essential for regulating blood pressure and preserving bone health because it facilitates the absorption of calcium, which strengthens bones (Maurya & Mogra, 2016). Additionally, the seeds have a high concentration of highly soluble protein, which helps to prevent and alleviate anxiety and mental stress. As the seeds absorb less water and fat, obesity is less likely to occur. They have anti-carcinogenic properties, improve digestion, and lessen the visibility of wrinkles on the skin. Eating jackfruit seeds is quite nutritious (Chhotaray & Priyadarshini 2022). The minerals iron, copper, zinc, potassium, sodium, manganese, calcium, magnesium, phosphorus, and hajj were found (Hajj et al. 2022). They carry out a variety of functions, such as forming the building blocks of our bones, influencing the activity of muscles and nerves, and maintaining the proper balance of water in the body (Weyh et al. 2022).

The jackfruit's seeds contain 10% to 15% protein and are abundant in carbohydrates. When compared to commercially available modified starches, jackfruit seed flour or starch has the potential to be used in functional food compositions due to its high quantities of protein and amylose (Suzihaque et al 2022). Moreover, seeds have two lectins called artocarpin and lectin that have immunological qualities (Gat, Sharma & Rafiq. 2022).

Fig 5

2.6 PUMPKIN SEEDS

The pumpkin seeds (Cucurbita sp.) from Cucurbitaceae family are normally considered as industrial waste merchandise and thrown out. In some area's seeds are utilized as uncooked, cooked or roasted, even though honestly for the domestic purpose. As they are prosperous in protein, fibers, minerals like iron, zinc, calcium, magnesium, manganese, copper and sodium, PUFA (polyunsaturated fatty acids), phytosterol and vitamins, they would possibly be considered essential for the meals industries. As the seeds are regarded as byproduct of the pumpkin fruit, they are cheaper in cost and their utilization is special food products may additionally lead to beautify their nutritional cost at decrease cost. Health promotion impacts of pumpkin seeds on the stage of blood glucose, cholesterol, immunity, liver functioning, gallbladder, disabilities of leaning, prostate gland, depression, inflammation, cancer management and inhibition of parasites are established. The change of these agro industrial waste merchandise into valuable elements is possibly a massive footstep in the direction of the route of the time-honored efforts in food sustainability; hence, the similarly researches and studies be deliberate to explore importance and advisable effects of pumpkins and their seeds (Qamar Abbas Syed et al.,2019).

The bodily properties, chemical composition and fatty acid share was once decided by way of an investigator and his collogues they determined that pumpkin seeds contained 41.59% oil, 25.4% protein, 5.2 percent Moisture, 25.19% carbohydrates, 5.34% fiber, and 2.49% total ash. Total phenolic compounds, complete sterols, waxes and total tocopherols have been 66.25 (mg galic acid per kg oil), 1.86%, 1.56% and 882.65 (mg tocopherol per kg oil) respectively. (Qamar Abbas Syed et al.,2019).

Protein

The pumpkin seed protein, like legume proteins, is deficient in sulphur containing amino acids. These results agree well with those for another cucurbita, fluted pumpkin, reported by Longe et al.,1983. However, it contains slightly higher levels of all essential amino acids except lysine and tryptophan (Mansour et al.,1993). Protein isolates have higher levels of essential amino acids than concentrate and meal, respectively.

Carbohydrates

Pumpkin seed meal contains low levels of total carbohydrate and flatulence factors compared with other oilseed meal such as soyabean and peanut.

Vitamins

The pumpkin seed meal is a top supply of niacin compared with other oilseeds such as soyabean and cotton seed meals. The other B vitamins existing in pumpkin seed are thiamine, riboflavin, pyridoxine and panthothenic acid. The quantity of B crew nutritional vitamins appreciably decreased for the duration of the guidance of protein concentrate and isolates; this discount might also be attributed to the dissolution and precipitation in the course of preparation. (Mansour et al.,1993)

Minerals

Pumpkin seed meal is prosperous in Ca, K, P, Mg, Fe and Zn (Longe et al.,1983). Both meal and listen are rich in macro- and micro-elements such as Ca, K, P, Mg, Fe and Zn (Mansour et al.,1993)

Table 6: Minerals composition of pumpkin seed kernel (N Manda Devi et al., 2018)

Sl. no.	Minerals	Mean value (mg/100g)
1	Iron (Fe)	16.1
2	Manganese (Mn)	487
3	Zinc (Zn)	907
4	Copper (Cu)	124
5	Phosphorus (P)	848.6
6	Potassium (K)	404.9
7	Calcium (Ca)	25.7
8	Magnesium (Mg)	335.6
9	Sodium (Na)	2.2
10	Cobalt (Co)	0.6

Fig 6

2.7 FLAXSEED

The flax plant, an annual herb belonging to the Linaceae family, yields flaxseed. It grows best in deeply damp, clay-, silt-, and sand-rich soils. The species is indigenous to the area bounded by the Middle East and the Eastern Mediterranean, via Western Asia and India (Bernacchia R et al., 2014). The entire flaxseed is round, flat, and has pointed tips. It is composed of two embryos, an embryo axis, a thin endosperm, and the seed coat, also known as the real hull (sometimes called testa (Morris DH,2007). All parts of the linseed plant are used for commercial purposes, either unprocessed or processed. The seed produces oil rich in omega-3, digestible proteins, and lignans; it is also used to make paints, varnishes, linoleum, oilcloths, printing inks, soaps, and many other items. The shell yields high-quality fiber with low density and good mechanical qualities (Bernacchia R et al.,2014).

According to certain research, the protein content of flaxseed ranges from 10.5% to 31% (Oomah and Mazza, 1993). It is reported that 21.9% of the protein in Indian-grown Khategaon cultivars was present (Madhusudhan et al.,1983). Similar to all other plants, flaxseed proteins have technofunctional properties that affect how they interact with other elements in a food chain. Their hydration mechanisms are primarily responsible for their solubility and water-dense oil-retention capacities. Soybean protein, which is considered to be among the most nutrient-dense plant proteins, and flax protein have a similar amino acid pattern (Rabetafika et al.,2011). Variations in protein can be explained by both environment and inheritance. The approximate protein content of dehulled and defatted flaxseed varied greatly depending on the cultivar (Rajju Priya Soni et al.,2016)

Due to the possible health benefits associated with its physiologically active components—lignan, secoisolariciresinol diglycoside (SDG), and dietary fiber—flaxseed has drawn the attention of medical researchers and nutritionists. As a functional food, flaxseed is becoming more significant in the global food chain (Toure et al., 2010).

Fig 7

Table-1: Nutritional composition of flaxseed

Nutrients	Amount per 100 g of edible flaxseed
Moisture (g) 6.5	6.5
Protein (N×6.25) (g)	20.3
Fat (g)	37.1
Minerals (g)	2.4
Crude fiber (g)	4.8
Total dietary fiber (g)	24.5
Carbohydrates (g)	28.9
Energy (kcal)	530.0
Potassium	750.0
Calcium (mg)	170.0
Phosphorous (mg)	370.0
Iron (mg)	2.7
Vitamin A (µg)	30.0
Vitamin E (mg)	0.6
Thiamine (B1) (mg)	0.23
Riboflavin (B2) (mg)	0.07
Niacin (mg)	1.0
Pyridoxine (mg)	0.61
Pantothenic acid	0.57
Biotin (µg)	0.6
Folic acid (µg)	112

*Morris 2007; Gopalan *et al.*, 2004; Payne, 2000

Table 7

Dietary fiber, protein, and fat are all abundant in flaxseed. Flaxseed composition might vary depending on genetics, growing conditions, and seed processing technique (Daun et al., 2003). Flaxseed composition is given in Table 1. 41% fat, 20% protein, 28% total dietary fiber, 7.7% moisture, and 3.4% ash were found in an examination of brown Canadian flaxseed (Anonymous, 2001). As the seed's oil content rises, its protein content falls (Daun et al., 1994). Flax seeds are well recognized to contain a high concentration of polyunsaturated fatty acids (Pradhan et al., 2010).

Among the functional foods, flaxseed has emerged as a potential functional food being good source of alpha-linolenic acid, lignans, high quality protein, soluble fiber and phenolic compounds (Oomah, 2001). The composition of flaxseed is presented in table-1 (Morris, 2007; Gopalan et al., 2004; Payne, 2000).

The composition of flax can vary with genetics, growing environment, seed processing and method of analysis. (Bernacchia R et al.,2014).

Protein

There have been reports that flaxseed has anywhere from 10.5% to 31% protein (Oomah and Mazza, 1993). According to Madhusudhan and Singh (1983), the protein content of Khategaon cultivars cultivated in India was 21.9%. The technofunctional characteristics of flaxseed proteins, similar to those of all plants, influence how they behave within a food chain through interactions with other components. Their solubility and water-dense oil-retention capabilities are mostly reliant on their hydration mechanisms. According to (Rabetafika et al. 2011), flax protein shares an amino acid pattern with soybean protein, which is thought to be one of the most nutrient-dense plant proteins. Both heredity and environment can explain variations in protein. Depending on the cultivar, the approximate protein content of dehulled and defatted flaxseed differed significantly.

Alpha-linolenic acid

The primary ingredient that makes flaxseed useful is alpha-linolenic acid. The reason why fatty acids are considered necessary is that although the body needs them, it is unable to synthesis them and must therefore obtain them from the food.
The enzymes needed for the synthesis of these vital fatty acids are absent from the human body. Blood lipids benefit from the action of ALA found in flaxseed. It was discovered to be equally successful as oleic acid (18:2η-6) and linoleic acid (18:2η-6) in lowering plasma total cholesterol, low density lipoprotein cholesterol, and very low-density lipoprotein cholesterol in healthy males aged 20 to 34 decades. (Chan et al., 1993).

Dietary fibre

The term "dietary fiber" refers to a broad range of plant materials that are difficult for human digestive enzymes to break down. Crude, acid detergent, neutral detergent, and total fibers (cellulose, lignine, and hemicellulose) are all obtained from flaxseed meal. Two times as many fibers as high-fiber beans are found in beans with a fiber level of 22% to 26%. 20% to 25% of your daily fiber requirements can be met by consuming half an ounce of dry whole flax seed. The ratio of soluble to insoluble dietary fiber in flaxseed varies from 20:80 to 40:60. Cellulose and lignin make up the majority of the insoluble fiber fraction, while mucilage gums make up the soluble fiber fraction (Qian, 2012, Cui et al., 1996).

Lignans

Plant lignans are most abundant in flaxseed. Plants high in fiber, cereals (wheat, barley, and oats), legumes (bean, lentil, soybean), vegetables (broccoli, garlic, asparagus, and carrots), fruits, berries, tea, and alcoholic beverages are all excellent sources of lignans, which are phytoestrogens. Compared to cereal grains, legumes, fruits, and vegetables, flaxseed has between 75 and 800 times more lignans (Mazur et al. 2000; Meagher and Beecher 2000; Murphy and Hendrich 2002; Hosseinian and Beta 2009).

Flaxseed's antioxidant activity has been demonstrated to lower platelet aggregation and total cholesterol. Antioxidants that effectively prevent DNA damage and lipid peroxidation include secoisolariciresinol Diglucoside (SDG), as well as the mammalian lignans enterodiol (ED) and enterolactone (EL). Evaluate supraphysiological doses of ED, EL, and secoisolariciresinol (SECO) to see if they inhibit activated cell chemiluminescence. The 3-methoxy4-hydroxyl substituents of SDG and SECO were assigned the role of the lignan antioxidant action. Diabetes type-1 and type-2 can be effectively prevented or postponed by flaxseed's secoisolariciresinol diglucoside. Researchers have proposed that SDG's antioxidant activity accounts for its hypoglycemic effect in type 2 diabetes. A rate-limiting enzyme in the gluconeogenetic pathway, phosphoenol pyruvate carboxy kinase enzyme, may be suppressed in the context of type-2 diabetes, which could explain the hypoglycemic action of SDG (Hu et al., 2007).

Infant allergies and respiratory diseases:

The possible preventive role of allergy and respiratory disorders has been established by decreased consumption of omega-6-PUFAs in favor of greater anti-inflammatory omega-3-PUFAs (flax is high in ALA, a biological precursor to omega-3-fatty acid) in modern diets. PUFAs modify immune function through a variety of methods. By reducing cytokine production, which in turn reduces immunoglobulin E synthesis and T helper 2 cell development, omega-3-PUFAs may change the balance of T helper cells. PUFAs have the ability to change gene expression, trigger the metabolism of eicosanoids, and remodel the cellular membrane (Soni et al.,2016)

Anti-diabetic functions:

A study conducted by 49Mitra A, Bhattacharya in 2009 in order to find out whether flaxseed gum, like guargum, is effective in reducing the blood glucose level in non-insulin dependent diabetes mellitus (NIDDM). In this study 20 NIDDM patients were fed, for 3 months, 5 chapattis each containing 5 g flaxseed gum and 25 g wheat flour. Blood biochemistry of these patients when on normal monitored diet for the preceding 3 months, before initiation of therapy with flax gum, was measured monthly using standard procedures and monthly therefore, after the initiation of therapy. 20 other (non-diabetic) patients subjected to identical conditions acted as controls. It was observed that flax gum-containing therapeutic diet reduced TLC, LDLC, and FBS significantly (Soni et al.,2016).

Flaxseed in bone health:

When consuming foods high in these omega-3 fats leads to a decreased ratio of omega-6 to omega-3 fats in the diet, alpha linolenic acid, an omega-3 fat found in flaxseed, helps to avoid excessive bone turnover, which in turn benefits bone health (Griel et al., 2007). After taking two tablespoons of crushed flaxseed twice daily for six weeks, women who had been experiencing 14 hot flashes per week for at least a month and weren't using estrogen to treat their menopausal symptoms saw a halving in the frequency of their daily hot flashes. Furthermore, there was a 57% decrease in the women's hot flash intensity. According to (Pruthi et al. 2007), two of the side effects were moderate diarrhea in 8 women and stomach bloating in 14 women.

Anti-nutrients in flaxseed:

Two substances that are regularly questioned about the safety of flaxseed are linatine, an antipyridoxine component, and cyanogenic glycosides. Flaxseed would release very little hydrogen cyanide—below the dangerous fatal level. About 5–10 mg of hydrogen cyanide are generated from flaxseed at the recommended daily intake of 1-2 table spoons, which is far less than the estimated acute hazardous dose for an adult of 50–60 mg of inorganic cyanide and less than the 30-100 mg/day that people can detoxify (Roseling, 1994).

Cancer control cause:

The flaxseed results highlight the necessity to include flaxseed in dietary evaluations of lignan consumption and are in line with recent meta-analyses indicating that dietary lignan intake may be related with a slight reduction in breast cancer risk, particularly in postmenopausal women (Velentzis LS et al.,2009) Lignan-rich foods are part of a healthful dietary pattern; the role of lignans is important in the prevention of hormone-associated cancers, osteoporosis, and cardiovascular diseases.

CHAPTER 3

3. MATERIALS AND METHODS

3.1. Ingredients

The following ingredients were used: Ragi flour, all-purpose flour, cocoa powder, baking powder, powdered sugar, milk, vanilla essence, pumpkin seed, flax seed, jackfruit seed, hazelnut, peanut, almond.

3.2. Formulation of the protein rich choco rolls from finger millet

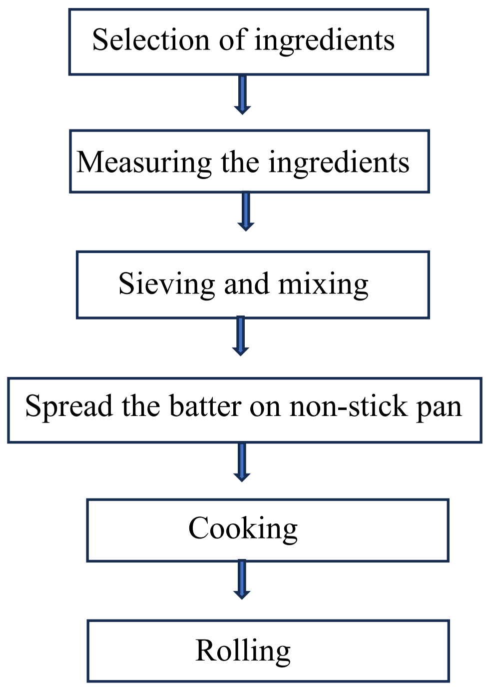
The choco-ragi rolls were prepared using 30 grams of all-purpose flour, 30 grams of ragi flour, 35 grams of powdered sugar, 8 grams of cocoa powder, 0.25 grams of baking powder, 50 milliliters of milk, 1 milliliters of vanilla essence.

For the preparation of chocolate nut – seed filling; 8 grams of cocoa powder, 30 grams of powdered sugar, 2 grams of corn starch, 4 grams of each nuts and seeds were roasted, powdered and added, 100 milliliters of water.

Fig 8

3.3. Preparation of choco ragi rolls

Flow chart



3.4. Preparation of chocolate nut seed mixture

Flow chart

Mixing cocoa powder and milk

↓

Addition of corn starch slurry

↓

Cooking (until reaches thick consistency)

↓

Roasting the nuts and seeds

↓

Powdering

↓

Addition of powder to chocolate sauce

↓

Filling into rolls

Fig 9

Fig 10

3.5. Equipment

 Fig 11	 Fig 12
 Fig 13	 Fig 14
 Fig 15	 Fig 16
 Fig 17	 Fig 18
 Fig 19	 Fig 20

Fig 21

Fig 22

Fig 23

3.6. For the preparation of control

60 grams of all-purpose flour, 8 grams of cocoa powder, 30 grams of powdered sugar, 0.25 grams baking powder was taken. Mixing them with 50 ml of milk and 1 ml of vanilla essence. To a heated non-stick pan, the batter is brushed and cooked until crisp and rolled them immediately. For the filling, 5 grams of cocoa powder was mixed with 100 ml of water and heated. To the mixture 4 grams corn starch mixed with 10 ml of water was added and cooked until it becomes thick. The chocolate sauce was filled into the prepared rolls.

3.7. Pre-preparation of nuts and seeds

All the nuts and seeds were roasted in low flame separately except jackfruit seed and allowed them cool. After that finely powdered each of the nuts and seeds in a mixer jar and transferred them to air tight container and kept a side.

For the preparation of jackfruit powder, the outer cover of the seeds was removed and crushed them in a mixer jar (do not powder them finely) and transferred them to a mould for roasting them in oven until the moisture is reduced and forms crispy. Allowed them to cool and ground it in a mixer jar for making them into fine powder.

3.8. Procedure for making choco ragi rolls (sample)

Equal amount (30 grams) of ragi was incorporated with all-purpose flour, 30 grams of powdered sugar, 8 grams of cocoa powder, and 0.25 grams of baking powder were taken. 50 ml of milk and 1 ml of vanilla essence were added to the dry mixture and mixed well. A non- stick pan heated in low flame and turned it off. The batter was brushed onto the pan and it was again heated to cook until it reached a slight crisp stage. The product was taken out onto a plate and rolled it immediately.

For the preparation of chocolate nut – seed mix, 5 grams of cocoa powder along with 100 ml of water was taken in a sauce pan and mixed them to prevent lumps. The mixture was heated and 3 grams of corn starch and 10 ml of water taken and added. Cooked them until it forms thick consistency. 4 grams of each nuts and seeds powder were taken and added to the chocolate sauce. And filled them to the prepared rolls using piping bag.

The ragi choco rolls are developed in 5 different proportions. The product with different proportions were developed as follows:

Sample No.	Ragi Flour	All-purpose flour
S1	-	20g
S2	5g	15g
S3	10g	10g
S4	15g	5g
S5	20g	-

Table 8

CHAPTER 4

STORAGE STUDY OF THE DEVELOPED PRODUCT

After conducting sensory analysis of 5 different proportions, one will be selected on the basis of highest score on the hedonic scale and further kept for storage study. Storage study of developed functional choco ragi roll is done as following:

Selected ragi choco roll is stored at two different temperature conditions such as room temperature and refrigerated conditions after keeping them in sealed polythene bags. Then the choco ragi roll is observed at regular intervals of days. When kept at room temperature, it was found that the choco ragi roll produced an off flavour and off odour after 3 days. However, in refrigerated condition the product maintain its sensory attributes and quality profiles.

CHAPTER 5

SENSORY EVALUATION OF DEVELOPED CHOCO RAGI ROLL

For conducting the sensory evaluation of developed choco ragi roll, nine points hedonic scale method was followed.

5.1. HEDONIC SCALE

Like Extremely	9
Like Very Much	8
Like Moderately	7
Like Slightly	6
Niether Like nor Dislike	5
Dislike Slightly	4
Dislike Moderately	3
Dislike Very Much	2
Dislike Extremely	1

Table 9

Ragi choco rolls were prepared by combining the ingredients in 5 different proportions to find the appropriate combinations. The ingredients for all 5 samples (S1, S2, S3, S4, and S5) were taken in different bowls. They were prepared according to the procedure. The panel of two faculty members and three undergraduate students of the department of Food Processing Technology, St. Teresa's College was selected with care to evaluate the blends for sensory parameters such as appearance, aroma, taste, texture and overall acceptability.

5.2. HEDONIC SCALE RATING

Food Analysts	Sample	Appearance	Aroma	Taste	Texture	Overall Acceptability
Analyst1	S1	8	8	8	7	8
	S2	7	8	6	6	7
	S3	7	8	7	7	7
	S4	6	8	5	6	6
Analyst 2	S1	8	8	7	7	8
	S2	8	8	8	8	8
	S3	8	8	8	8	8
	S4	8	8	7	8	8
Analyst 3	S1	8	8	7	7	8
	S2	8	8	8	8	8
	S3	7	7	7	6	7
	S4	6	6	7	6	6
Analyst 4	S1	8	8	7	7	8
	S2	8	8	8	8	8
	S3	7	7	7	7	7
	S4	6	6	6	6	6

Analyst 5	**S1**	**6**	**5**	**7**	**6**	**6**
	S2	**6**	**5**	**6**	**7**	**6**
	S3	**7**	**7**	**8**	**8**	**8**
	S4	**5**	**5**	**4**	**4**	**5**

Table 10

CHAPTER 6

CHEMICAL ANALYSIS

6.1. DETERMINATION OF TOTAL PROTEIN CONTENT

TEST METHOD: AOAC 20th Edn 2016 .920.152

SCOPE: To determine the total protein content.

PRINCIPLE: Test portion is digested in H_2SO_4, using HgO as catalyst, converting nitrogen to NH3 which is distilled and titrated.

REAGENTS:

- Sodium hydroxide solution: 450g in one-liter distilled water
- Boiling stones
- Standard Sulphuric acid solution: 0.25M
- Standard Sodium hydroxide Solution: 0.5M
- Methyl Red indicator: 1g in 100ml methanol

PROCEDURE:

- Accurately weigh 0.70 to 2.20g of the sample into the digestion flask
- Add 0.7g HgO and 15g Na_2SO_4.
- Add 25ml of Sulphuric acid.
- Place the flask in an inclined position on a heater and heat gently until frothing ceases
- Boil until clear.
- Cool and add about 200ml distilled water and cool to room temperature
- Add 25ml Thiosulphate solution (8% in water) and mix to precipitate mercury.
- Add sodium hydroxide solution more carefully through the sides of the flask to make the solution strongly alkaline
- Assemble the apparatus taking care that the tip of the condenser extends below the surface of a known quantity of standard sulphuric acid and add 5-7 drops of methyl red indicator
- Heat immediately until all ammonia has distilled (150ml)

- Lower the receiver before stopping distillation and wash the tip of the condenser with distilled water.
- Titrate against std. Sodium hydroxide solution
- Correct for blank determination on reagents

CALCULATION

$$\text{Nitrogen content (N) in \%} = \frac{[(M_{acid})(ml_{acid}) - (ml_{NaOH})(M_{NaOH})] \times 1400.67}{\text{mg test portion wt}}$$

Where,

M_{acid} = molarity of standard acid,

ml_{acid} = volume in ml of acid used as trapping solution

M_{NaOH} = molarity of standard base

ml_{NaOH} =volume in ml of standard base used for titrating

6.2. DETERMINATION OF THE IRON CONTENT

TEST METHOD: AOAC 20th 2016 944.02

SCOPE: To determine the Iron content.

REAGENTS:

- o – Phenanthroline solution
- α, α-Dipyridyl solution
- Iron standard solution
- Hydroxylamine hydrochloride solution
- Magnesium nitrate solution
- Acetate buffer solution

PROCEDURE:

By dry ashing:

- Ash 5.00 g test portion in Pt, SiO2 or porcelain dish
- Cool and weigh if percent ash is desired.
- Continue ashing until practically C- free, to diminish ashing time, or products that do not burn practically C- free, use one of the following ash aids.
- Moisten ash with 0.5 – 1.0 ml Mg $(NO_3)_2$ solution or with redistilled HNO_3
- Dry and carefully ignite in furnace, avoiding spattering. (do not add these ash aids to self-rising flour (products containing NaCl) in Pt dish because of vigorous action on dish.)
- Cool, add 5 ml HCl, letting acid rinse upper portion of dish, and evaporate to dryness on steam bath.
- Dissolve residue by adding 2.0 ml HCl, accurately measured, and heat 5 min on steam bath with watch glass on dish.
- Rinse watch glass and dilute residue solution to 100 ml with H_2O.
- If necessary, filter diluted residue solution through ashless paper and discard first 15 – 20 ml filtrate
- Pipet 10 ml aliquot into 25 ml volumetric flask and add 1 ml $H_2NOH.HCl$ solution; stand for 5 min.
- Add 5 ml Acetate buffer solution and 1 ml o – Phenanthroline, or 2 ml dipyridyl solution, and dilute to volume,
- Determine absorbance in spectrophotometer at ca 510 nm.
- From reading, determine Fe concentration from equation of line representing standard points or by reference to standard curve for known Fe concentration

- If further dilution required to maintain test solution absorbance reading below highest standard point on curve, pipet smaller Aliquot into 25.0 ml flask, dilute to 10 ml with 2% HCl solution and continue as described in above procedure
- Determine blank on reagents and make correction.
- Calculate Fe in flour as mg/Ib.

6.3. DETERMINATION OF FAT CONTENT

TEST METHOD: IS: 12711:1989; R-2015

SCOPE: Method of determination of Fat content.

APPARATUS:

- Soxhlet Extraction Apparatus
- Electric oven
- Weighing balance

PROCEDURE:

- Weigh accurately about 5g of the material in a suitable thimble and dry for 2hours at 100±2˚C.
- Place the thimble in the Soxhlet extraction apparatus and extract with Petroleum Ether (40-60˚C) for 8 hours.
- Dry the extract contained in the Soxhlet flask, the empty mass of which has been previously determined by tareing at 95˚C -100˚C for one hour.
- Cool in a desiccator and weigh.
- Repeat the process of drying, cooling and weighing at half-hour intervals until the difference in mass between two successive weighing is less than two mg
- Record the lowest mass obtained

CALCULATION

$$\text{Fat, percent by mass} = \frac{100\,(M_1 - M_2)}{M}$$

Where M_1 = mass, in g of Soxhlet flask with the extracted fat

M_2 = mass in g of empty Soxhlet flask, and

M = mass in g of the material taken for test.

6.4. DETERMINATION OF CARBOHYDRATES

TEST METHOD: AOAC 20th Edn 2016 986.25

SCOPE: To determine the carbohydrates content.

PROCEDURE: Total carbohydrates are calculated as follows after determining the percentage of moisture, total protein, fat and total ash.

CALCULATION

Total carbohydrates = 100 - (A+B+C+D)

Where A = percent by mass of moisture

B = percent by mass of total protein

C = percent by mass of fat and

D = percent by mass of total ash

6.5. DETERMINATION OF TOTAL ASH

TEST METHOD: IS: 12711:1989; R-2015

SCOPE: To determine the Total ash content.

APPARATUS:

- Crucible made of porcelain
- Furnace
- Weighing balance
- Desiccator

PROCEDURE:

- Weigh accurately about 5g of powdered sample in a crucible.
- Ignite the sample in the crucible with the flame of a suitable burner for about one hour.
- Transfer the crucible into a muffle furnace at 500 ±10°C until grey ash results.
- Cool the crucible in a desiccator and weigh.
- Repeat the process of igniting, cooling and weighing at half-hour intervals until the difference in mass between two successive weighings is less than one milligram
- Record the lowest mass obtained

CALCULATION

$$\text{Total ash (on dry basis), percent by mass} = \frac{100\,(M_2 - M) \times 100}{(M_1 - M) \times (100 - W)}$$

Where M_1 = mass, in g of dish with the material taken for test

M_2 = mass in g of dish with ash

M = mass in g of the empty dish

W = moisture % of the sample

CHAPTER 7

RESULT AND DISCUSSION

The proportion of the final developed product was sample 2, which was 1:1 proportion of ragi and all-purpose flour. The product was of good texture and flavour. Hence, we decided as the final product and sent to proximate analysis. The proximate analysis was done for major nutritional composition such as protien, fat, carbohydrates, iron, and total ash in 200g of the ragi choco rolls.

Chemical analysis was conducted to determine the nutritional composition of the two samples. Parameters measured included protein content, iron content, total fat content, carbohydrate content, and total ash content.

1. **Protein Content:**

   - Sample 2 (finger millet and Nuts- seeds mix) exhibited a significantly higher protein content (6.36%) compared to Sample 1 (all-purpose flour) (4.10%).

   The higher protein content in finger millet suggests it could be a valuable source of protein compared to all-purpose flour, which may be beneficial for individuals seeking to increase their protein intake.

2. **Iron Content:**

   - Both samples had comparable iron content, with Sample 2 (finger millet) slightly higher (3.83 mg/100g) than Sample 1 (all-purpose flour) (3.57 mg/100g).

   Although both samples contain iron, finger millet contains slightly more iron than all-purpose flour. This could be important for individuals at risk of iron deficiency, such as pregnant women and children.

3. **Total Fat Content:**

   - Sample 2 (finger millet) had a higher total fat content (0.43%) compared to Sample 1 (all-purpose flour) (0.07%).

Finger millet has a higher total fat content compared to all-purpose flour. This difference could impact dietary choices for individuals aiming to manage their fat intake.

4. **Carbohydrate Content:**

   - Sample 1 (all-purpose flour) exhibited a slightly higher carbohydrate content (62.55%) compared to Sample 2 (finger millet) (59.49%).

   All-purpose flour has a slightly higher carbohydrate content compared to finger millet. This finding could be relevant for individuals monitoring their carbohydrate intake, such as those managing diabetes.

5. **Total Ash Content:**

   - Sample 2 (finger millet) had a higher total ash content (2.53%) compared to Sample 1 (all-purpose flour) (2.21%).

   The higher total ash content in finger millet indicates a greater mineral content compared to all-purpose flour, which could contribute to its nutritional value.

CHAPTER 8

SUMMARY AND CONCLUSION

This study aimed to develop chocolate ragi rolls utilizing finger millet, all-purpose flour, cocoa powder, and a nut-seed mix comprising roasted and powdered almonds, peanuts, hazelnuts, pumpkin seeds, flaxseeds, and jackfruit seeds. The goal was to achieve the ideal taste, aroma, and nutritional composition by incorporating these ingredients. The rolls were created using a 50-50 ratio of finger millet and all-purpose flour.

Through experimentation and formulation, the researchers combined these ingredients to create chocolate ragi rolls that satisfied sensory preferences while providing essential nutrients. Roasting and powdering the nuts and seeds contributed to the texture and flavor of the rolls, enhancing their overall appeal.

In conclusion, this study successfully developed chocolate ragi rolls that incorporated finger millet, all-purpose flour, cocoa powder, and a nut-seed mix. By utilizing a 50-50 ratio of finger millet and all-purpose flour and incorporating roasted and powdered nuts and seeds, the rolls achieved. The choco ragi rolls is generated in 4 samples based on their ratios (0 + 100%, 25% + 75%, 50%+ 50%, 75% + 25%, 100% + 0).The desired taste, aroma, and nutritional components were assessed to find the better product (50-50).

Future research could explore variations in ingredient ratios or processing techniques to further optimize the sensory and nutritional qualities of the rolls. Additionally, sensory evaluation studies could provide valuable insights into consumer preferences and potential modifications to the recipe. Overall, this study highlights the potential of using locally available ingredients to create innovative and nutritious snack options.

CHAPTER 9

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TEST CERTIFICATE

Date of Issue : 28.03.2024

Page 01 of 01

Issued To:		
Ms. Anjitha L A-05, Type - II Pampa Vihar 2, Palluruthy Kochi-682 006	Sample Code Sample Receipt Date of Analysis Reported Date	: FQLAB/23-24/1425/C2643 : 21.03.2024 : 22.03.2024 - 27.03.2024 : 27.03.2024

Particulars of sample : Choco Ragi Crepe - Main

Condition of Sample : Received in good condition

Customer Sample ID : Nil

Sample Quantity : 210g

Sample Drawn by : Customer

Sample Description : Dark brown colour roll

TEST RESULTS

SL NO.	PARAMETERS	UNIT	TEST METHOD	RESULT
1	Protein	%	AOAC 22nd Edn. 2023; 920.87, Ch.32.1.22	6.36
2	Iron	mg/100g	AOAC 22nd Edn. 2023; 944.02, Ch.32.1.09	3.83
3	Total Fat	%	IS 12711 : 1989; RA 2020, M.10	0.43
4	Total Carbohydrate	%	AOAC 22nd Edn. 2023; 986.25, Ch.50.1.16	59.49
5	Total Ash (on dry basis)	%	AOAC 22nd Edn. 2023; 923.03, Ch.32.1.05	2.53

No.of parameters tested: 5

************ End of the Report ************

For FQLAB AND RESEARCH CENTRE (P) LIMITED

Authorised Signatory
MANOJ P
Sr. Technologist
(Chemistry)
FQL & RC

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Doc.No: FQLAB/F/7801A — **TEST CERTIFICATE**

Date of Issue : 28.03.2024

Issued To: **Ms. Anjitha L** **A-05, Type - II** **Pampa Vihar 2, Palluruthy** **Kochi-682 006**	Sample Code Sample Receipt Date of Analysis Reported Date	: FQLAB/23-24/1425/C2644 : 21.03.2024 : 22.03.2024 - 27.03.2024 : 27.03.2024

Particulars of sample	: Choco Ragi Crepe - Control
Condition of Sample	: Received in good condition
Customer Sample ID	: Nil
Sample Quantity	: 220 g
Sample Drawn by	: Customer
Sample Description	: Dark brown colour roll

TEST RESULTS

SL NO.	PARAMETERS	UNIT	TEST METHOD	RESULT
1	Protein	%	AOAC 22nd Edn. 2023; 920.87, Ch.32.1.22	4.10
2	Iron	mg/100g	AOAC 22nd Edn. 2023; 944.02, Ch.32.1.09	3.57
3	Total Fat	%	IS 12711 : 1989; RA 2020, M.10	0.07
4	Total Carbohydrate	%	AOAC 22nd Edn. 2023; 986.25, Ch.50.1.16	62.55
5	Total Ash (on dry basis)	%	AOAC 22nd Edn. 2023; 923.03, Ch.32.1.05	2.21

No.of parameters tested: 5

************ End of the Report ************

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(Chemistry)

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