Formulation and Development of Value-Added Multi-Nuts and Seeds Spread

AATHITHYA S

(21PFD002)

Thesis submitted to

Avinashilingam Institute for Home Science and Higher Education for Women,

Coimbatore – 641 043

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in

FOOD SERVICE MANAGEMENT AND DIETETICS

MAY 2023

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Signature of the Supervisor

Signature of the Head of the Department

CERTIFICATE

This is to certify that the thesis entitled, "**Formulation and Development of Value-Added Multi-Nuts and Seeds Spread**" submitted to Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore in partial fulfillment of the requirements for the award of the degree of Master of Science in Food Service Management and Dietetics , is a record of original research work done by **Ms. S. Aathithya** with Register Number 21PFD002 during the period of this study under the Supervision and Guidance of **Dr. N. Rekha,** Assistant Professor, Department of Food Service Management and Dietetics, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore – 641 043, Tamil Nadu , India.

Signature of the Supervisor

Signature of the Candidate

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INTRODUCTION

Nuts have historically been a staple ingredient throughout the world. Nuts consumption has been documented as far back as the Stone Age, about 7000 BC. Early records of diets and food consumption suggest that nuts were used by the Romans, Persians, and Arabs to thicken stews and sauces; this practice later spread to Europe. Today, nuts and seeds are still enjoyed all over the world in several ways, including as delicacies, spreads, snacks, and culinary ingredients **(King *et al.*, 2008).**

A study conducted by **Micha *et al.*, 2015** reported that in 2010 globally, the average intake of nuts and seeds in the countries namely Malaysia, Lebanon, United Kingdom were 57.2 g/day, 30.6 g/day, and 14.9 g/day respectively. The most popular country for producing raw nuts is Vietnam, whereas the top country for processing and exporting nuts is India **(Dendena & Corsi, 2014).**

A nut is a dry fruit with one seed and an exceptionally hard pericarp (outer layer of the ovary wall), according to botanical definition. Chestnuts and hazelnuts are included in this definition. Contrary to botanical definitions, culinary definitions frequently refer to the edible portions of plant foods. For nuts, this typically denotes any large, oily kernel enclosed in a shell and suitable for human consumption **(Vainio & Weiderpass, 2006).**

A little plant wrapped in a seed coat is referred to as a seed and serves as the plant's food reserve as it grows. Before eating, the husk must be removed from some seeds, such as sunflower and pumpkin seeds, but not from others, including sesame and poppy seeds. Flaxseeds, poppy seeds, pumpkin seeds, sesame seeds, sunflower seeds, and chia seeds are a few types of seeds that are frequently eaten. Although the classification systems are different, "nuts" and "seeds" have similar nutritional characteristics **(George et al., 2022).**

Increased consumption of fruits, vegetables, and plant-based protein sources like nuts is promoted by national dietary recommendations. A shift to diets that are primarily plant-based can have positive effects on the environment and human health **(Behrens *et al.*, 2017).** According to **(King *et al.*, 2008)** 42 g daily serving of nuts contains more than 10% of the recommended daily intake of protein, fiber, and various vitamins and minerals, making them a crucial part of sustainable diets**.**

Surveying reliable data on nut intake is becoming more important as interest in the health benefits of nut and seed consumption increases. Dietary intake surveys can provide

information on a person's consumption of nut varieties, determining a person's total nut intake is challenging due to the fact that nuts are consumed not only in their whole form and as spreads but also as ingredients in foods and manufactured goods (bread, cereals, sweets, candy, etc.) **(Jenab *et al.*, 2006).**

Silberbauer & Schmid, 2017 states that in recent days, the demand from consumers for quick-to-prepare dishes is raising. Many people are eager to purchase ready-to-eat foods as a result of the fast-paced lifestyle of today. Certainly, due to their convenience and quick preparation time, ready-to-eat (RTE) food products are growing in popularity.

According to **(Rohini *et al.*, 2021)** spread is a savory paste that can be applied to other dishes. It is typically eaten with bread, toast, and other similar pastries like pancakes and pasta. The spread has a higher fat content, which adds shortening, richness, and tenderness, and improves mouthfeel, flavor, and perception.

Consuming plant foods, such as nuts and seeds, increases the nutritional value of diet and may help avoid chronic illnesses, particularly if we are exposed to environmental toxins. Phytonutrients are nutritive substances found in plant-based foods. Some plant chemicals have only recently been studied. There is no Recommended Dietary Amount (RDA) for phytonutrients, in contrast to vitamins and minerals **(Gaetke et al., 2010)**.

The advantages of regularly eating nuts for health are adequately supported by research. Nuts have been used for a long time as a nutrition management technique for malnutrition, which has expanded to older adults, in developing nations. For instance, studies have demonstrated the value of nuts for the prevention and management of a variety of chronic diseases, including cardiovascular disease (CVD), type 2 diabetes, non-alcoholic fatty liver disease, and cognition, either as an individual dietary component or as part of healthy dietary patterns.

In general, children are restless and exhibit a dislike to eat for long hours of time. To manage this Quick-to-eat, nutritious dishes should be offered on menus. Additionally, children's appetites fluctuate, and they favor light snacks over substantial meal. Since most kids prefer sweeter foods, they frequently eat sweet spreads such as jams, marmalades, and chocolate spreads, which are high in carbohydrate and fat contents and poor protein and vitamin content. Different nuts and seeds spreads are sold in the market and fall into the category of sweet spreads, but few people are aware of the advantages it has over other sweet spreads in terms of health **(Iserliyska *et al.*, 2005)**.

Spreadable foods prepared from nuts that have been mashed into a paste are known as nut butter and nut spreads. Nut products can be spread similarly to commercial butter. Almonds, cashew, hazelnut, macadamia nut, peanut, pecan, pistachio, and walnuts can all be used to make them. Other seeds, such as sesame, pumpkin, soybean, and sunflower, can also be used to create similar products. Although nut spreads have several applications, making sandwiches is the most popular one. Other applications include serving as vegetable dips or toppings for edible crackers. In addition, there are several baking and cooking uses for nut spread **(Mangels, 2001)**.

Freitas *et al.*, 2012 states that the health-promoting poly-phenolic flavonoid antioxidants carotenes, resveratrol, lutein, cryptoxanthin, etc. are abundant in nuts and seeds. Oil seeds and nuts have a high level of fat in addition to being high in protein as pulses do. As a result, they are excellent sources of protein as well as concentrated sources of energy and can give kids the right nutrients to support their growth and development. They have a high concentration of B vitamins. They contain high concentrations of all the necessary omega-3 essential fatty acids, including linoleic acid, alpha-linolenic acid (ALA), eicosapentaenoic acid, and docosahexaenoic acid.

Nuts and seeds are excellent providers of fats and protein. Also, due to their distinctive flavours, nuts and seeds are frequently consumed as food and used for their oil content in butters and biscuits. Due to their high vitamin B and E content, nuts and seeds are profitable and possess to have anti-aging properties **(Chung *et al.*, 2013)**.

Seventy to eighty percent of the fatty acids frequently found in nuts and seeds are important fatty acids, which are parts of the plasma membrane and contain a lipoprotein called lecithin in brain cells. As a result, nuts and seeds are great sources of nutrition for growing kids and tasty snacks for adults **(Kim *et al.*, 2000)**.

The incidence of obesity, cardiovascular disease (CVD), diabetes, cancer, and other harmful diseases has recently been linked to changes in food habits and enhancements in quality of life. These illnesses are linked to elevated plasma lipid levels, thrombosis, oxidized LDL cholesterol, and the production of free radicals **(Chung *et al.*, 2013)**.

For cardiovascular disease (including coronary heart disease incidence and mortality, atrial fibrillation, and stroke mortality), eating 28 g of nuts per day was associated with a 21% risk reduction, for cancer deaths it was associated with an 11% risk reduction, and for all-cause

mortality it was associated with a 22% reduction. Also, eating nuts was linked to a lower chance of dying from diabetes, viral diseases, and respiratory illnesses **(Balakrishna *et al.*, 2022).**

The healthiest fat for the body is found in nuts because it is entirely natural and unprocessed. It is the least harmful to the heart and arteries and is particularly high in linoleic acid (Omega-3). As a matter of fact, it accounts for around 47% of the nut's overall weight. Half the weight of nuts is frequently produced as oil **(Akinhanmi *et al.*, 2008).**

Nuts can be preserved during lengthy winters to give a consistent food supply throughout the year. It is a more reliable food source than smaller, less hearty cereal grains that would have been harmed by extreme weather, and provides energy, necessary fatty acids, protein, and crucial micronutrients. Since ancient times, nuts have also been utilized as medicine **(Dreher *et al.*, 1996).**

Nuts are low in saturated fats and cholesterol and high in unsaturated fatty acids, dietary fiber, proteins, antioxidants, vitamins E, B6, folic acid, and niacin. They are also rich in minerals including magnesium, zinc, iron, copper, selenium, phosphorus, and potassium. Almonds, cashews, brazil nuts, pistachios, walnuts, peanuts, and Brazil nuts are among the widely consumed edible nuts **(De, 2020).**

As seeds are a high source of fiber, protein, iron, zinc, and vitamins, they can be used in place of meat, fish, and eggs. Most edible seeds assist in regulating body weight and lowering the risk of diabetes, heart disease, and other illnesses. Flax seeds, which are rich in Omega 3 fatty acids and fiber, can enhance immunity and gives us more energy. Zinc-rich pumpkin seeds aid in the growth and operation of the body's white blood cells that fight infections **(Sarwar, 2011).**

Oilseeds have a high fat, protein, and fiber content but a low amount of digestible carbohydrates. These characteristics have been linked to lower blood sugar and insulin levels, low glycaemic index, and high levels of satiety **(Kim *et al.*, 2017).**

By promoting fullness, quenching appetite, and balancing energy expenditure, nuts assist in controlling weight through fat absorption in the body. Because nuts are a great source of fiber, protein, healthful unsaturated fats, phytochemicals, vitamins, and minerals, frequent nut consumption is linked to a lower risk of death from heart disease. Nuts are the best source of monounsaturated and polyunsaturated fats, as well as having a low content of dangerous saturated fats **(Ros, 2010).**

Nutrients abound in raw nuts and seeds. They contain plant proteins and plant sterols that naturally decrease cholesterol as well as lignans, bioflavonoids, minerals, and other antioxidants that preserve the delicate freshness of the lipids within.

Nuts contain tocopherols, phytosterols, folic acid, and some minerals, such as selenium or magnesium, which give them their anticarcinogenic and antioxidant characteristics. Nuts include polyphenols including ellagitannins and urolithins that increase their anticancer effects **(Roman *et al.*, 2022).**

Additionally, because nuts and seeds contain certain fibers, phytochemicals, phytosterols, and bioactive nutrients (including polyphenols and arginine) that are absent from other foods, they have additional positive benefits that reduce blood vessel inflammation **(Fuhrman, 2015).**

Almonds are said to be a rich source of Energy, Protein, Vitamins, Minerals, Fats and Free fatty acids. Compared to meat, almond is a good source of Protein. The abundant minerals including Calcium, Magnesium, Phosphorous, and Potassium significantly maintain blood pressure, bone and teeth development, and blood production a significant source of amino acid leucine, phenylalanine, and tyrosine **(Ozdemir et al., 2016).**

Copper, a vital mineral, is also abundant in almonds. Hematopoiesis is mostly reliant on copper (production of blood cells). Additionally, almonds contain a lot of phytosterols. Fatty acids, phenolic acids, or glycosides can be esterified with phytosterols or present in their free form.

The eating of almonds has a hypocholesterolemic benefit because of the beneficial fat content and fiber. Almonds are expected to reduce various modifiable cardiovascular and diabetes risks, including body weight, glucose homeostasis, inflammation, and oxidative stress, as a result of their distinctive nutritional content **(Kamil and Chen, 2012).**

Walnuts are the true species of the genus Juglans. Across the world, walnut consumption is widespread. The nuts are incredibly nutrient-dense and contain a wide range of phytochemicals, such as phytosterols, phenolics, tocopherols, and carotenoids.

Walnuts are distinguished by high antioxidant activity and possess numerous bioactivities that may be significant to human health as a result of the presence of these phytochemicals. These substances may work in a variety of ways to help prevent certain malignancies from developing, lifestyle-related illnesses from occurring, and the onset of

inflammation. Walnuts are one of the extremely nutrient-rich oil nuts. These are frequently used as food ingredients in dishes including baklava, Circassian chicken, chicken in walnut sauce, walnut pie, brownie, fudge, and ice cream**.** Traditional uses for walnuts include treating stomachaches, coughs, helminthiasis, and diarrhea **(Nguyen and Vu, 2021; Duke, 2001; Galus & Kadzińska, 2016).**

Cashew nuts have a huge amount of unsaturated fatty acids. The presence of MUFA and PUFA in cashew consumption promotes decreased risk of Coronary Heart Disease, Cancer, Diabetes, and Obesity. It protects the heart, maintains healthy bones, prevents the formation of gallstones, and is good for healthy eyes **(Vyavahare*et al.*, 2020).**

Research shows that cashew nuts are highly important for health and are utilized for a variety of medical applications. These are applied in the treatment of a wide range of clinical conditions, including bone relaxing, cold and flu, diabetes, heart disease, urinary and digestive diseases, and obesity. It is crucial for cancer treatment and anti-aging **(Iqbal *et al.*, 2021)**.

The pumpkin, a well-known edible plant that is a member of the Cucurbitaceae family, has long been utilized as a functional food and act as a herbal remedy. The main component of pumpkin seeds is a variety of unsaturated fatty acids, which may help prevent disease and improve health. The essential phytoestrogen chemicals secoisolariciresinol and lariciresinol, which have estrogenic-like effects such as reducing hyperlipidemia and osteoporosis for menopausal women, are also present in pumpkin seeds **(Lestari & Meiyanto, 2018).**

Syed e *et al.*, 2019 report that in a selected part of Mexico, Canada, the United States, China, and Europe, seasoned and roasted pumpkin seeds are eaten as a snack. They have a distinctive flavour and pleasant taste. Pumpkin seeds are rich in iron, protein, manganese, magnesium, zinc, potassium, copper, phosphorous, PUFA (polyunsaturated fatty acids), c-tocopherol, and carotenoids.

The watermelon (Cucumis melo) is a large fruit with an oblong, oval, or round shape that belongs to the cucumber family (Cucurbitacea). Depending on how it is prepared, watermelon can be eaten for breakfast, as an appetizer, or as a snack. It is a very rich source of vitamins **(Kerje and Grum, 2003).**

There are a lot of seeds in melon fruit. The kernels are occasionally used as a topping for bread, cakes, confections, sweetmeats, and snack items, frequently taking the place of pistachios and almonds. The seeds can be roasted, crushed, and fermented and is used as a

flavour enhancer in gravies and soups in African countries. The seeds can also be cooked, ground, and served as snacks in Egypt and Iran **(Koocheki *et al.*, 2007).**

Protein, B vitamins, minerals (including magnesium, potassium, phosphorus, sodium, iron, zinc, manganese, and copper), and fat are all found in watermelon seeds, in addition to other nutrients (**Braide *et al.*, 2012).**

Due to the high concentrations of linolenic acid (ALA, an omega-3 fatty acid), lignans, and fiber in flaxseed, it is becoming a vital functional dietary ingredient. A reduction in cardiovascular disease, atherosclerosis, diabetes, cancer, arthritis, osteoporosis, and autoimmune and neurological disorders is one potential health effect of flaxseed oil, fibers, and lignans (**Goyal *et al.*, 2014**).

The primary classification of flaxseed is oilseed crop. Furthermore, additional nutritional factors outside its oil content make it a more preferable option for food technologists to create functional foods. While lysine, methionine, and cystine are the limiting amino acids, flaxseed proteins are comparatively abundant in arginine, aspartic acid, and glutamic acid. Dietary fibre from flaxseed has beneficial effects on reducing constipation, maintaining healthier bowel movements, and acting as a hypocholestermic agent **(Ganorkar & Jain, 2013).**

Around 863 000 tonnes of date seeds were produced worldwide in 2004. Large amounts of date seeds are discarded primarily utilised as animal feed for camels, cattle, sheep, and poultry. In addition, a caffeine-free beverage with a coffee-like flavour is made on a very small scale using date seeds **(Habib & Ibrahim, 2011).**

Diabetes, cardiovascular conditions, and cancer are the most common causes of illness and mortality worldwide. One of the fundamental mechanisms in the emergence and progression of chronic diseases is oxidative stress. Due to their antioxidant characteristics, polyphenols, which are particularly present in date seeds, can aid in the emergence of chronic diseases (**Habib *et al.*, 2017).**

Lauric acid ranges from 0.56 to 5.4% in date palm seeds. The seed, which makes up 11–18% of the weight of date fruit, is made up of protein, carbs, dietary fiber, fat, and ash.

Dietary fiber, protein, carbs, phenols, and minerals make up the majority of the date seed's ingredients (potassium, magnesium, calcium, phosphorus, sodium, and iron). From a biological perspective, these compounds carry out a variety of tasks, including antioxidant, antibacterial, and antiviral properties **(Mrabet *et al.*, 2020).**

Honey is a sweet, flavourful liquid that is made by Apis mellifera from the nectar of flowers. Honey is an organic natural material. It has sugars, traces of proteins, enzymes, amino acids, minerals, vitamins, aroma compounds, and polyphones in tiny amounts. All generations, traditions, and civilizations both old and modern accept it extensively as food and medicine **(Liyanage & Mawatha, 2017).**

Due to the presence of number of nutrients and multiple health benefits in nuts and seeds, they are added in the development of multi-nuts and seeds spread. Hence, the addition of nuts and seeds will enhance the overall quality of the spread.

The value-added multi nuts and seeds spreads are loaded with essential nutrients namely protein, fat, vitamins, and minerals. They are rich in antioxidant that helps to fight against free radicals and prevent several non-communicable diseases. Phytochemicals present in nuts and seeds aids in the overall health benefit of an individual.

Hence the study titled, "Formulation and Development of Value-Added Multi-Nuts and Seeds Spread" was carried out with the objectives as follows,

Primary Objective:

- To formulate and develop a nutrient-rich multi nuts and seeds spread as a healthy option.

Secondary Objective:

- To develop a nutrient-rich spread with different variations.
- To enhance the functional property of spread by incorporating different nuts and seeds.
- To analyse the acceptability and nutritive value of the developed product.
- To find out the shelf life of the spread.

II. REVIEW OF LITERATURE

The literature pertaining to the study on **"Formulation and Development of Value-Added Multi-Nuts and Seeds Spread"** is reviewed under the following headings:

A. Overview of Nuts and Seeds Spread
B. Morphology of Nuts and Seeds
C. Nutritional quality of Nuts and Seeds
D. Health Benefits of Nuts and Seeds
E. Anti-Nutritional Factors in Nuts and Seeds

A. Overview of Nuts and Seeds Spread

The growing desire for healthier foods has resulted in the substitution of animal-based foods for plant-based foods. Consumers today are looking for products that provide more health benefits, which has resulted in a significant increase in consumer awareness and interest in the health-enhancing roles of specific foods or food components. Many households use margarine as a spread, but due to health practitioners' concerns about the trans-fats in margarine, its use is discouraged. In contrast, cashew nuts are high in macro- and micronutrients, phytochemicals, tocopherols, and phenolic compounds.

Analyzing the nutritional composition of nuts revealed that they are high in unsaturated fatty acids, fiber, minerals, and proteins, making them healthy foods. Additionally, consuming them is linked to a lower risk of diabetes and cardiovascular disorders, which are prevalent today. They include essential fatty acids, which are crucial for the body's healthy operation and are crucial for controlling a number of metabolic, transport, and excretion activities. The formulation of a nut spread may increase consumer awareness of a healthy breakfast or snack option while also enhancing the culinary applications of nuts **(Damian Laryea *et al.*, 2018).**

Malnutrition often affects all groups in a community, but new borns and young children are the most vulnerable due to their high nutritional requirements for growth and development. Poor economic circumstances is not necessarily the cause of undernourishment. One of the main causes of undernourishment persisting among medium and high income groups as well is a lack of resources and awareness **(Kaur & Maruf 2018).**

A plant-based diet can be defined as an eating pattern dominated by fresh or minimally processed plant-based foods and reduced consumption of meat, eggs, and dairy products.

Legumes, nuts and seeds versus a meat-heavy diet. Diets that emphasize greater consumption of plant-based foods are increasingly being recognized by health authorities as having important health benefits, including a reduced risk of diseases such as heart disease, various cancers and type 2 diabetes **(Lea *et al.*, 2006)**. Health concerns are increasingly influencing people's dietary preferences as the world is threatened by diseases like obesity, diabetes, and other lifestyle-related illnesses. Given this, individuals will have a healthier spread option to choose from plant-based spread **(Kulkurani & Soni, 2014)**.

Nuts that have been roasted and salted are rarely consumed. Children and the elderly find it difficult to open and eat nuts like pistachios. The storage and handling of nuts after processing and before consumption is another issue that affects the product's quality. Numerous findings indicate that mycotoxins, particularly aflatoxin, are present in nuts. The key factors contributing to an increase in fungal growth and aflatoxin formation are increases in moisture content, atmospheric temperature, and relative humidity **(Campbell *et al.*, 2003*)***.

Some data suggests that contamination can happen during export, marine transport, or storage in an imported country. Nuts cannot be consumed by people if their \total mycotoxins (particularly aflatoxin, B1) levels above the maximum permissible threshold. There have been occasional reports of nuts being rejected for export because of aflatoxin levels. The risk of product losses due to contamination with mycotoxins can be decreased by creating new products (like nut spread) from nuts and utilising proper packing materials. The development of nut spread could expand the range of foods that can be made with nuts and offer consumers a better, vegan breakfast snack option **(Shakerardekani *et al.*, 2013)**.

For millennia, nuts and seeds have been a staple of diets throughout the world. Nuts and seeds are extremely nutrient-dense food items that are high in MUFAs and PUFAs, proteins, and fibres. Additionally, they include a variety of active metabolites such phenolic acids, phytosterols, carotenoids, and polyphenolic compounds, as well as a wealth of vitamins and minerals. Polyphenols, one of the substances contained in nuts, has been shown to have antioxidant, antibacterial, and antiproliferative qualities. Ancient therapeutic practices made use of nuts; Hippocrates, for instance, described almonds as a cure for colds and coughs **(Casas-Agustench *et al*., 2011)**.

Tree nuts and peanuts are the two botanical subgroups of nuts. Almonds, walnuts, hazelnuts, cashews, Brazil nuts, macadamias, and pistachios are some examples of commonly eaten tree nuts. Nuts have hard shells that protect the seed. Although peanuts are botanically

classed as legumes, they share numerous compositional and nutritional characteristics with tree nuts despite having a different culinary application. Both the varieties of nuts and seeds preferred, and the amounts ingested vary across cultural contexts, with larger intakes generally reported in Canada, several African nations, regions of Europe, and the Middle East, and lower intakes in South America **(Balakrishna *et al*., 2022)**.

Nuts and seeds are food ingredients that are dried and have minimal water in them. They are rich in many nutrients because of their evolutionary adaptability to the plant embryonic nourishment from which they originated. Different nut and seed species have different chemical compositions, particularly in terms of the amounts of proteins, carbohydrates, and lipids, as well as qualitative makeup. Low levels of saturated fatty acids and high levels of mono- and polyunsaturated fatty acids (MUFAs and PUFAs), including n-3 and n-6 acids, are two characteristics of nuts and seeds.

They also contain significant amounts of magnesium and vitamin E. By serving as one of the body's most vital antioxidants, vitamin E defends the immune system. In turn, magnesium is involved in a number of important processes. Studies have revealed that while its low serum level may contribute to the development of metabolic syndrome, its deficiency may cause arterial hypertension, diabetes, heart disorders, and depression. Additionally, nuts include a lot of dietary fiber that may help lower postprandial glycemia **(Lozna *et al.*, 2020)**.

Nuts and seeds are significant dietary sources of minerals because they store these compounds during plant growth and employ them for future growth demands. The nutrients in plants vary based on the type of plant, farming methods, soil and climate conditions, as well as technological and gastronomic techniques. Because of their high levels of fat and protein as well as the fact that they are a rich source of minerals, these products are becoming more and more popular around the world.

Products having naturally low sodium and high potassium content include nuts and seeds. Clinical studies and meta-analyses of their findings reveal that a high intake of potassium is associated with lowered blood pressure in both arterial hypertension patients and healthy individuals. However, there is no clear scientific proof that adding potassium to your diet would lower your blood pressure. Therefore, potassium-rich food products such as fruit, vegetables, and nuts are advised for people without kidney problems instead of dietary supplements that contain this mineral **(Ndanuko *et al.*, 2017).**

The advantages of regularly eating nuts for health are amply supported by research. Nuts have been used for a long time as a nutrition management technique for malnutrition, which has expanded to older individuals, in developing nations. For instance, studies have demonstrated the value of nuts for the prevention and management of numerous chronic diseases, either as an individual dietary component or as a part of good dietary patterns. Dietary guidelines frequently suggest including nuts and seeds as a component of a balanced diet, for instance as meat substitutes. Important to take into account given the rise in popularity of foods containing seeds in our food system, such cereals, granola, linseed sunflower almond (LSA) mix, muesli, and snack bars **(De Souza *et al.*, 2017)**.

The regular consumption of nuts has been shown to be associated with multiple health benefits. First, lower CVD risk has been reported with habitual nut consumption. The potential mechanisms that explain the protective effects of nuts against CVDs have been reported in detail in a previous review, which include lowering blood cholesterol and blood pressure, improving vascular function and oxidative stress in the body; benefits that are proposed to be due to the unsaturated fat, antioxidant, and polyphenolic content of nuts. Nuts have also been reported to reduce inflammation.

Second, nut intake has been shown to play an important role in body weight regulation, through the regulation of appetite and food intake, increased postprandial energy expenditure and fat oxidation, and lower-than-expected fat absorption. Third, nut-enriched diets have been shown to reduce postprandial glycaemic responses to carbohydrate meals, and lower acute and long-term fasting insulin and reduce insulin resistance, although no effect was found on fasting glucose or glycated haemoglobin.

Fourth, there is emerging evidence that nuts improve cognitive function and may lower rates of depression. It was proposed that the benefits of nuts on cognition may be via reducing inflammation and improving vascular and endothelial function, which subsequently improves cerebral vascular function **(George *et al.*, 2022)**.

B. Morphology of Nuts and Seeds

The almond is indigenous to Western and Central Asian countries. It has been grown in China since the 10th century B.C. Since the fifth century B.C., it has also been cultivated in Greece. Almond is mostly grown in the Kashmir area of India, where it is one of the main crops. Prunus amygdalus L., a Rosaceae plant, produces almonds as one of its products (rose family). Almonds were once assigned to the Prunoideae (sub-family), but they are typically

kept in their own family now (*Amygdalaceae or Prunaceae*). There are two main varieties of almonds grown for commerce: bitter almonds (*Prunus amygdalus amara*) and sweet almonds (*Prunus amygdalus dulcis*). Based on the colour of their flowers, plants that produce both bitter and sweet almonds can be distinguished **(Abdullah & Hussain (2017)**.

In hotter areas of the world with extensive summers, such as California, Persia, Spain, Italy, Morocco, Australia, Kashmir, India, Afghanistan, Armenia, and Pakistan, almond trees are frequently grown. In 2017 and 2018, the production of almonds can reach 1.2 million metric tonnes. About 81% of the almonds produced worldwide are grown in California (USA), with the next-largest producers being Australia (7%), Spain (4%), Tunisia, and Iran (1%) **(Potter *et al.,* 2007)**. The optimal soil for almonds is well-drained soil with a light to medium texture. Almonds do not grow well on thick or poorly drained soils **(Verma 2014)**.

Walnuts are tree species of the genus Juglans, which belongs to the small family Juglandaceae. English walnut (*J. regia L.*) and black walnut are the most commercially cultivated walnuts valued for their high-quality hardwood products and edible nuts (*J. nigra L.*). English walnut (also known as Persian walnut) is primarily grown in California (the United States), as well as throughout much of Europe and China. Black walnut (BW), an endemic deciduous tree species of North America, is found throughout the central and eastern United States. Unlike English walnut (EW), BW has a relatively spherical, thick, and hard shell that makes removing the kernel from the shell more difficult **(Nguyen & Vu, 2021)**.

Walnut is a fruit that contains many of the essential nutrients that people require for good health. Because, like other hard shell fruits, walnut is a seed, and all seeds are extremely nutrient dense. Thus, consuming a handful of raw walnuts per day provides the majority of the proteins, fat, antioxidants, vitamins, and minerals that a person requires each day. As a result, we must consider walnut as an enriched food in terms of beneficial substances for health. Because the botanical structure of walnut is similar to that of the human brain, it is classified as a brain nutrient.

Many phytochemical substances can be found in walnuts. When we eat enough walnuts on a daily basis, we can see that walnut is an excellent disease preventer. Walnut desserts have been popular for thousands of years due to their walnut flavour and medical benefits. Those who use walnut are well aware of its numerous applications as a food additive or as a pure food item, and because it is known as a perfect brain nutrient, they can't live without it in their pockets and meals **(Sen, 2013)**.

People have a common misconception about hard shelled fruits. Many people avoid eating hard shell fruits out of fear of gaining weight. Truly, walnuts have a high calorie content.

Theoretically, most hard shell fruits and seeds are ideal food stores in their raw state. In raw and organic form, walnut, the most valuable of all hard shell fruits, contains a wide range of healthy substances. The most important and outstanding nutritive properties of walnut are that they feed and support the brain and nervous system. Walnut can be thought of as a food drugstore that prevents the harmful health effects that other types of food, including vegetables, can cause **(Sen & Karadeniz, 2015)**.

Walnut can be eaten raw, unprocessed, but it can also be eaten roasted, salted, and flavoured. Because the inner part of a walnut has a pleasant flavour, it can be used as a flavour enhancer in yoghurt, pizza, cake, or it can be sprinkled on salad, dessert, especially walnut ice cream and other ice creams. One of the many uses for walnuts is in the candy industry, where it is added to biscuits, cakes, and desserts. In Middle Eastern countries, walnut is combined with almond, date, and grape to make a cake called Mamoul in Ramadan **(Sen, 2011)**.

A handful of walnuts per day contains twice the amount of antioxidants and vitamins as other hard shell nuts. However, people generally consume other hard shell nuts besides walnuts. Walnuts, in fact, must be included in healthy nutrition programmes **(Vinson *et al.*, 2012)**.

In Africa and the West Indies, the cashew nut (Anarcadium occidentale) is a popular fruit with a heart-like form. The Brazilian cashew tree is a valuable economic crop in the United States, the West Indies, Madagascar, India, and Malaysia. Tanzania, India, Mozambique, Sri Lanka, Kenya, Madagascar, Thailand, Malaysia, Nigeria, Malawi, and Angola are the main cashew producing nations.

According to World Bank data, only 3% of production comes from established plantations while 97% comes from wild trees. With an annual production of roughly 100,000 tonnes, Africa is the third-largest supplier of cashew nuts in the world (Spare 1997). Cashew production trends are linked to consumer trends, which in turn depend on the state of the global economy **(Ojinnaka & Agubolum, 2013)**.

The "healthy fat" found in cashews is referred to the ratio of saturated to monounsaturated and polyunsaturated fats in cashews is 1:2:1, which is excellent for human consumption. The relative abundance of monounsaturated fatty acids in cashew nuts contributes to the development of good health, and their relative fat richness in no way compromises their nutritious value. The benefit of cashew kernel is that it has a delicious, meaty flavour and is suitable just as it is **(Akinhanmi *et al.*, 2008)**.

At least 60 percent of cashew kernels are believed to be consumed as salted nuts, however the relative importance of these uses changes from year to year and country to country. Cashew nut sales must be driven by a strong consumer desire for flavour because they are substantially more expensive than peanuts or other snacks. The fact that cashew nuts are typically seen as a luxury good may contribute to some of their attraction **(Azam-Ali & Judge, 2001)**.

The dark greenish hue and distinctively potent nutty and roasty flavour of pumpkin seed oil are its distinguishing features. Because of its chemical makeup, particularly the fatty acids. Temperatures of 100 to 130 C are used during the roasting process, and the typical aroma, which is characterised as nutty, roasty, spicy, "warm," slightly green, and fatty, is created. It is interesting that there is no information in the literature about the flavour changes that occur while pumpkin seeds roast because the roasting process is what creates the scent. Furthermore, no scientific research has been done to clarify the temperature ranges required to produce the product's typical aroma **(Syed *et al.*, 2019)**.

The watermelon, Cucumis melo, is a large fruit with an oblong, oval, or round shape that belongs to the cucumber family (Cucurbitacea). Smooth, dark green rind or occasionally pale green lines that turn yellowish green when ripe are present on the skin. Depending on how it is prepared, watermelon, which is a highly rich source of vitamins, can be eaten for breakfast, as an appetiser, or as a snack. One of the most commonly overlooked fruits growing in the tropics is the watermelon. While the rind and seeds of the watermelon constitute significant solid wastes, the juice or pulp is used for human consumption. The rind is used to extract pectin and to make items like pickles and preserves **(Koocheki *et al.*, 2007)**.

In practically all of Africa and South East Asia, watermelon is a common fruit. At least 4000 years ago, the watermelon was assumed to have been domesticated in Africa. Watermelons are grown on more than 1.3 million hectares globally, with China and the Middle East producing the majority of them (68.9%). Turkey (4.7%), Iran (2.3%), the United

States (2.2%), and Egypt (1.7%) round out the top five. The fruit of the watermelon is big, smooth, and has a range of shapes, from round to cylinder. The skin may be entirely green or green with yellow stripes. Typically pink in colour, the edible pulp contains several flat, oval, black seeds **(Addo *et al.*, 2018*)***.

It is well recognised that watermelon seeds have positive economic effects, particularly in nations where agriculture is expanding. For example, the seeds can be used to make sauces, flour, and snack foods. The oil from the seeds is utilised in cosmetic manufacturing as well as in cooking. Despite the many possible uses, watermelon seeds are frequently thrown away as the fruit is consumed **(Tabiri *et al.*, 2016)**.

Flaxseed, or Linseed (Linum Usitatissimmum), is a blue blooming rabi crop and a member of the Linaceae family. It is also referred to as Alsi, Jawas, and Aksebija in Indian languages. 3.06 million tonnes of flax were produced annually, and Canada, which accounts for 38% of global production, is the greatest producer in the world. Around the world, flaxseed is produced as an oil crop or a fibre crop, with fibre variants producing linen from the stem and linseed variations producing oil from the seed.

Flaxseed has a delightful nutty flavour and a crisp, chewy texture. Beyond its potential to produce oilseeds, flaxseed's close composition makes it more promising for use in many culinary preparations. One of the richest vegetarian sources of soluble mucilage and linolenic acid (an omega-3 fatty acid) is flaxseed. As consumer knowledge of health issues has grown, functional foods have become increasingly popular in the modern day. Flaxseed is a versatile, top-notch source of nourishment **(Ganorkar & Jain, 2013)**.

The Middle East and the Kingdom of Saudi Arabia have large populations of people who are familiar with dates (the date palm/dates). The date palm was historically significant. Around 4000 BC, it is believed that this plant originated on the plains of Mesopotamia, Palestine, or northern Africa (Morocco). Since 3000 BC, it has expanded into parts of Egypt, Africa, Central Asia, and the neighbourhood **(Wahini, 2016)**.

The date palm, also known by its formal name Phoenix dactylifera L., is a significant member of the Palmacea family. Date varieties come in approximately 2000 various shapes, sizes, and weights. They are typically oblong in shape, though some kinds can be nearly spherical. The average weight per fruit is 260 g, and the length spans from 1.8 to 11.0 cm and the breadth from 0.8 to 3.2 cm. The features of the seed vary widely depending on type, as well as on the location and growing conditions, just like those of the fruit. The seed's weight

is between 0.5 and 4 g, its length is between 1.2 and 3.6 cm, and its breadth is between 0.6 and 1.3 cm **(Al-Farsi et al., 2011)**.

The seeds are still mostly used as animal feed. Date seeds are dried, roasted, and ground similarly to coffee beans to make a coffee-like product that is caffeine-free. In body creams, shampoos, and shaving soap formulations, date seed oil has been used to replace some of the other vegetable oils, and the quality of these cosmetic formulations is generally favourable **(Bouaziz et al., 2008)**.

The date palm belongs to the Arecaceae family, which has seeds with only one institution (monocots). Date seeds are either odourless or tasteless and have a little bitter after taste. It has both light and dark brown tones in general. Various studies on date seeds have recently been published. The composition of macro and micronutrients, the composition of phenolic acids, as an ingredient in bread, and protein solubility are only a few of the functional qualities of date seed that have been reported to be used for both food and non-food items **(Rahman et al., 20017)**.

C. Nutritional quality of Nuts and Seeds

The Corpus Hippocraticum, a collection of medical writings, was written by the Greek physician Hippocrates, who is regarded as the "father of medicine." In this work, the medicinal benefits of almonds are first addressed. In his journal, he writes, "Almonds are burning but nourishing; nutritious because they are fleshy and burning because they are oily." Almonds would have been classified as a hot and dry diet, or a food that stimulates choler in the body, in the Greek system of humoral physiology.

The dietary quality of almonds is significantly influenced by harvesting, storing, and processing techniques. Consumers use almonds in all of their varieties, including roasted, raw, and sliced varieties. In addition to being used to prepare a range of sweet (cereals, biscuits, and cakes) and sour (salads, tajines, and curries) foods, they are primarily eaten as snacks. Roasting, blanching, particle size reduction, and oil extraction are methods used to process almonds. Almonds are heated during roasting, which results in dehydration **(Harris & Ferguson, 2013)**.

Walnuts are particularly vulnerable to oxidative rancidity due to their high quantity of polyunsaturated fatty acids, which results in oil that has an unpleasant flavour and is discoloured. It offers significant amounts of potassium (316.7 mg per 100 g), phosphorus

(316.7 mg per 100 g), magnesium (168.3 mg per 100 g), and vitamins (2.5 mg per 100 g) **(Chatrabnous et al., 2018)**.

Walnut, mineral composition indicated potassium (4029.14 mg/kg), sodium (3480.00 mg/kg), Calcium (3014.28 mg/kg), magnesium (726.11 mg/kg), iron (68.00 mg/kg), zinc (24.01 mg/kg), manganese (19.00 mg/kg), and copper (14.00 mg/kg). The nut to have alkaloids (2.29 mg/100 g), glycoside (2.19 mg/100 g), saponins (8.07 mg/100 g), flavonoids (0.02 mg/100 g), tannins (0.89 mg/100 g), reducing sugars (4.10 mg/100 g), and soluble carbohydrate (1.06 mg/100 g) **(Oke et al., 2020)**.

In cashew kernels, weighing 100g there are 18.22g of protein, 27.13g of carbs, and 46.92g of fat. In every gram of cashew kernels, there are 2.123 grams of arginine, 0.456 grams of histidine, 0.928 grams of lysine, 0.508 grams of tyrosine, 0.951 grams of phenylalanine, 0.375 grams of cystine, 0.365 grams of methionine, 0.688 grams of threonine, and 1.09 grams of valine. All the essential amino acids are present in cashew kernel protein, which is also high in glutamic acid, aspartic acid, and arginine.

Unsaturated fatty acids like oleic acid (73.7%) and polyunsaturated fatty acids like linoleic acid (7.67%) are abundant in the lipids of cashew kernels. 11.2% of the substance contains stearic acid. The ratio of unsaturated to saturated fatty acids in triglycerides, monoglycerides, glycolipids, and phospholipids, respectively, is 5.9, 3.0, 0.008, and 2.0. Cashew kernels are low in cholesterol and contain a significant amount of oleic acid, a monounsaturated fatty acid that is now thought to be just as effective as polyunsaturated fatty acids in decreasing cholesterol. The cashew nut has no anti-nutritional ingredients.

The calorie content of cashew kernels is 611 kcals per 100g, which is quite similar to the energy content of almonds (612 kcals per 100g). Additionally, it includes minerals like calcium, phosphorus, sodium, potassium, potassium, magnesium, iron, copper, zinc, and manganese. Zinc (51 g/g) and Copper (21 g/g) are both present in cashew kernels **(Allen *et al.*, 1977)**.

This heat treatment peels almond skin using both dry and moist approaches. Blanching diminishes the nutritional value of almonds because it removes the skin, which is an important source of flavonoids and phenolic compounds. Almonds that have been blanched have more moisture than almonds that have been roasted. Almonds that have already been roasted and blanched can be further processed to change their size and form by cutting, grinding, or slicing

them. Due to the existence of more shattered cells, smaller particles release more nutrients than larger particles **(Venkatachalam *et al.*, 2002)**.

Almonds are used in a wide range of applications, from food to medical. Marzipan, a mixture of ground almonds and sugar, is used in confections and pastries. Butter made from almonds can be used in place of butter made from dairy. Those who are lactose intolerant or allergic to the proteins in cow's milk can use almond milk as a substitute for cow's milk. Various disorders are treated using almond oil, pills, paste, and decoctions.

Alzheimer's disease, headaches, and insomnia are among the neurological conditions that are treated with almond. Its oil is beneficial for kidney infections, bladder stones, and dry brain. The properties of kernels include laxative, anti-tussive, and cerebrotonic effects. Nephrolgia, cystitis, and urinary problems can all be treated with sweet almonds. Uteralgia and hysteria are treated with bitter almonds **(Mushtaq *et al.*, 2015)**.

Almonds make sense as a remedy for colds and other phlegmatic conditions in the allopathic medical approach, in which diseases are treated by the administration of substances with opposing properties. Almonds: "They induce sleep, stimulate appetite, serve as a diuretic, and stimulate ovulation." They're also employed topically for headaches, especially when there is a fever **(Casas-Agustench, 2011)**.

A 100g dry walnut contains 630 kcal, making it a high-energy dietary source. More than 84% of the dry weight of a walnut kernel is made up of lipids and proteins (up to 70%). Walnuts have high levels of fibre, polyunsaturated fatty acids, necessary amino acids in their protein, and superior mineral compositions.

By analysing the physical characteristics, chemical make-up, and ratio of fatty acids, a researcher and his associates discovered that pumpkin seeds included 41.59% oil, 25.4% protein, 5.2% moisture, 25.19% carbs, 5.34% fibre, and 2.49% total ash. The overall amounts of phenolic compounds, sterols, waxes, and tocopherols were 66.25 mg of gallic acid per kilogramme of oil, 1.86%, 1.56%, and 882.65 mg of tocopherol per kilogramm of oil, respectively **(Gohari *et al.*, 2011)**.

Typically, pumpkin seeds are a remarkably abundant source of nutraceutical, medicinal, and cosmeceutical qualities with several pharmacological effects and health advantages. Recent in vitro, in vivo, and pre-clinical investigations have demonstrated the

extraordinary biological properties that pumpkin seed oil contains **(Lestari & Meiyanto, 2018)**.

Watermelon seeds have very few calories. Only 23 calories are present in about 4 grams of seeds. Good fats can contain both monounsaturated and polyunsaturated fatty acids, which are recognised as healthy fats. It helps prevent heart attacks and strokes and lowers cholesterol. 1.1 grams of polyunsaturated fat and 0.3 grams of monounsaturated fat are both present in a serving of four grams of watermelon seeds. A nutrient required for metabolic process is magnesium. Magnesium is rich in watermelon seeds, which helps maintain a healthy metabolism. According to the National Institutes of Health (NIH), people's bodies need 420 grams of magnesium daily. Watermelon seeds are a good source of zinc. It promotes cell development, digestion, immunity, and nervous system health **(Oyeleke *et al.*, 2012)**.

In dried watermelon seeds without the shell, there are 28.3 grams of protein, 47.4 grams of fat, 5.1 grams of water, 2340 kJ (557 kcal) of energy, 15.3 grams of carbohydrate, 54 mg of calcium, 755 mg of phosphorus, 7.3 mg of iron, 0.19 mg of thiamine, 0.15 mg of riboflavin, 3.55 mg of niacin, and 58 g of folate per 100 The seed oil is said to include oleic, palmitic, stearic, and linoleic glycosides. **(Schippers, 2002)**.

Flax is high in dietary fibre, protein, and fat. Brown Canadian flax had an average of 41% fat, 20% protein, 28% total dietary fibre, 7.7% moisture, and 3.4% ash, which is the mineral-rich residue that remains after burning samples. The amount of protein in the seed reduces as the amount of oil increases.

Flax protein shares the same amino acid composition as soybean protein, which is regarded as one of the most nutrient-dense plant proteins. Low in carbohydrates is flaxseed. At least three different types of phenolic compounds are present in flax, including phenolic acids (approximately 1%), flavonoids (35–70 mg/100 g), and lignans. From 1 mg/g of seed to about 26 mg/g of seed, lignans can be found. They are also regarded as phytoestrogens and work to maintain a healthy balance of hormones in the body, including oestrogen **(Katare *et al.*, 2012)**.

The reported differences in seed composition are as follows: 3.11 to 10.3% moisture, 2.36 to 6.4% protein, 5.01 to 13.2% fat, 0.18 to 0.9% ash, and 71.9 to 87.0% carbs. Comparing the protein and fat content of date seeds to date meat, which had levels of 1.53.0% and 0.11.4%, respectively provided information on six types of date seeds in relation to their mineral content: the following results were obtained (mg/100 g): 459.8542.2 kilocalories,

21.726.1 molar sodium, 6.511.3 g of calcium, 61.369.5 g of magnesium, 2.86.0 g of iron, 1.31.7 g of manganese, 1.01.4 g of zinc, and 0.40.6 g of copper. The majority of necessary amino acids are found in date seed protein, with glutamic acid constituting the majority of these amino acids **(Bouaziz et al., 2008)**.

The phenolic and antioxidant content of date seeds ranged from 3102 to 4430 mg of gallic acid equivalent per 100 g and 58,000 and 92900 mmol of trolox equivalent per 100 g, respectively. The phenolic acids of date seeds; of the nine phenolic acids discovered, the greatest concentrations were determined to be p-hydroxybenzoic (9.89 mg/100 g), protocatechuic (8.84 mg/100 g), and m-coumaric (8.42 mg/100 g). Date seeds may be used as a functional food element since they contain higher levels of antioxidants (14,600–16,200 mmol Trolox equivalent/100 g), phenolics (172–246 mg gallic acid equivalent/100 g), and dietary fibre (5.9–8.7 g/100 g) than date flesh **(Al-Farsi et al., 2007).**

Single Dates seeds have a total mineral content that is comparable to that of barley. Sodium, potassium, calcium, iron, copper, magnesium, manganese, zinc, phosphorus, lead, and cadmium are among the minerals found in date seed. This implies that a single seed can serve as a good supply of nutrients and can be used in place of barley in food preparations.

The majority of variations nearly exclusively contain invert sugar, which the body absorbs quickly in which 70% of dates are made up of carbohydrates, the majority of which are sugars Dates are regarded to be an excellent source of several minerals, such as iron, potassium, and calcium, and they also contain significant amounts of dietary fibre. Dietary fibre, which is crucial for maintaining the health of the digestive system, is one of the functional components of dates. Dietary fibre is made up of edible plant matter that the human digestive system does not hydrolyze. Numerous studies advise people to eat enough plant-based meals that are high in dietary fibre **(Al-Farsi et al., 2008)**.

Many phytochemicals that are well-known for their antioxidant properties can be found in dates. These phytochemicals include, among others, carotenoids (such as beta-carotene, lycopene, lutein, zeaxanthin, and neoxanthin), phenolics, cinnamic acids and their derivatives (such as ferulic, sinapic, syringic, vanillic, gallic, caffeic, protocatechuic, and coumaric acids), flavonoid glycosides **(Biglari et al., 2008)**

D. Health Benefits of Nuts and Seeds

Almonds could be a part of a balanced, nutritious diet in body weight management because they are a rich source of several nutrients, vitamins, minerals, unsaturated fat, protein,

and antioxidants. While postprandial hyperglycemia has been linked to an increased risk of CVD, almonds may reduce the prevalence of metabolic syndrome, T2DM, and CVD through the mechanism of glucose management. A variety of antioxidants, such as polyphenols and tocopherol, are present in almonds. Almond antioxidants have a variety of qualities that may combine or synergistically improve antioxidant defence capacity through radical scavenging activity, activation of endogenous antioxidant systems, or bot **(Kamil & Chen, 2012)**.

Due to the high fat content, almonds and other tree nuts were once disregarded as heart-healthy food options. Yet, the results of several clinical investigations completed to far in healthy subjects as well as subjects with hypercholesterolemia have shown that almond consumption has favourable effects on lipoprotein profiles, which are the main goals for CVD prevention. Many studies have been conducted on the potential mechanisms of action of almond ingestion as well as its impact on the lipoprotein profile **(Berryman et al., 2001)**.

Daily consumption of 48g of walnut for 4 days will increases the concentration of apolipoprotein A, which will deliberately improve the lipid profile. Walnuts are rich in omega 3 fatty acids helps to maintain our blood pressure by regulating the angiotensin-converting enzyme-2 **(Njike.Y *et al.*, 2021)**. It helps in reducing inflammation and decreases the risk of chronic diseases. In addition, walnut aids in bone health, manage diabetes mellitus, increases gut health and mental stability. The regular dietary intake of walnut prevents the risk of dementia and Alzheimer disease. Whatever the person who is having hypersensitivity to nuts should avoid walnuts. Higher intake of walnuts are associated with diarrhea, so it is advised to consume moderately **(Mahendra Pal 2020)**.

The supportive role of walnut is mainly performed in brain and nervous system. Walnut helps to smoothens the blood circulation through the vein, prevent heart attack. Antioxidant present in walnut is 15 times more than the pure vitamin E. Antioxidant is defined as the substance which will protect the cells from harm full substance called free radicals. It reduces the oxidative stress caused by free radicals **(Sen & Karadeniz, 2015)**.

Due to the process of aging, the process of neurodegenerative disorder are increased. Neurodegenerative disorders are mainly related to increased exposure of oxidative stress, inflammation and toxins. Walnuts are the rich source of phytochemicals contribute healthy neurons. The other prime nutrients present in walnuts are polyphenols, melatonin, organo sulfur compounds and minerals. The polyphenols present in walnut promote neuronal calcium

homeostasis, important for the functions of memory. Walnuts are the neuro-protective against various stressors **(Poulose.M *et al.*, 2014)**.

Adding extra fibre to our diet lowers cholesterol levels and lowers the risk of heart disease, which is why cashews are known as "heart snacks." The assimilation of cholesterol from food consumption is slowed down by the fibre in the digestive tract. Regular consumption of these nuts as part of a low-fat eating regimen can lower the risk of coronary disease overall by favourably affecting blood cholesterol levels and lowering the likelihood of suffering a subsequent respiratory and cardiovascular failure **(Allen *et al*., 1977)**.

Consuming food on a regular basis that quickly raises blood sugar levels results in the development of heart disease and diabetes as well. Cashew nuts have a lot of mono saturated fat, which helps to lower blood sugar levels and boost insulin production. Cashew are high in selenium, beneficial for cancers of the lungs, liver, skin, brain, and gastrointestinal tract **(Bes-Rastrollo *et al*., 2007)**.

It is possible to prevent acne and skin damage by consuming a few cashews every day. For beautiful, glowing skin, this is the cashew nut's most advantageous effect. Fiber is present in cashews in 1.30%. For stomach-related disorders, dietary fibre is essential. Water is preserved, the stool is soothing, and the obstruction is cleared. It is therefore helpful for diverticulosis, hiatal hernias, varicose veins, and haemorrhoids **(Oliveira *et al*., 2015)**.

One-fourth cup of cashews has 22.3% of the recommended daily intake of magnesium. It has calcium and magnesium, both of which are crucial for maintaining nerve and muscle tone. According to recent research, magnesium reduces the frequency of headache attacks, circulatory strains, and cardiovascular failures, controls the hormonal effects of menopause in women, and lessens the severity of asthma **(Iqbal *et al*., 2021)**.

Pumpkin seeds are a remarkably abundant source of nutraceutical, medicinal, and cosmeceutical qualities with several pharmacological effects and health advantages. Pumpkin seed extract had antioxidant and geno protective properties. Overall, the high concentration of tocopherol found in pumpkin seeds may be thought to provide anti-toxin and anti-free radical properties. Through various mechanisms, pumpkin seeds have both estrogenic and antiestrogenic effects **(Lestari & Meiyanto, 2018)**.

The growth of Aeromonas veronii, Candida albicans, Enterococcus feacalis, Escherichia coli, Salmonella enterica, Typhimurium, and Staphylococcus aureus are all inhibited by pumpkin seed oil at a dosage of 2% **(Hammer *et al.*, 1999)**.

LaChance & Ramsey, 2018 found that pumpkin seeds had an antidepressant food score (AFS) of 47%. This indicates that pumpkin seeds have the potential to be an antidepressant.

The amount of boosted antioxidant defence system and level of malondialdehyde were indicators of the anti-atherogenic action of the pumpkin and flax seeds combo. Utilizing a mixture of pumpkin seeds with flax seeds or pumpkin seeds with purslane seeds lowers lipid levels and is advised because these seed combinations have anti-atherogenic properties **(Makni *et al.*, 2008)**.

Pumpkin seeds are crucial in decreasing blood pressure and relaxing blood vessels. The calcium channel blocker effects of pumpkin seeds as a dietary supplement are similar to those of the medication amlodipine **(El-Mosallamy *et al.*, 2012).**

The most common health issue right now is cancer. Selecting preventative and therapeutical ways to prevent and treat cancer is the biggest hurdle facing investigators, experts, and researchers. It has been determined that consuming a lot of pumpkin seeds reduces the risk of developing cancer. The high concentration of different carotenoid pigments in pumpkin seed oil has been demonstrated to lower the risk of cancer **(Jian *et al.*, 2005)**.

The two most common kinds of diabetes are type I and type II. Numerous studies have found that pumpkin seeds and pumpkin both contain substances that reduce blood glucose levels. According to research, eating a diet high in oil from pumpkin seeds lowers the plasma's elevated levels of the enzymes alanine aminotransferase (ALT) and aspartate aminotransferase, which reduce the risk of developing diabetes **(Syed *et al.*, 2019)**.

In contrast to orthophosphate supplementation, pumpkin seeds increase urine levels of glycosaminoglycans, phosphorus, potassium, and pyrophosphate. Pumpkin seeds also reduce the production of calcium-oxalate crystals and calcium levels. The large amounts of phosphorus found in pumpkin seeds make them a beneficial supplement for reducing the risk of bladder stones **(Suphakarn *et al.*, 1987)**.

If consumed frequently, the magnesium, copper, and potassium-rich watermelon seeds can help prevent bone disorders. Watermelon seeds are a rich source of vitamin B, which promotes the health of your brain and nerve system. It is beneficial for both mood disorders and dementia. Watermelon is a great source of zinc, which is essential for the health of the male reproductive system. Both the seeds of the watermelon contain a chemical called lycopene. According to studies, lycopene has strong anti-cancer properties. Lycopene may aid in certain cases prevent the onset and/or progression of prostate cancer, according to a 2015 study **(Rajappa *et al.*, 2023)**.

It is becoming more and more clear that lignans have a variety of advantageous characteristics. Dietary fibre and phytoestrogen have both been found to have anti-cancer properties. Urinary excretion was dramatically boosted by flaxseeds. Lignans without altering the premenopausal women's serum hormone levels, indicating that the chemoprotective effects observed for flaxseed may not have been the consequence of a hormonal action **(Frische *et al.*, 2003)**.

When people consume foods high in these omega-3 fats, the ratio of omega-6 to omega-3 fats in their diet decreases, which helps to prevent excessive bone turnover and supports bone health. Alpha-linolenic acid is an omega-3 fatty acid found in flaxseed **(Griel *et al.*, 2007)**.

Alpha-linolenic acid, an essential omega-3 fatty acid, is abundant in flaxseed. A number of chronic diseases, including type 2 diabetes, kidney disease, rheumatoid arthritis, high blood pressure, coronary heart disease, stroke, Alzheimer's disease, alcoholism, and some types of cancer, can be prevented and managed with the help of omega-3 fatty acids due to their beneficial biologic effects **(Das, 2006).**

The chemoprotective effects observed for flaxseed may have occurred from mechanisms other than a hormonal effect because flaxseeds significantly increased urine excretion of lignans without affecting the serum hormone concentration of premenopausal women **(Frische *et al*., 2003)**.

The bioavailability of the enterolignans is significantly increased by crushing and milling flaxseed. During flaxseed administration, there was a significant rise in serum levels of alpha-linolenic acid, eicosapentaenoic acid, and docosapentaenoic acid, and the concentration of enterolactone more than doubled. Lignans have been demonstrated to reduce

the relative risk factors for heart disease and have also been linked to liver protection **(Katare *et al*., 2012)**.

It is the richest known source of both Alpha-linolenic acid (ALA) and the phytoestrogen lignans, as well as being a high source of soluble fibre, flaxseed has recently attracted attention in the field of cardiovascular disease. The long-chain n-3 fatty acids, which have heart-protective properties, are naturally produced from alpha-linolenic acid **(Ueshima *et a*l., 2007)**.

Date seeds' high nutritional value is based on their dietary fibre level, which qualifies them for the creation of nutritional supplements and meals high in fibre. Dietary fibre may have a preventive impact against hypertension, coronary heart disease, high cholesterol, colorectal and prostate cancers, as well as intestinal problems. Dietary fibre has substantial therapeutic implications for some ailments, including diabetes, hyperlipidemia, and obesity **(Tariq *et al*., 2000)**.

Dates are a fantastic source of energy and a functional diet to treat health-related issues because they are rich in natural sugars and other nutrients. Dates are categorised as functional foods since they are high in antioxidants, vitamins, minerals, and other important macronutrients. When included as a complimentary ingredient in energy nutrition bars, dates can offer significant energy. Moreover, dates have a distinct texture that works well when combined with other ingredients to create date bars **(Agoudjil *et al.*, 2011)**.

Dates contain a unique type of fibre called -D-glucan, which has been shown to have strong anticancer properties. These polysaccharides have a primary chain made up of (1→3)-D-glucopyranosyl residues and a branching saccharide chain that is (1→6)-linked. Dates have modest levels of the microelements zinc and copper, but larger levels of iron are observed. Those with hypertension can benefit from dates' high potassium and low sodium content **(Ayad *et al*., 2020)**.

E. Anti-Nutritional Factors in Nuts and Seeds

Anti-nutritional factors are generally linked to natural or manmade molecules or substances that prevent nutrients from being absorbed, diminish nutrient intake, digestion, and utilization, and may have other negative effects. Anti-nutrients are naturally produced in plants and are commonly associated with plant-based, raw, or vegan diets. Many anti-nutrients in the body can cause a variety of symptoms, including bloating, headaches, rashes,

nutritional deficits, and nausea. On the other hand, these chemicals can be clearly beneficial to humanity when used sensibly. Plants largely use anti-nutrients for self-defense **(Popova & Mihaylova, 2019).**

Phytates, tannins, lectins, oxalates, and other antinutrients are the main ones to be found in plant-based diets. Only when a person's diet consists solely of uncooked plant foods should one be concerned about the antinutrients in vegetables, whole grains, legumes, and nuts. For instance, oxalate binds to calcium and hinders calcium from being absorbed by the body **(Jiru & Urga, 1995)**.

Lectins are non-immune derived proteins or glycoproteins that are particularly prevalent in plants. Lectins play several different roles. By destroying the surface of the small intestine, they can get past the human immune system and spread throughout the body, producing disorders like Crohn's disease, Coeliac Sprue, colitis, etc. By providing incorrect immune system codes and promoting the proliferation of some white blood cells, lectins can also contribute to autoimmune disorders **(Boyd & Shapleigh, 1954)**.

Recent research on cashew nut allergies suggests that the condition is becoming more common. Patients with allergies who consume cashew nuts may experience severe responses, including anaphylaxis. Studies show that cashew nut allergy is also growing in importance as a food allergen, despite the fact that peanut allergy has been on the rise for at least 20 years. The significance of cashew nut allergy may be growing due to the consumption of cashew nuts rapidly rising as well as changes in eating and cooking habits. Avoiding allergic food is the cornerstone of treatment for patients with food allergies. Due to the growth of cashew nuts in many food products, this is becoming more and more challenging to accomplish in patients with cashew nut allergies **(Van Der Valk *et al.*, 2014)**.

Since little attention has been paid to the nutritional value and anti-nutrient content of watermelon seeds, these seeds are frequently thrown out when the fruit is being consumed. Exploiting and using available food sources and resources is one potential means of achieving nutrition security. It is necessary to identify the anti-nutrient factors in order to guarantee the security of human and animal nutrition. Anti-nutritional factors are compounds that obstruct or suppress vital metabolic processes, particularly digestion. The bioavailability of nutrients like proteins, vitamins, and minerals is typically decreased by these compounds. Tannins, phytate, and oxalate are the most prevalent anti-nutritional elements **(Kolawole & Obueh, 2013)**.

There may be antinutritional properties in several organic acids. Oxalates are frequently found in plants, such as leafy vegetables, or are produced by the body. They can be soluble (in potassium and sodium) or insoluble (in calcium, magnesium, and iron) salts or esters. The foods that contain a lot of oxalates include cruciferous vegetables (such as kale, radishes, cauliflower, and broccoli), chard, spinach, parsley, beets, rhubarb, black pepper, chocolate, almonds, berries (such as blueberries and blackberries), and beans **(Mamboleo, 2015)**.

According to research, antinutrient levels can be decreased with regulated cooking for at least 15 minutes at a temperature below boiling. Furthermore, tannins, phytic acid, hydrogen cyanide, trypsin inhibitors, and oligosaccharides can all be significantly reduced by autoclaving **(Salunkhe & Chavan, 1989)**.

III. METHODOLOGY

The methodology for the present study entitled "**Formulation and Development of Value-Added Multi-Nuts and Seeds Spread"** was carried out under the following steps.

A) Selection and Procurement of Ingredients
B) Formulation and Development of Multi-Nuts and Seeds Spread
C) Development of Five Variations Using Different Proportions of Selected Ingredients
D) Organoleptic Evaluation and Standardization of Recipes
E) Nutrient and Viscosity Analysis of Developed Multi-Nuts and Seeds Spread
F) Shelf-Life Analysis of Developed Multi-Nuts and Seeds Spread
G) Analysis of Data

A. Selection and Procurement of Ingredients:

Tree nuts are rich in macro and micronutrients, phytochemicals, tocopherols, and phenolic compounds. The development of nut spreads would potentially increase the usage of nuts and will be a healthier option for the consumers to select it as a accompaniment for breakfast, meal, or snack **(Shakerardekani *et al*., 2013).**

The spread, which is made using oilseeds such as pumpkin seeds, watermelon seeds, date seeds, and flax seeds, has a creamy texture and an acceptable taste. The value-added spreads, on the other hand, tend to show positive effects on human health when consumed in significant quantities.

For the development of value-added multi-nuts and seeds spread, ingredients were selected based on the health benefits and nutraceutical properties of the ingredients. Nuts namely almonds, walnut, and cashew were selected. Seeds such as Flax Seed, Watermelon Seed, Pumpkin Seed, and Date Seed were included. Dates were added as a natural sweetener to enhance the texture of the spread. The required ingredients needed for the formulation of the spread were purchased from the supermarket situated in the town hall, Coimbatore. Plate 1 represents all the ingredients which are chosen for the development of value-added multi-nuts and seeds spread.

The Institutional Human Ethics Committee (IHEC) of the Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore with approval no.

AUW/IHEC/FSMD-22-23/XMT-02 of the requested study, which is given in the Annexure-I.

Almond

Walnut

Cashew

Flax Seeds

Pumpkin

Watermelon Seeds

Dates Seeds

Dates

Honey

Plate 1: Selection of Ingredients

B. Formulation and Development of Multi-Nuts and Seeds Spread:

Plant-based ingredients are gaining popularity due to their sustainability, versatility, and relatively low cost, as well as their well-deserved health benefits. Different cultures and religions all around the world use seeds to treat diseases and ailments as a method of traditional medicine. These qualities have opened the door to a leap in the use of seeds and nuts in food product development.

Figure 1 brief the preparation process of multi-nuts and seeds spread. Development of Multi-Nuts and Seeds spread involves various pre-preparation and preparation techniques to attain the final product as a spread. The preparation process step by step in the formulation of the product includes,

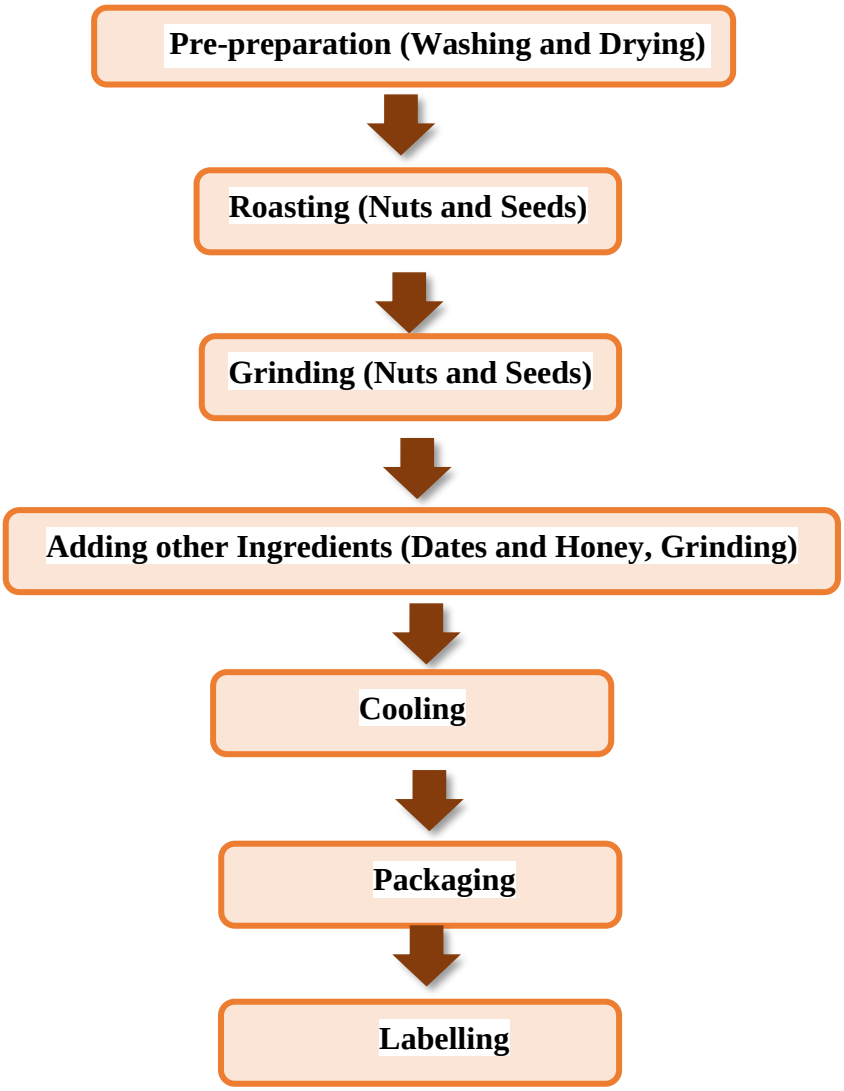


Figure 1: Preparation Process of Developing Multi-Nuts and Seeds Spread

Pre-preparation:

The initial process in the development of the value-added multi-nut and seed spread, involved various pre-preparation techniques. As preliminary steps, the nuts and seeds were separated by size and then the nuts and seeds were washed and sundried. Especially with dates, the fruits and seeds were separated prior to make the process easier. Date seeds required more time for sun drying compared to other nuts and seeds, which helped in thorough grinding of dates seeds.

Roasting of Nuts and Seeds:

Raw nuts contains an enzyme named lipoxygenase, which accelerates the oxidation of damaged nuts. Lipoxygenase is normally destroyed during the nut roasting process. The roasting conditions for nut spreads depend on the type of nut and the type of roaster. The most suitable roasting temperature and duration of time for roasting was 135°C for 20 minutes **(Shakerardekani *et al.*, 2013).**

Nuts: The oven was preheated to 347° F (175 °C) and the nuts were spread out on a tray. Overloading of nuts and seeds was avoided as it was difficult to roast the nuts and seeds evenly. After preheating the oven, the tray was placed in the center of the oven to begin roasting process of nuts. Once the nuts were placed in the tray, to ensure even roasting a wooden ladle was used to turn and move the nuts around the sheet every 2 to 3 minutes during the roasting time for even roasting. For lighter nuts like cashews and walnuts, roasting took 7-9 minutes and for thicker nuts like almonds, it took 9-11 minutes. Once the nuts got roasted, it was transferred to a plate and spread out for cooling.

Seeds: For seeds, the oven was preheated to 350°F (177 C). A baking sheet lined with parchment paper is the best way to prevent the seeds from sticking. As shown in plate 2, once the oven was preheated, the seeds were placed on the lined parchment paper and spread out using a ladle. It was ensured that the seeds does not clump to each other and lay flat so that this will help in even roasting. If the seeds are being layered, try baking them in two smaller batches to encourage even toasting. The baking sheet was removed from the oven every 10 minutes and the seeds were agitated with a wooden ladle to ensure even roasting. Once the roasting of the seeds was completed nice a aroma was felt and it was removed from the oven.

Plate 2: Roasting of Nuts and Seeds

Grinding:

After roasting nuts and seeds, it was completely cooled down for the grinding process. The cooled nuts and seeds were placed in a mixer grinder and blended in moderate to high mode for 1-2 minutes to finely grind them into a powder. Nuts and seeds were ground for 45 minutes to 2 hours at different intervals of time. Every 10 minutes the lid was opened and the sides of the mixture were scraped down for better mixing of nuts and seeds. After 30 minutes the nuts and seed started to release the natural oil to make the mixture turn to be smooth and creamy texture. Plate 3 shows the consistency of spread while grinding.

Plate 3: Grinding of Nuts and Seeds

Other Ingredient used in the formulation of Nuts and Seeds spread:

Dates (Kimia) contain natural sugars and fiber and are very high in carbohydrates. This fruit has a natural sweetness and a distinctive pleasant taste. In addition to a very good taste, it is considered as an easily digestible and simple food. When it is added to the spread it developed a better consistency towards the spread. The sugars present in dates are mostly fructose and glucose types. Dates are a great source of minerals, secondary metabolites,

and sugar. Additionally, dates have 29 grams of sugar that is naturally present as fructose, glucose, and sucrose, and 3 grams of dietary fiber. A serving of dates provides the body with 31 grams of carbohydrates, a great deal of energy **(Jain, 2013).**

As a natural sweetener dates and honey was added in the process of grinding the nuts and seeds.

Cooling:

After the process of grinding, the processed spread was allowed to cool completely.

Packaging:

Food packaging is used to ensure the safety and quality of food products from production to consumption, as well as to extend their shelf life by maintaining an appropriate environment, preventing microorganism spoilage, and keeping chemical contaminants, oxygen, moisture, light, and so on, at bay **(Echegoyen, 2015).**

Good packaging prevents waste and ensures that food retains the desired quality throughout its shelf life. Despite its importance and the key role that packaging plays, it is often viewed as somewhat redundant at best and a serious waste of resources, and environmental threat at worst. Before packing, the glass container should be sterilized properly to avoid contamination. The developed multi-nuts and seeds spread were transferred into the container and closed with the lid properly.

Labelling:

Food labels are essential for educating customers about the ingredients in foods. They serve as a guide for millions of people's dietary decisions **(Temple & Fraser, 2014).**

A label is a printed piece of paper that is either affixed to the container of a product or printed on the package itself. While some labels are simple graphic materials that are adhered to the food packaging (such as bottles or cartons), others are more complex graphic materials that are integrated within the container **(Hoffman, 2005).**

The following details must be included on product labels:

The product's country of origin, the manufacturer's name and address, the ingredients or materials used in the product via an ingredient list, the date before use, directions for use and serving ideas, warnings about potential ingredient or product abuse, the presence of allergens as a safety measure, the product's net contents in weight or volume, nutritional data, and authorized health and nutrition claims **(Prinsloo *et al.*, 2012).**

The developed multi-nuts and seeds spread label was designed for nutritional labelling. The ingredients, manufacturing date, best-before date, usage instructions, nutritional information, the net amount of the product, etc. were all listed on the label.

C. Development of Five Variations Using Different Proportions of Selected Ingredients:

Value-added multi nuts and seeds spread were prepared. By using different ratios of the individual ingredients, five distinct variations were created. Ingredients that are used in such a manner as to provide the population with wholesome health benefits.

TABLE I

QUANTITY OF INGREDIENTS USED IN VARIATION 1 OF MULTI-NUTS AND SEEDS SPREAD

S. No	Ingredients	Variation 1
1	Almond	40g
2	Walnut	30g
3	Cashew	40g
4	Pumpkin seeds	30g
5	Watermelon Seeds	20g
6	Flax seeds	20g
7	Dates seed	10g
8	Dates	60g
9	Honey	4ml

Table I represents the quantity of ingredients used in variation 1. In this variation, (40g) of almond, (30g) of walnut, (40g) of cashew, (30g) of pumpkin seeds, (20g) of watermelon seeds, (20g) of flaxseeds, (10g) of dates seed, and (60g) of dates and honey (4ml) was included as main ingredients. The nuts and seeds were weighed and roasted at 350°F (175°C). All the roasted ingredients were allowed to rest until it got cooled down. After the phase of cooling down, they were transferred into the mixer grinder for the process of grinding. They were blended thoroughly for 45 minutes.

TABLE II

QUANTITY OF INGREDIENTS USED IN VARIATION 2 OF MULTI-NUTS AND SEEDS SPREAD

S. No	Ingredients	Variation 2
1	Almond	40g
2	Walnut	30g
3	Cashew	40g
4	Pumpkin seeds	34g
5	Watermelon Seeds	20g
6	Flax seeds	24g
7	Dates seed	20g
8	Dates	60g
9	Honey	8ml

Table II denotes the number of ingredients used in variation 2. Almonds (40g), walnuts (30g), cashews (40g), watermelon seeds (20g), and (60g) of dates were added in this variation, the same as in variation one. But the quantity of pumpkin seeds (34g), flax seeds (24g), dates seeds (20g), and honey (8 ml) was increased in the variation two. All the ingredients were weighed and roasted at 350°F (175°C). After cooled down, they were allowed to grind for 1 hour with 10 minutes interval of time to mix the grinded spread thoroughly.

TABLE III

QUANTITY OF INGREDIENTS USED IN VARIATION 3 OF MULTI-NUTS AND SEEDS SPREAD

S. No	Ingredients	Variation 3
1	Almond	40g
2	Walnut	30g
3	Cashew	40g
4	Pumpkin seeds	38g
5	Watermelon Seeds	20g
6	Flax seeds	28g
7	Dates seed	16g
8	Dates	60g
9	Honey	12ml

Table III represents the quantity of ingredients used in variation 3. In this variation as same as variation 1 the quantity of almonds (40g), walnuts (30g), cashews (40g), watermelon seeds (20g), (60g) of dates were added, whereas flax seeds (28g), pumpkin seeds (38g), and dates seeds (16g) were included with changes in quantity. In addition, to improve the sweetness of the spread honey (12ml) was added. The pre-preparation process namely washing and drying was done. Then the nuts and seeds were roasted at 350°F (175°C). After the period of cooled down, they were grinded for 1 hour 30 minutes with 10 minutes interval of time to get a smooth spread.

TABLE IV

QUANTITY OF INGREDIENTS USED IN VARIATION 4 OF MULTI-NUTS AND SEEDS SPREAD

S. No	Ingredients	Variation 4
1	Almond	40g
2	Walnut	30g
3	Cashew	40g
4	Pumpkin seeds	42g
5	Watermelon Seeds	20g
6	Flax seeds	32g
7	Dates seed	12g
8	Dates	60g
9	Honey	16ml

The quantity of ingredients used in the variation 4 was mentioned in Table IV. The quantities of almonds (40g), walnuts (30g), cashews (40g), watermelon seeds (20g), and 60g of dates were added in this variation, the same as in variation 3. Flax seeds (32g), pumpkin seeds (42g), dates seed (12g), and honey (16 ml) was added for this variation. The process of roasting and grinding was used here to develop the spread. It took 1 hour 45 minutes to get the better consistency of spread with 10 minutes interval of time.

TABLE V

QUANTITY OF INGREDIENTS USED IN VARIATION 5 OF MULTI-NUTS AND SEEDS SPREAD

S. No	Ingredients	Variation 5
1	Almond	40g
2	Walnut	30g
3	Cashew	40g
4	Pumpkin seeds	46g
5	Watermelon Seeds	20g
6	Flax seeds	36g
7	Dates seed	8g
8	Dates	60g
9	Honey	20ml

Similar to variation 4, this variation almonds (40g), walnuts (30g), cashews (40g), watermelon seeds (20g), 60g of dates were included. As mentioned in table V, the quantity of honey was increased from 16ml to 20ml, Flax seeds 32g to 36g, pumpkin seeds 42g to 46g, and dates seeds decreased from 12g to 8g. The ingredients were weighed and roasted at 350°F (175°C). They were allowed to cool down and then grinded.

D. Organoleptic Evaluation and Standardization of Recipes:

A wide range of sensory attributes, including appearance, aroma, taste, and texture, are used by consumers to make food purchasing and consumption decisions. Trained panelist describe a product's acceptability in the mouth, in terms of quality and quantity, through its mechanical, geometric, and fat and moisture characteristics from first bite to full chew.

The texture is one of the sensory properties of food that plays an important role in consumer appeal, purchase decisions, and subsequent consumption. This is the most dominant attribute of consumer food preference. Spreadability is an extremely important property of the texture of semi-solid foods. Spreadability is a subjective term that refers to how easily a sample spreads evenly over a surface.

Descriptive attributes spreadability strongly correlated with consumer attribute spreadability. In addition to the textural properties, the general preference for spreads is related to the taste of the product. Flavor cannot be measured directly with instruments; it is an interaction between the consumer and the product.

In roasted nuts, the volatile profiles are highly complex and consist of compounds arising not only from lipid oxidation, but also from the Maillard reaction, Strecker degradation, and caramelization of sugars. Color is another important attribute used by consumers to judge the acceptability of food products. The sensory evaluation can be used to provide more information about the texture, color, taste, and hence the acceptability of nuts and seeds that are distributed by consumers **(Shakerardekani *et al.*, 2013).**

The sensory analysis measures how people react to food products through the five senses: sight, smell, taste, touch, and hearing. Semi-trained panel members were selected for the sensory evaluation of developed value-added multi-nuts and seeds spread in the laboratory. The score card for the sensory evaluation of developed spread was given in the Annexure VI.

The developed spread was offered to a group of semi-trained panelists for evaluation of appearance, colour, taste, texture, and general acceptability on a nine-point hedonic scale, with a score ranging from nine to one, likely indicating like extremely to dislike extremely. The quality parameters were quantified, and the evaluations mean scores were determined. Plate 4 shows the organoleptic evaluation of developed multi-nuts and seeds spread.

Plate 4: Organoleptic Evaluation of Multi-Nuts and Seeds Spread

Standardization of Multi-Nuts and Seeds Spread:

A standardized recipe is a recipe that has been tried, adapted, and repeated many times and found to produce the same good results and yield each time when the exact procedures are used with the same species of equipment and the same quantity and quality of ingredients are used.

The standardization of recipes is necessary for many reasons. The product will be of consistent quality each time it is prepared using standard recipes. The planned number of portions is produced by using standardized recipes. Nutritional values per serving are consistent across standardized recipes. There are three phases of recipe standardization: recipe verification, product evaluation, and quantity adjustment. The recipe review phase consists of reviewing the recipe in detail, crafting it, reviewing its yield, and writing any changes that occurred during the review.

In the product evaluation phase, the compatibility of the product made from the recipe was checked. At this stage, a sensory evaluation of the product was carried out and acceptance is decided based on the parameters such as the product's appearance, texture, and finally the taste of the product. If the product does not meet the standards, the quantity of the ingredient will be changed. These are all laboratory experiments where the product

goes through different phases. The different quality and quantity of the raw material is used for the desired product quality. A small amount of ingredients change the appearance of the product **(Patil & Pol, 2014).**

To standardize different variations of spread, it went through different stages of standardization. The recipe content for the development of the spread was reviewed, which included the list of all the ingredients, the amounts to be added, roasting and grinding time, etc. Then the recipe was prepared in a small amount and the amount of outputs was weighed. The yield of the product was determined. Different variations were tried. Different variations were prepared by adding different amounts of main ingredients. The variation with the greatest acceptance was selected and the same procedure was tried, tested, and evaluated.

E. Nutrient and Viscosity Analysis of Developed Multi-Nuts and Seeds Spread:

The nutrient content of value-added multi-nut and seed spreads, including macronutrients like energy, carbohydrate, protein, and fat (total fat, unsaturated fat), was analyzed using standard methods. Micronutrients including vitamin-A, vitamin- D, vitamin K, vitamin C, vitamin E, iron, and calcium were analyzed for nutritional factors.

The nuts and seeds are renowned for their antioxidant and phytochemical properties. As a result, the phytochemical screening was examined, and the antioxidant test was performed using DPPH standard method. The procedure for the estimation of nutrients, antioxidant capacity and phytochemical analysis was attached in the Annexure II, III and IV respectively.

Physiochemical analysis of viscosity of the spread was tested. Ford cup was used to measure the viscosity of the spread. The procedure for testing the viscosity of the spread is given in the Annexure V.

F. Shelf-Life Analysis of Developed Multi-Nuts and Seeds Spread:

Shelf life is defined as the period of time under defined storage conditions during which food remains acceptable for human consumption in terms of its safety, nutritional and sensory properties. During the shelf life of a product, chemical, biochemical, physical, and microbiological changes take place. Safety concerns, expressed as upper thresholds for microbial growth and the development or migration of toxic chemical compounds, are also used to mark the end of shelf life **(Corradini, 2018).**

For the shelf-life analysis, sterile glass containers were used for bottling. Before bottling the glass containers were sterilized by putting in boiling water for 10 minutes.

Then the glasses were wiped with a clean cotton cloth and allowed to dry well so as to avoid spoilage due to moisture content while storing. Developed multi-nut and seed spreads were transferred to the sterile bottles for storage and also were analyzed for the shelf life of the product. Every day the spread stored was checked for the attributes like taste, texture, smell, and color. Microbial analysis was carried out to check for the growth of microorganisms such as yeast or mould. Total platelet count, yeast, and mould tests were done for microbial analysis.

G. Analysis of Data

The data were collected from sensory evaluation, nutrient analysis, antioxidant assay, phytochemical analysis, Physiochemical analysis of viscosity testing was tabulated. Graphical form of representation was given to those tables. For Sensory evaluation mean values and standard deviation was used to analyse the scores. The variation with highest score of acceptability was selected and analysed for nutrients, antioxidants and phytochemicals. Finally, the cost of the developed spread was calculated and tabulated.

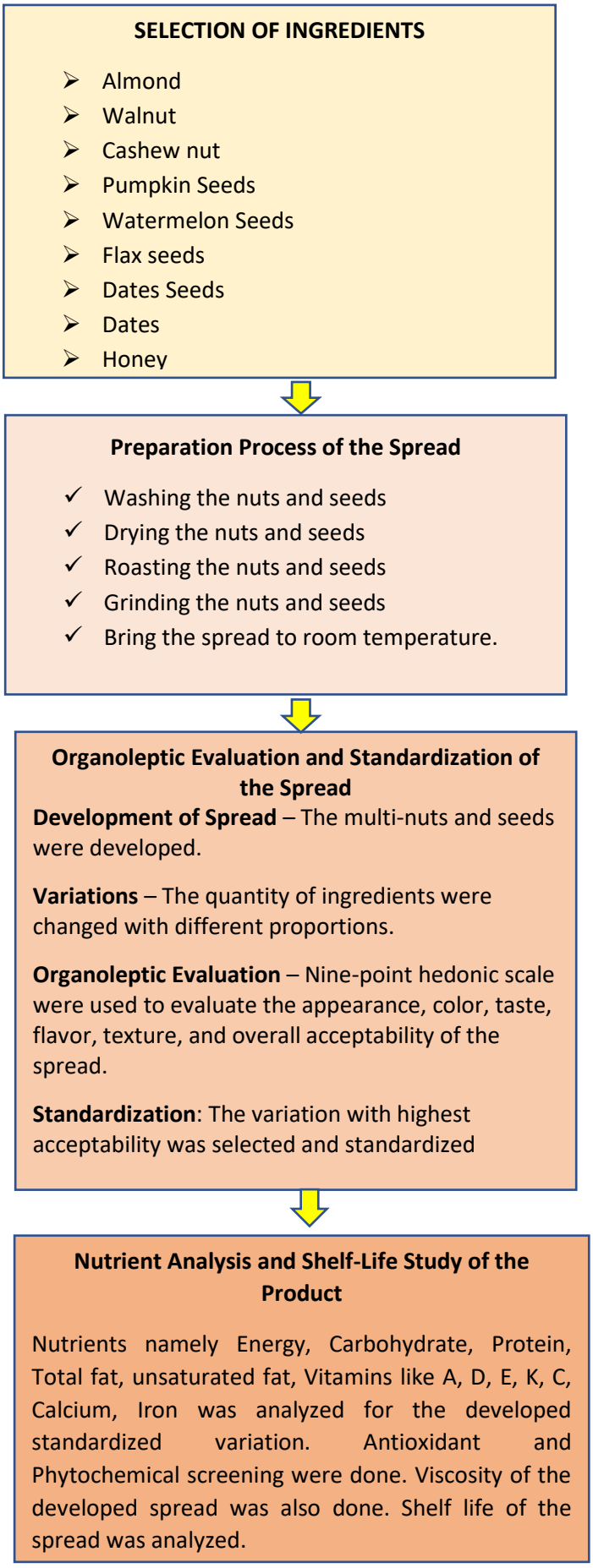


Figure 2: Research Design for the Development of Multi-Nuts and Seeds Spread

IV Result and Discussion

The result of the study entitled **"Formulation and Development of Value-added Multi-Nuts and Seeds Spread"** is presented under the following headings:

A. Selection of Ingredients and Formulation of Multi-Nuts and Seeds Spread
B. Organoleptic Evaluation and Standardization of Developed Multi-Nuts and Seeds Spread
C. Nutrient and Viscosity Analysis of the Developed Multi-Nuts and Seeds Spread
D. Observation of Shelf Life of the Spread
E. Cost Calculation, Packaging and Labelling of the Developed Multi-Nuts and Seeds Spread

A. Selection of Ingredients and Formulation of Multi-Nuts and Seeds Spread

The multi nuts and seeds spread were developed using different nuts and seeds namely almond, walnut, cashew, pumpkin seeds, watermelon seeds, flax seeds, dates seed, dates, and honey. The ingredients used to develop the spread were selected based on the nutritional and functional properties of the ingredients. Nuts and seeds are packed with nutrients like healthy fats, protein, energy, and other nutrients which provides potential health benefits. The difference between nuts and seeds is that nuts are dry fruits covered by hard shells which cannot be easily opened, but seeds are naturally open free from hard shells.

The added nuts have greatest functional and therapeutic properties to enhance the health of individuals. Nuts and seeds are a source of unsaturated fatty acids, dietary fiber, antioxidants, vitamins E, B6, folic acid, and niacin, and minerals including magnesium, zinc, iron, copper, selenium, phosphorus, and potassium. To increase the health-promoting properties of the spread, these ingredients were selected and added to develop the spread.

The date seed is known as an outstanding functional ingredient because it is high in polyphenols and total dietary fiber. Dates seeds have slightly coffee flavor to the developed spread. By the addition of dates seed to the spread, improved the color and flavour of the spread.

Other ingredients like dates were included to give a better consistency and sweetness to the product. It acts as a natural sweetener. Apart from acting as a sweetener, it is rich in ascorbic acid, riboflavin, niacin, calcium, copper, iron and magnesium. For additional sweetenes, Honey also acted as a natural preservative and stabilizing agent. It was added to spread in order to stabilize the nuts and seeds spread.

Despite being energy-dense, almonds are high in monounsaturated fat, fibre, tocopherol, minerals like magnesium and copper, and phytonutrients **(Kamil & Chen, 2012)**. Almond contains 5.93mg 0f lutein, 1.79 mg of zeaxanthin and 11.31mg of total carotenoids.

Walnuts have a very interesting nutritional makeup. Like all nuts, walnuts have a lot of fat (69%), but 49% of that fat is polyunsaturated, and 6% of it is omega 3 in the form of linolenic acid. Walnut eating has been proven to improve blood's capacity for antioxidants, which may provide further defense against disease-causing agents **(Tapsell, 2009).** Walnut has 4.94mg of cryptoxanthin, 84.92mg of polyquinones, 21.7 mg of lutein and 46.31 mg of ergocalciferol.

India is currently the world's top producer, processor, and exporter of cashew nuts. A beneficial food for both physical and mental wellness is the cashew nut. It provides complete nutrition and serves as a culinary remedy for a number of diseases **(Cordeiro, 2014).** Cashew contains 3.85 mg of ergocalcife, 1.83 mg of polyquinones and 3.21 mg of zeaxanthin.

The pharmacological effects of pumpkin seeds make them quite popular. Additionally, pumpkin seed oil has several health advantages. Pumpkin seeds are a healthier option **(Amin & Thakur, 2013).**

Flax is regarded as a functional food or source of functional components and is primarily known for its high alpha-linolenic acid content, but it is also a source of lignan, soluble fiber, and protein, substances that are biologically active in the prevention of various non-transmissible chronic diseases **(Rubilar *et al*., 2010).**

Antioxidants known as carotenoids, including lycopene, phytofluene, phytoene, beta-carotene, lutein, and neurosporene, are abundant in watermelon seeds. Citrulline, amino acids, fibre, and antioxidants defend the free radicals that cause conditions like asthma, atherosclerosis, diabetes, colon cancer, and arthritis **(Alemika *et al*., 2017).**

According to recent studies, date seeds are a source of healthy food components such as oleic acid, dietary fiber, and polyphenols. These substances have been linked to a decreased risk of cardiovascular illnesses and enhanced the general health of the individual **(Brouk & Fishman, 2016).**

Dates are regarded as being particularly nutrient-dense due to their phenolic and antioxidant content. Dates are effective in the treatment of heart ailments, cancer, and diabetes

because they include certain nutritional compositions like fiber, carbohydrates, fatty acids, mineral elements, and vitamins **(Mousavi *et al*., 2014).**

Honey is highly nutritious as well as an energizer, assisting workers and athletes in overcoming exhaustion and regaining vitality. Honey can be consumed safely by both young and old people, regardless of age. Honey has antibacterial, antiviral, and antifungal properties **(Kumar *et al*., 2010).**

Considering all these nutritional aspects of the ingredients, they were selected and procured from supermarket in town hall, Coimbatore.

The spread was developed, and undergone different steps of preparation like in pre-preparation, the ingredients were selected, and the nuts and seeds were roasted. Especially, dates seed was removed from the dates, washed, and dried for better grinding. After that, it was roasted and grinded. Roasting and grinding of nuts and seeds gave appetizing flavor. The addition of honey made the grinded powders stickier. Continuous grinding allowed the nuts and seeds to release their oil. After that, all the ingredients are mixed by grinding to give a smooth paste-like spread. To attain an acceptable appearance, color, taste, flavor, and texture, different variations are developed by changing the quantities of main ingredients.

TABLE VI

QUANTITY OF INGREDIENTS USED IN DIFFERENT VARIATIONS OF MULTI-NUTS AND SEEDS SPREAD

Ingredients	**Variation 1**	**Variation 2**	**Variation 3**	**Variation 4**	**Variation 5**
Almond	40g	40g	40g	40g	40g
Walnut	30g	30g	30g	30g	30g
Cashew	40g	40g	40g	40g	40g
Pumpkin seeds	30g	34g	38g	42g	46g
Watermelon Seeds	20g	20g	20g	20g	20g
Flax seeds	20g	24g	28g	32g	36g
Dates seed	10g	20g	16g	12g	8g
Dates	60g	60g	60g	60g	60g
Honey	4ml	8ml	12ml	16ml	20ml

Variation 1:

Table VI depicts the quantities of the ingredients used in the different variations of multi-nuts and seeds spread. Initial preparation process involved roasting of nuts and seeds. At 175°C, all the nuts were roasted in the oven for 10 minutes. Except dates seed, other seeds were roasted at 175°C for 5 minutes. Dates seeds was removed from the dates and kept separately. For dates seed, it was kept in the oven for 20 minutes at 175°C for better roasting. After roasting, the dates seed was grinded and sieved to get a smooth powder. Dates seeds had the appearance of coffee bean after roasting and gave coffee flavor after grinding. After the nuts and seeds were cooled down, they were grinded. It took 45 minutes for fine grinding with 10 minutes interval of time. The ingredients were grinded to get a smooth and spreadable consistency. After grinding, the spread was weighed and transferred to the clean sterilized glass container.

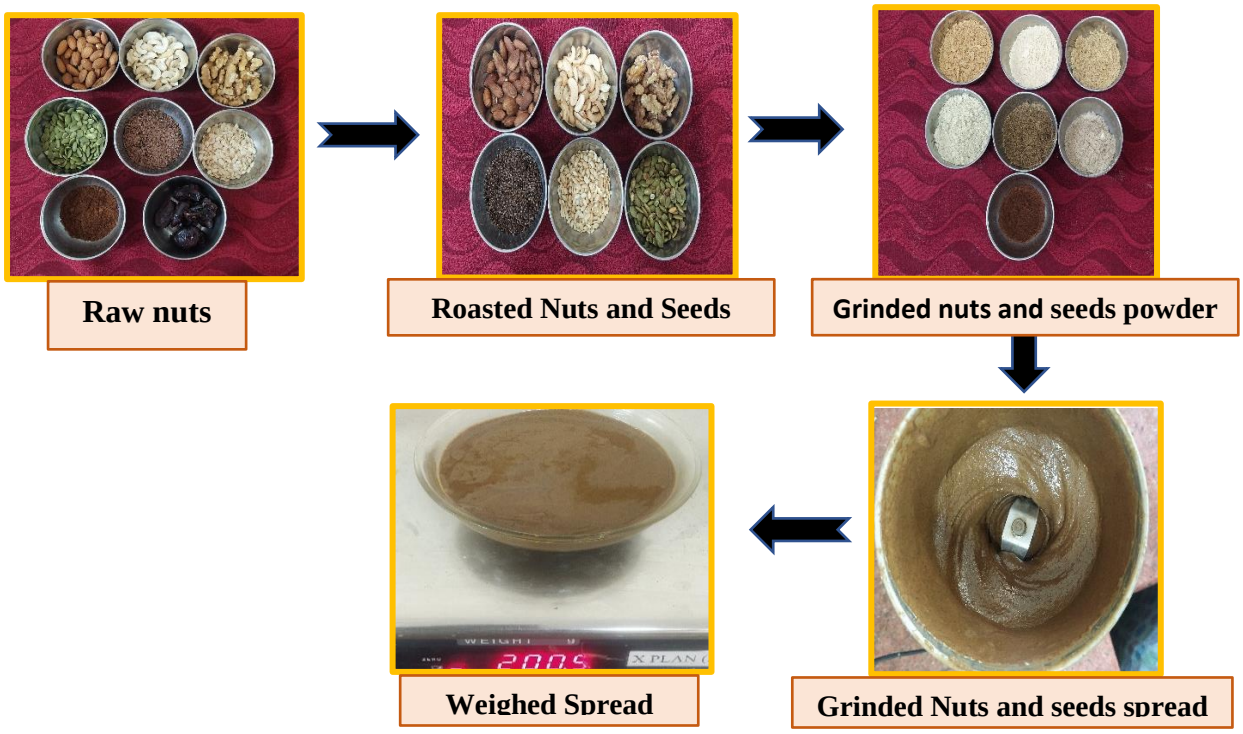


Plate 5: Preparation Process of Multi-Nuts and Seeds Spread for Variation 1

The preparation process of nuts and seeds spread is given in plate 5. Nuts provided a smoother texture to the spread than seeds, hence they were used in greater amounts than seeds. In relation to other seeds, the flavor of the pumpkin seed was excellent after roasting and grinding and acted as a great base for the consistency, so that it was added in greater quantity. In this variation, the spread's texture came out well. The spread didn't have a particularly strong

flavor from the dates seed. Although dates and honey were added for sweetness was not felt very much in this variation.

Variation 2:

The table VI shows the list of ingredients used to prepare variation 2. The nuts and seeds were weighed and roasted at 175°C for 10 minutes and 5 minutes respectively. Dates seed alone was roasted at 175°C for 25 minutes. It was crushed and sieved to get a smooth powder. Then all the ingredients were pulverized for an hour to get the spread consistency. In the process of grinding, with 10 minutes of interval, the mixer lid was opened, and sides of the mixer was scraped down for better mixing of spread and grinded. Preparation process of variation two is given below in plate 6.

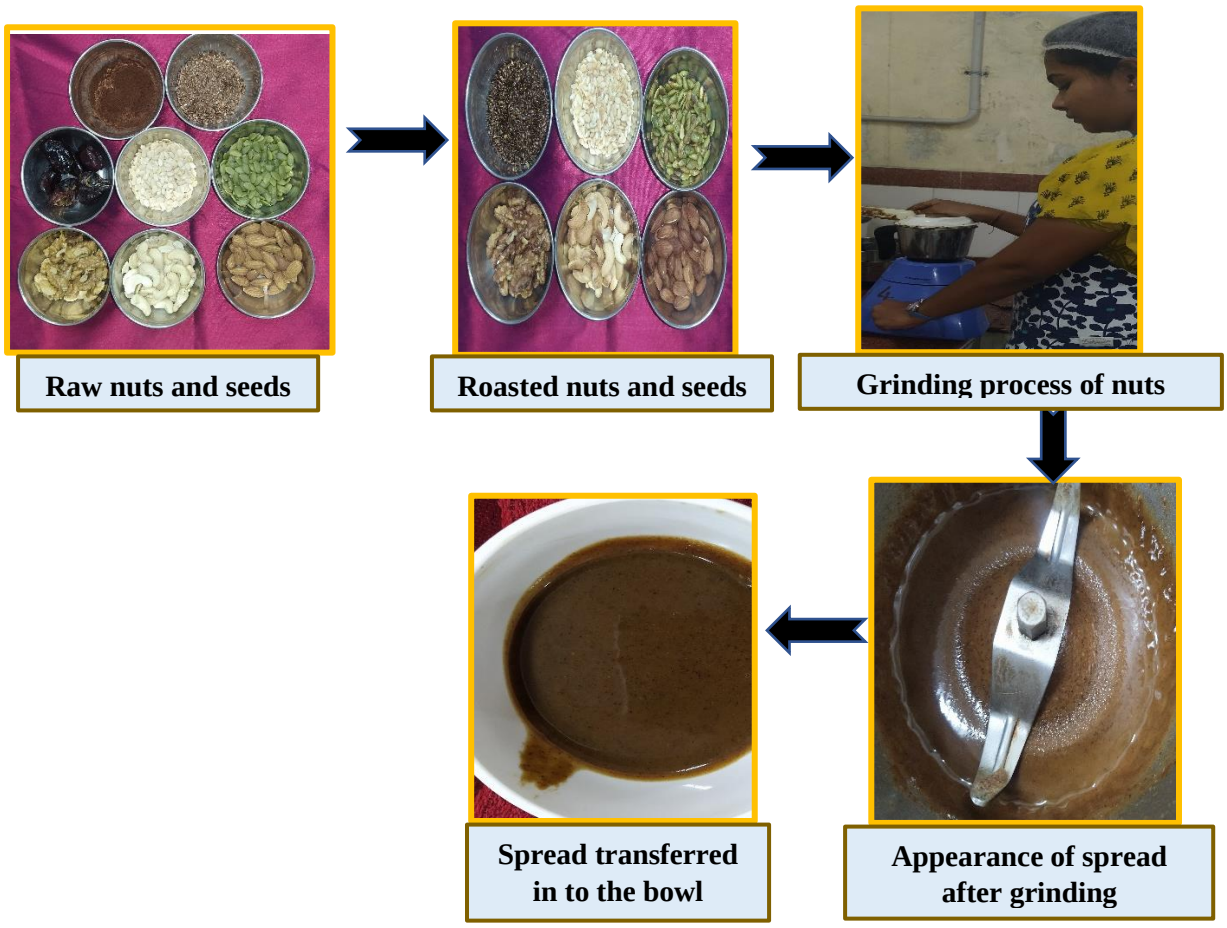


Plate 6 : Preparation Process of Multi-Nuts and Seeds Spread for Variation 2

In this variation, the seed weights were raised by 4g to observe the flavor and taste changes in the spread. The amount of dates seed was directly raised to 20g to enhance the spread's dates seed flavor. The spread had a good consistency. Dates seeds, 20g were added. It

gave a slight bitterness but overall improved the flavor. In contrast to variation one, in this variation, sweetness of the product was slightly increased by the addition of 8ml honey.

Variation 3:

As mentioned in the variation one and two the same procedure was done to develop the multi nuts and seeds spread. The quantity of ingredients used in this variation is depicted in the above table VI. In grinding, it took 1 hour 30 minutes to get the spread consistency. The increased quantity of honey slowed down the nuts and seeds to release its oil. So, it took much time for grinding and attain a good consistency. The preparation process was given in variation plate 7.

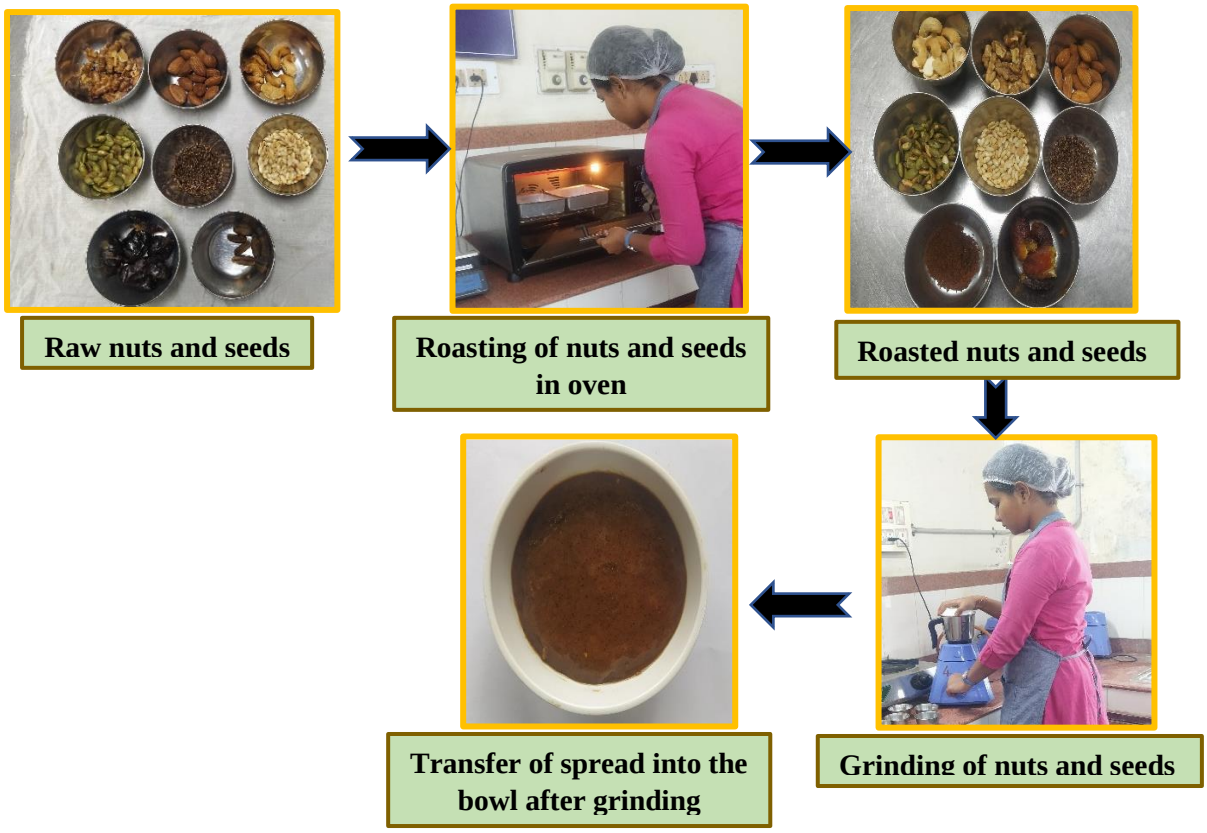


Plate 7: Preparation Process of Multi-Nuts and Seeds Spread for Variation 3

Following variations 1 and 2, in variation 3 the amount of pumpkin seeds and flax seeds was increased. Flax seed is a versatile component that gave the final product a nutty flavor and improved consistency. The amount of dates seed was decreased from 20g to 16g in this variation to reduce the bitterness of the spread caused by the dates seed. The additional taste of honey boosted the spread's sweetness. It significantly decreased the spreads bitter flavour.

Variation 4:

The multi nuts and seeds spread was developed using the same process as described in variations 1, 2 and 3. The information in the table VI shows the ingredients and the amounts of each item needed to prepare variation 4. For getting the better consistency of the spread, it required 1 hour and 45 minutes for grinding.

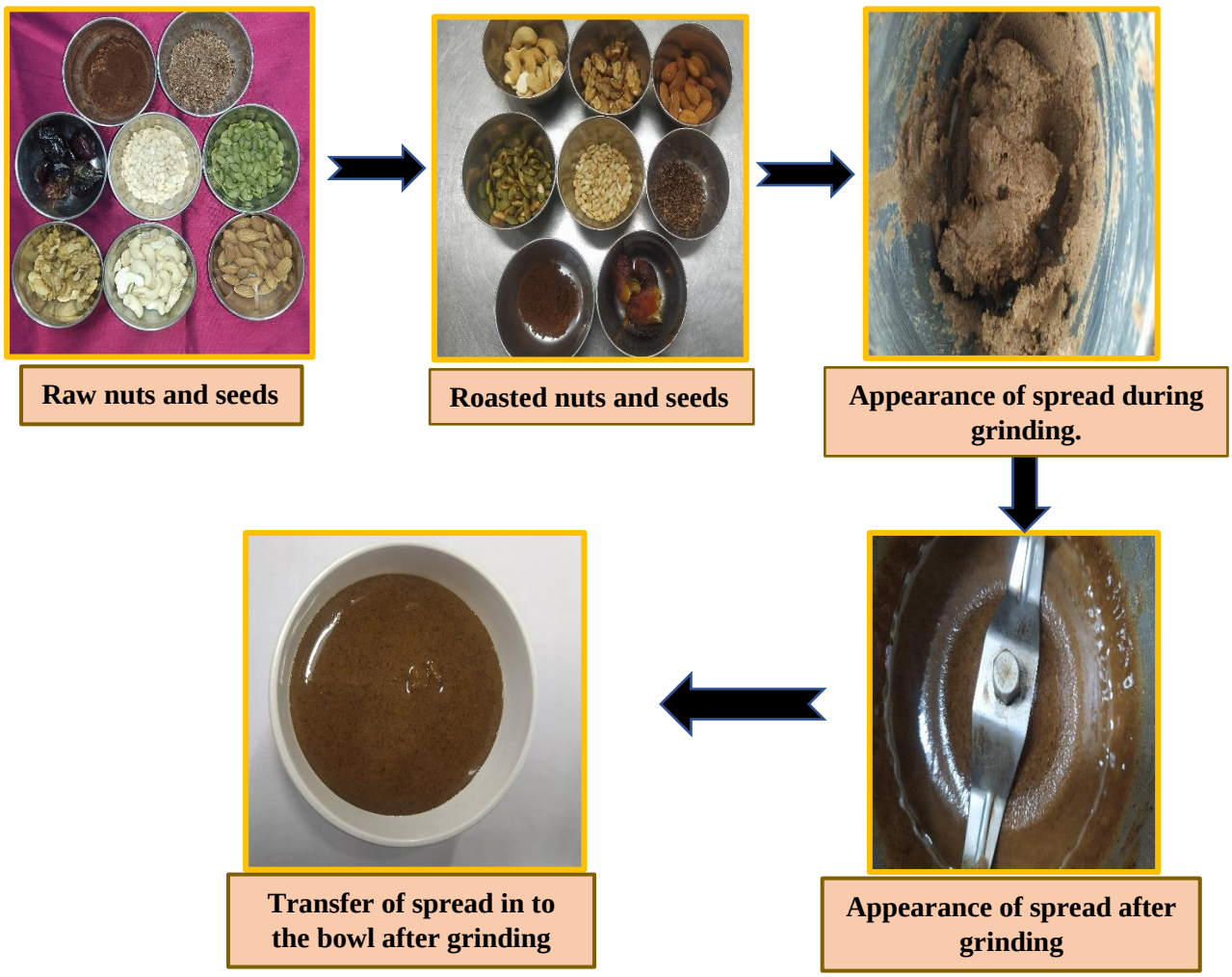


Plate 8: Preparation Process of Multi-Nuts and Seeds Spread for Variation 4

Plate 8 represent the preparation process of variation four. Compared to other variations, the consistency of the variation increased by the addition of pumpkin seeds, flax seeds. To improve the taste, the quantity of dates seeds was also decreased. The spread had a delicious flavor. Additionally, more honey was added. It provided the spread its sweetest flavor.

Variation 5:

The method used to develop this variation is the same as that in variations1, 2, 3 and 4. Ingredients and their quantity to develop variation 5 were mentioned in the above table VI. It took two hours to grind the ingredients to achieve a better spread consistency. Plate 9 shows the preparation process of variation 5.

Plate 9: Preparation Process of Multi-Nuts and Seeds Spread for Variation 5

This variation provided the finest aroma and taste to the spread. The spread's spreading consistency was excellent. It added a rich nutty flavor and a creamy texture to the course. Because the quantity of pumpkin seed and flax seed was increased. It resulted in the product, possessing that texture and flavor. The amount of honey was increased and the dates seed was decreased. The honey enhanced the sweetness of this variation while reducing the bitterness of the spread.

B. Acceptability and Standardization of Developed Multi-Nuts and Seeds Spread

The organoleptic evaluation was done using nine-point hedonic scale. It provided the objective information on how well the product is accepted by the individuals. Nine-point hedonic scale was used here to rate the developed multi-nuts and seeds spread.

Sensory attributes like appearance, color, flavor, texture, taste of the developed variation was evaluated. As follows, based on the scales,

Sensory evaluation was done by 15 semi- trained panel members from Avinashilingam University, Coimbatore. By using nine-point hedonic scales, the semi trained panelists rated the developed product of value-added multi-nuts and seeds spread with different variations

TABLE VII

MEAN SENSORY ACCEPTABILITY SCORE OF MULTI-NUTS AND SEEDS SPREAD (VARIATION 1)

S. No	Variation 1	Sensory Score
1	Appearance	8.0±1.16
2	Colour	8.0±1.27
3	Flavor	7.5±0.91
4	Texture	7.2±1.16
5	Taste	7.6±1.12
6	Overall Acceptability	7.7±0.98

The sensory evaluation of multi-nuts and seeds spread of variation 1 was done and mean score is indicated in table VII. The appearance (8.0) and color (8.0) received the highest score, in comparison to the other characteristics. The spread flavor and taste received a score of 7.5 and 7.6 respectively, indicating that they were liked moderately by the panel members. The texture received the lowest score (7.2) out of all other criteria was due to the addition of dates seeds. This variation had a total acceptability score of 7.7, which indicates that it falls between the criteria liked moderately somewhat and liked very much.

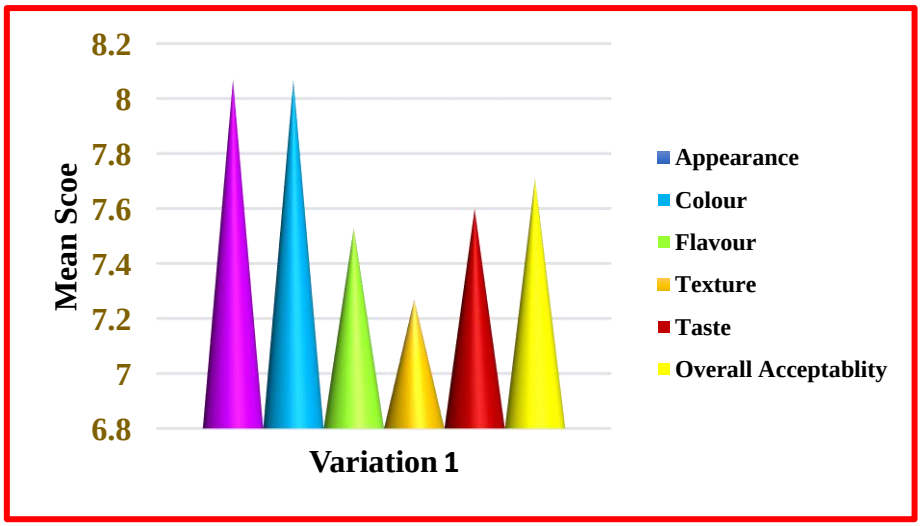


Figure 3: Acceptability Evaluation of Multi-Nuts and Seeds Spread (Variation 1)

TABLE VIII

MEAN SENSORY ACCEPTABILITY SCORE OF MULTI-NUTS AND SEEDS SPREAD (VARIATION 2)

S. No	Variation2	Sensory Score
1	Appearance	8.5±0.51
2	Colour	8.3±0.41
3	Flavor	7.3±1.17
4	Texture	7.6±1.18
5	Taste	7.0±1.25
6	Overall Acceptability	7.7±0.77

As mentioned above, in the table VIII, appearance and color got the highest score. It had an excellent appearance and color due to the highest concentration of dates seed in it. Flavor and taste received the lowest score of 7.3 and 7.0 respectively which was mainly more quantity of dates seed, which was added gave a made bitter taste. Even though, quantity of honey was increased, the bitter taste of dates seed dominated the sweetness of honey. The overall acceptability got the score of 7.7 which stands in between the criteria of like moderately and like very much. The texture of this variation improved when compared to variation one is due to the gradual increase in quantity of pumpkin seeds and flax seeds.

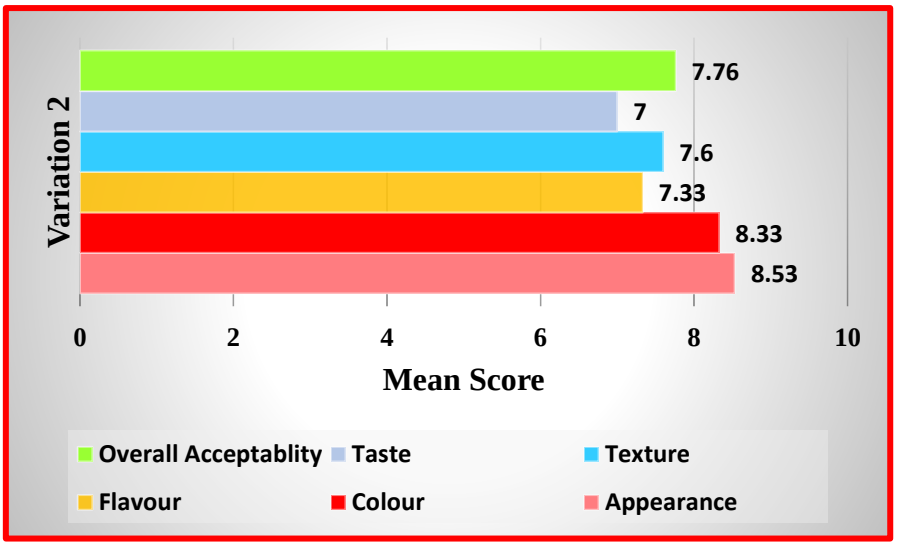


Figure 4: Acceptability Evaluation of Multi-Nuts and Seeds Spread (Variation 2)

TABLE IX

MEAN SENSORY ACCEPTABILITY SCORE OF MULTI-NUTS AND SEEDS SPREAD (VARIATION 3)

S. No	Variation 3	Sensory Score
1	Appearance	8.3±0.72
2	Colour	8.1±1.06
3	Flavour	7.7±1.33
4	Texture	7.6±1.35
5	Taste	7.6±1.35
6	Overall Acceptability	7.8±1.02

Table IX, shows the mean acceptability score of variation 3. Appearance and color of the developed spread got 8.3 and 8.1 respectively. Taste and texture both received a score of 7.6, which falls between the criteria of like moderately and like very much. The taste of the spread was improved from 7.0 - 7.6 compared to variation one. The improvement in taste and texture was due to the gradual changes made in quantity of ingredients like pumpkin seeds (38g), flax seeds (28g), dates seed (16g) and honey (12ml) which was increased compared to variation 2.

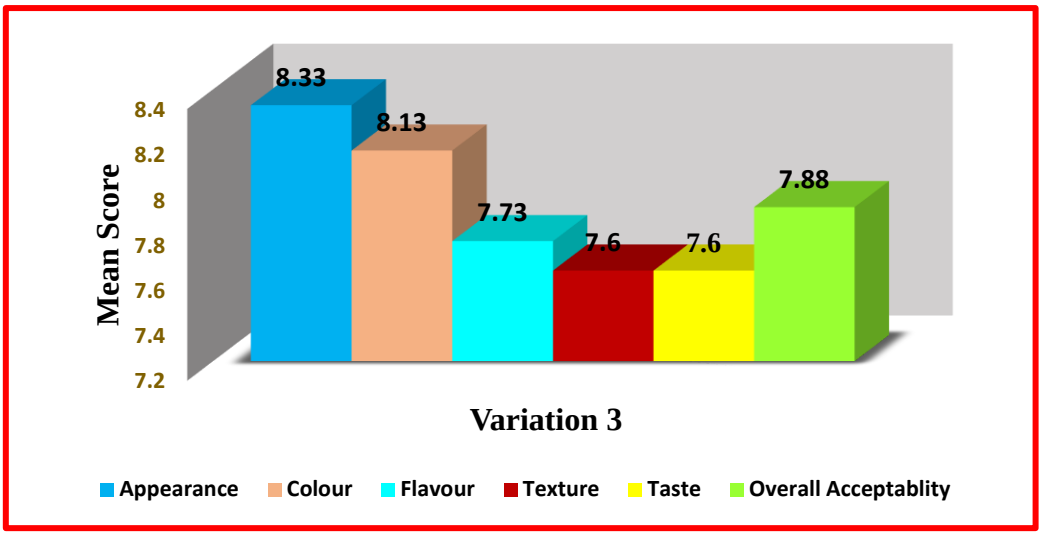


Figure 5: Acceptability Evaluation of Multi-Nuts and Seeds Spread (Variation 3)

TABLE X

MEAN SENSORY ACCEPTABILITY SCORE OF MULTI-NUTS AND SEEDS SPREAD (VARIATION 4)

S. No	Variation 4	Sensory Score
1	Appearance	8.2±0.79
2	Colour	8.2±0.56
3	Flavor	7.4±1.12
4	Texture	7.4±0.82
5	Taste	7.0±1.09
6	Overall Acceptability	7.6±0.67

The sensory evaluation of variation four multi-nuts and seeds spread was evaluated. Table X, depicts the sensory mean score of variation 4. For the developed spread, like the other variations appearance and color got the highest score of 8.2 compared to other attributes. It was due to the addition of dates seed, which gave that chocolate brown color to the spread, made it outstanding. Flavor and texture got the same score of 7.4 which had an excellent consistency is due to the increased quantity of pumpkin seeds (42g) and flax seeds (32g) which gave the product smooth texture and nutty flavor. The overall acceptability of the variation got 7.6 which was between the criteria of like moderately and like very much.

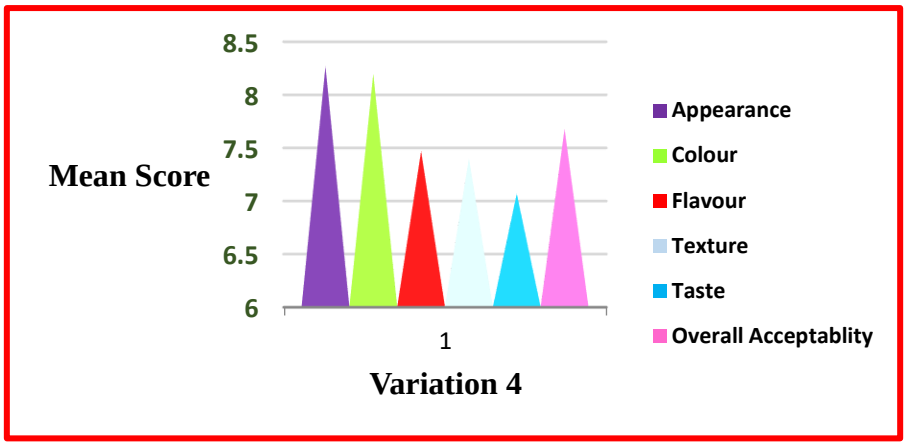


Figure 6: Acceptability Evaluation of Multi-Nuts and Seeds Spread (Variation 4)

TABLE XI

MEAN SENSORY ACCEPTABILITY SCORE OF MULTI-NUTS AND SEEDS SPREAD (VARIATION 5)

S. No	Variation 5	Sensory Score
1	Appearance	8.4±1.06
2	Color	8.4±0.50
3	Flavor	7.7±0.70
4	Texture	7.5±0.99
5	Taste	7.5±1.12
6	Overall Acceptability	7.9±0.75

The sensory evaluation of the mean score of variation 5 was mentioned in the Table XI. The appearance and the color got the highest score of 8.4 was mainly because of the ingredient, dates seed. Next to appearance and color, other than overall acceptability, flavor got the highest score, it was due to the addition of honey (20ml) and less quantity of dates seed (8g) and other nuts and seeds. They altogether gave an improved nutty flavor to this variation. Texture and taste received a similar score of 7.5 which stands in between the criteria of like moderately and like very much. This variation exhibits excellent spreadability with good consistency. The increased quantity of honey gave the sweetest and delightful taste towards this spread. The overall acceptability of this spread got 7.9 score which was close to the criteria of like very much.

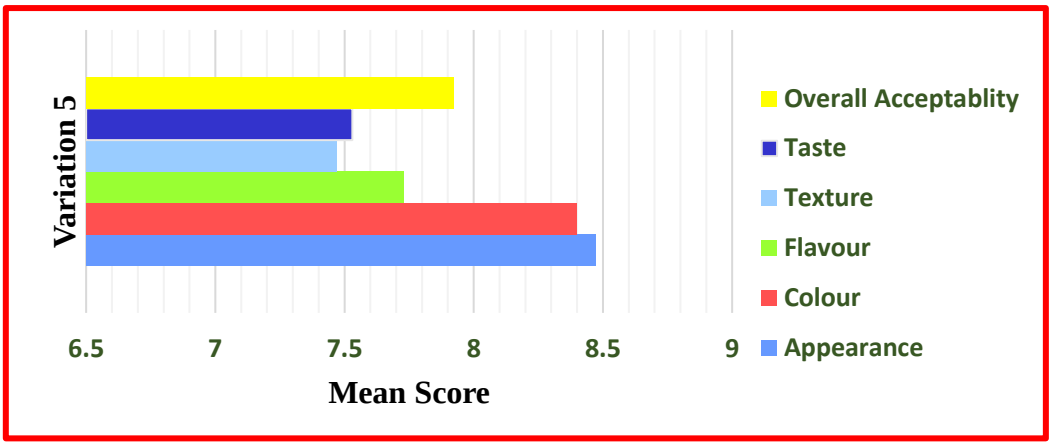


Figure 7: Acceptability Evaluation of Multi- Nuts and Seeds Spread (Variation5)

TABLE XII

MEAN OVERALL ACCEPTABILITY SCORE OF MULTI-NUTS AND SEEDS SPREAD OF DIFFERENT VARIATIONS

S. No	Overall Acceptability	Sensory Score
1	Variation 1	7.71
2	Variation 2	7.76
3	Variation 3	7.78
4	Variation 4	7.68
5	Variation 5	7.92

Table XII denotes the mean score of overall acceptability of developed variations of spread. The overall acceptability of the product was determined by taking the mean of every attribute like appearance, color, flavor, taste, and texture. Variation 5 received the overall highest acceptability score of 7.92. Variation 4 got the lowest acceptability rate of 7.68. The most acceptable variation 5 scored higher because the quantity of pumpkin seeds, flax seeds, dates seed, honey improved each attribute thereby improving the overall acceptance which was categorized under the criteria of like very much.

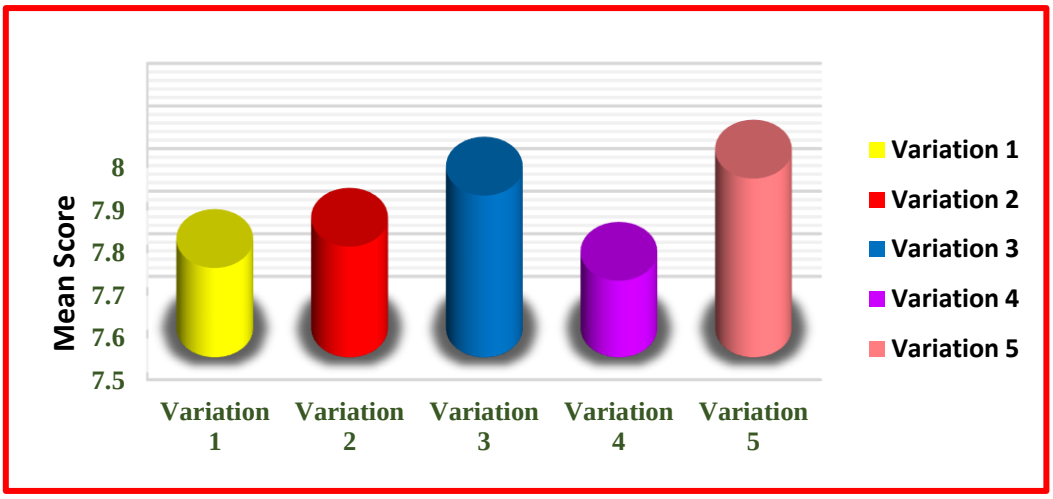


Figure 8: Overall Acceptability Mean Score of Multi-Nuts and Seeds Spread of Different Variations

Plate 10: Sensory Evaluation of Different Variations of Multi-Nuts and Seeds Spread

Standardization of the Recipe for Preparation of Value-Added Multi-Nuts and Seeds Spread:

The multi-nuts and seeds spread recipe was prepared in such a way that the final output of the spread was 220g. To ensure that the recipe's quantity and quality attributes were not

changed each time it was prepared, the same procedure and the same equipment was used in the standardization process. Therefore, the procedures was followed with same quality and quantity of ingredients was used to obtain consistent output of 220g of spread. The consistency, texture, flavor, color and appearance were also maintained throughout the standardization process.

C. Nutritional and Physiochemical Analysis of the Developed Multi-Nuts and Seeds Spread

The nutrient analysis was done for the developed variation 5, which received the highest score compared to other variations in organoleptic evaluation test. The macronutrients like energy, carbohydrate, protein, total fat, and unsaturated fat were analyzed. Micronutrients namely vitamin A, vitamin C, vitamin K, vitamin D, vitamin E, calcium, and iron were also analyzed. Selected ingredients are rich in antioxidants and phytochemicals. So that the antioxidant and phytochemical test was done. The amount of nutrients analyzed was given in the table XIII, XIV, XV, XVI, XVII.

TABLE XIII

MACRONUTRIENT ANALYSIS OF DEVELOPED MULTI-NUTS AND SEEDS SPREAD

S. No	Parameters	Multi-Nuts and Seeds Spread (Variation-5)	Unit
1	Energy	618.9	Kcal
2	Carbohydrate	20.7	g/100g
3	Protein	22.2	g/100g
4	Total Fat	49.7	g/100g
5	Unsaturated Fat	38.2	g/100g

The nutrient analysis of the multi-nuts and seeds spread was done. The macronutrient analysis of Table XIII represents the number of nutrients present in 100g of multi-nuts and seeds spreads. This spread had the highest energy content of 618.9 Kcal/100g. Generally, nuts and seeds are good sources of energy. The usage of nuts and fat content present has contributed to this energy value. The carbohydrate content was 20.7g in 100g of spread. Studies have shown that, nuts and seeds usually low in carbohydrates which makes them more versatile.

Nuts and seeds are highly nutrient-dense food items that are high in proteins like essential amino acids, and fibers **(Balakrishna et al., 2022).** Good amount of protein is the main reason for the huge consumption of nuts and seeds among people. It plays a crucial role in bodybuilding and better growth and maintenance. Around 22.2g of protein was present in 100g of multi-nuts and seeds spread. Both nuts and seeds are responsible for the protein content of the spread.

Nuts are the best source of monounsaturated and polyunsaturated fats. Low-density lipoprotein cholesterol gets reduced in the body by both polyunsaturated and monounsaturated fatty acids **(De, 2020).** A total of 49.7 g of fat was present in 100g of multi-nuts and seeds spread, in which 38.2 g was unsaturated fat.

TABLE XIV

MICRONUTRIENT ANALYSIS OF DEVELOPED MULTI-NUTS AND SEEDS SPREAD

S. No	Parameters	Multi-Nuts and Seeds Spread (Variation-5)	Unit
1	Vitamin A	815	mcg/100g
2	Vitamin C	96.7	mg/100g
3	Vitamin D	0.12	mcg/100g
4	Vitamin K	0.22	mcg/100g
5	Vitamin E	6.0	mg/100g
6	Iron	38.78	mg/100g
7	Calcium	199	mg/100g

Table XIV portrays the micronutrient content of the developed spread. Fat-soluble vitamins like 815 mcg of vitamin A, 0.12 mcg of vitamin D, and 0.22 mcg of vitamin K and 6.0 mg of vitamin E were present in 100g of developed spread. The addition of seeds mainly contributed to the minerals content of the developed spread. Minerals namely, iron and calcium content of the spread were 38.78 mg and 199 mg respectively.

TABLE XV

ANTIOXIDANT ASSAY OF DEVELOPED SPREAD (STANDARD ASCORBIC ACID)

Concentration (µg/ml)	% Inhibition
3	62.30
6	70.49
9	83.61
12	90.16
15	95.90

The DPPH free radical scavenging method is the common method used for determining whether a substance, an extract, or other compounds have antioxidant capacity. The desired product or extract is combined with DPPH solution, and then the absorbance is measured after a predetermined amount of time **(Kedare and Singh, 2011).** The antioxidant assay was done using the DPPH method. Ascorbic was used as a standard solution. The DPPH solution (2,2-diphenyl-1-picryl-hydrazyl-hydrate) was prepared and added to the developed diluted spread with different concentrations. The table XV shows the calculated percentage of the inhibition rate in standard ascorbic acid.

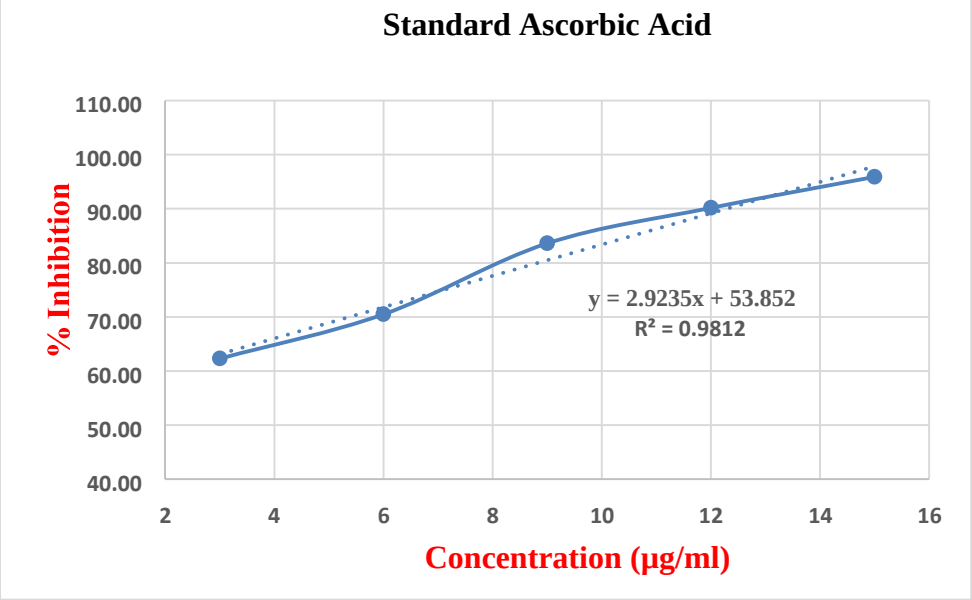


Figure 9: Percentage of Antioxidant Inhibition Rate in Developed Spread

TABLE XVI

ANTIOXIDANT ASSAY OF DEVELOPED SPREAD

(DILUTED SPREAD)

Concentration (µl)	% Inhibition
10	50.82
50	60.66
150	54.92
250	50.82
350	43.44
500	38.52
750	34.43

Total antioxidant analysis of the developed spread is depicted in table XVI. Six different concentrations of 10, 50, 150, 250, 350, 700, and 750 of solvents were prepared. The

diluted spread showed different levels of inhibition rates. Free radical scavenging activity of the diluted spread inhibition rate was observed. At 50µl of concentration showed the highest antioxidant activity at 60.66% inhibition rate. The percentage of inhibition is given in the table XVI.

TABLE XVII

PHYTOCHEMICAL ANALYSIS OF DEVELOPED SPREAD

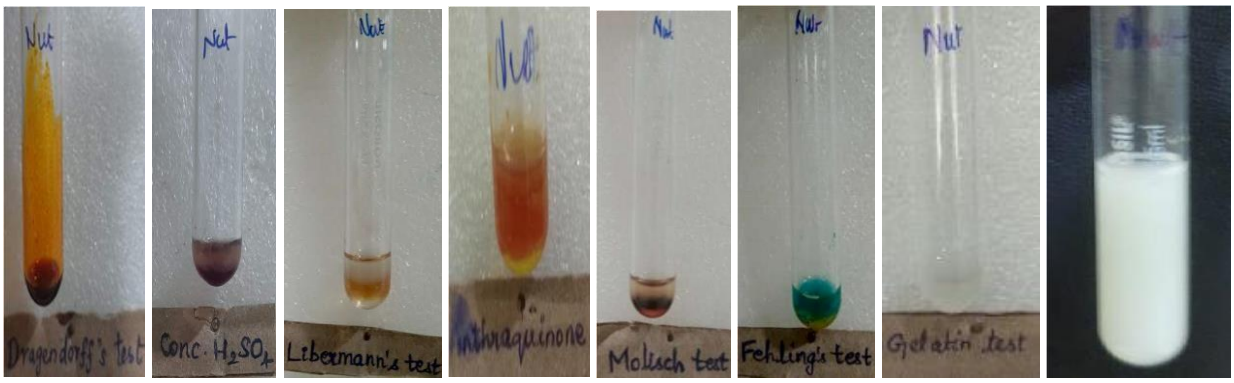
S.No	Metabolite	Test Performed	Observation	Result	Figure No.
1	Alkaloid	+ Dragendorff's reagent	Presence of reddish brown precipitate	+	1
2	Flavonoids	$+H_2SO_4$	Presence of reddish Orange colour	+	2
3	Anthraquinone (Borntragers Test)	+ $FeCl_3$ + Conc.HCl+diethyl ether +Ammonia	Presence of reddish orange color	+	4
4	Sterols (Libermann test)	$+CHCl_3$+ Acetic anhydride +Conc.H_2SO_4	Presence of reddish brown ring	+	3
5	Carbohydrate	Molisch's test	Presence of Violet ring	+	5
		Fehling's test	Presence of Red precipitate	+	6
6	Tannin	+Gelatin test	Presence of white precipitate	+	7
7	Saponin	Shaken with water	Presence of foam	+	8

Phytochemical analysis was done. The table XVII projects the presence or absence of phytochemicals present in the developed spread. Due to the presence of a wide variety of phytochemicals, nuts, and seeds perform several beneficial physiological functions **(Lu et al., 2022).** Alkaloids and flavonoids showed a positive result which denotes the presence of alkaloids and flavonoids in the developed spread. The functional hydroxyl groups in flavonoids exhibit their antioxidant properties by chelating metal ions or by scavenging free radicals. This

aids in reducing the production of free radicals, which damage biomolecules and cause oxidative stress and a variety of diseases **(Tiwari & Husain, 2017).**

Sterols are lipids generated from isoprenoids that play crucial roles in cell physiology, structure, and function. Using the Libermann test, the presence of sterol was confirmed in the developed spread by the formation of a reddish-brown ring with conc. H_2SO4. The phytosterol and cholesterol has a similar structure thereby it affects the absorption rate of cholesterol in the body. This substitution effect reduces the micellar cholesterol levels, which in turn reduces the cholesterol absorption rate **(Sanclemente *et al.,* 2009).** Borntrager's test was done to identify the presence of anthraquinone. The inference of the test depicted the formation of reddish orange color with 10ml of 10% ammonia solution, which confirmed the anthraquinones are found in the developed nits and seeds spread.

Molisch's and Fehling's test was carried out to identify the presence of carbohydrates, the formation of violet ring with alcoholic α–naphthol and 1ml of conc. H_2SO4 and red precipitate with 1ml each of Fehling's solution, showed the positive result, for the presence of carbohydrate in the developed spread. For identifying the presence of tannin, the gelatin test showed a positive result with the formation of white precipitate with 1% of gelatin solution and 10% of NaCl. Tannins have potential antioxidant capacity. They have been said to be cardioprotective, anti-inflammatory, anti-carcinogenic, and anti-mutagenic **(Kumari and Jain, 2012).** Presence of saponins was confirmed in the developed spread, when the sample was mixed with water and shaken lead to the formation of foam which confirmed the presence of saponins. Saponins have number of pharmacological characteristics including antifungal, insecticidal, antibacterial, cytotoxic, anti-inflammatory, immune booster and also lower cholesterol and blood glucose level in body **(Marrelli *et al.,* 2016)**. Plate 11 represents the result occurred while the phytochemical screening was done.



1 2 3 4 5 6 7 8

Plate 11: Phytochemical Analysis of Multi-Nuts and Seeds Spread

TABLE XVIII

ANALYSIS OF VISCOSITY OF THE DEVELOPED SPREAD

S. No	Multi-Nuts and Seeds Spread	Viscosity
1	Variation 1	484.7 cSt
2	Variation 2	528.4 cSt
3	Variation 3	524.7 cSt
4	Variation 4	500.9 cSt
5	Variation 5	738.6 cSt

The viscosity of the developed multi-nuts and seeds spread of different variations is depicted in table XVIII. The viscosity of the spread is used to measure the quality and spreadability of the spread. The higher the viscosity, the better the product quality **(Marfo *et al.*, 2016).** Variation one had the lowest viscosity rate of 484.7 cSt (Centistoke) and the Variation five had the highest viscosity rate of 738.6 cSt. Viscosity is the measure of the products resistance to flow. Naturally, nuts and seeds spread are semi-solid in nature. Thus, while testing the product it took long time (30 to 45 minutes) to flow due to its thick consistency.

D. Observation of the Shelf Life of the Spread

The shelf life of the developed spreads was observed for fifteen days. The developed five variations were assessed for any sensory changes or microbial growth in the storage process. All these variations were kept at a room temperature of 24 -25 degrees Celsius. These five different variations were developed and packed in a closed glass container. Before pouring the spread into the glass jar, the glass containers were sterilized and dried properly under hygienic conditions to prevent future spoilage. All the hygienic practices were followed to avoid spoilage. Then the five different variations were transferred into the five different glass containers and closed properly with tight-fitting lids to restrict the entry of moisture and any other foreign agents.

From day one to day fifteen, the packed spread in glass containers was opened daily and checked for any changes in sensory attributes like appearance, colour, taste, texture, and flavour. Observation of microbial changes was also done to test any form of yeast or mould in the developed spread. The product's shelf life was determined after the changes to these properties were examined and mentioned. The multi-nuts and seeds spread shelf-life study is shown in table XIX.

TABLE XIX

SHELF-LIFE STUDY OF THE DEVELOPED SPREAD UNDER ROOM TEMPERATURE

Dates of Observation of Microbial Growth	Variation 1	Variation 2	Variation 3	Variation 4	Variation 5
Day1	X	X	X	X	X
Day2	X	X	X	X	X
Day3	X	X	X	X	X
Day4	X	X	X	X	X
Day5	X	X	X	X	X
Day6	X	X	X	X	X
Day7	X	X	X	X	X
Day8	X	X	X	X	X
Day9	X	X	X	X	X
Day10	X	X	X	X	X
Day11	X	X	X	X	X
Day12	X	X	X	X	X
Day13	Y	Y	Y	Y	Y
Day14	Y	Y	Y	Y	Y
Day15	Y	Y	Y	Y	Y

X – Absence of sensory changes and microbial growth

Y – Presence of sensory changes and microbial growth

Sensory attributes like appearance, colour, taste, flavour, texture, and overall acceptability were tested over a period of fifteen days. Other factors namely microbial growth of yeast, and mould were also studied. The taste and flavour remained unchanged for 12 days. But from the 13th day the developed multi-nuts and seeds spread are separated from the oil. The oil is separated on the top of the spread and the consistency of the spread were changed. Generally, Spreads have a good shelf life but when it was stored for several months, there may be mild changes in the texture. Good hygienic practices and a better storage atmosphere will only allow the product to stand for long days. Plate 12 shows the shelf-life study of the developed spread.

Plate 12: Shelf-Life Study of the Developed Multi-Nuts and Seeds Spread

TABLE XX

SHELF-LIFE STUDY OF THE DEVELOPED SPREAD UNDER REFRIGERATION

Dates of Observation of Microbial Growth	**Variation 1**	**Variation 2**	**Variation 3**	**Variation 4**	**Variation 5**
Day1	X	X	X	X	X
Day2	X	X	X	X	X
Day3	X	X	X	X	X
Day4	X	X	X	X	X
Day5	X	X	X	X	X
Day6	X	X	X	X	X
Day7	X	X	X	X	X
Day8	X	X	X	X	X
Day9	X	X	X	X	X
Day10	X	X	X	X	X
Day11	X	X	X	X	X
Day12	X	X	X	X	X
Day13	X	X	X	X	X
Day14	X	X	X	X	X
Day15	X	X	X	X	X

Table XX depicts the storage of developed multi-nuts and seeds spread under refrigeration. The appearance, colour, taste, flavour, consistency remain unchanged for 15 days. The absence of microbial growth developed was observed. The microbial analysis of total plate count, yeast and mould was tested. A maximum limit of 10^6 CFU of total aerobic mesophilic bacteria was given by the International Commission on Microbiological Specifications for Foods (ICMSF). Acceptable quality is defined as a total aerobic mesophilic count of less than or equal to 10^4 CFU/g. And CFU/g between 10^4 and 10^6 is of marginal quality. Values greater than 10^6 are not acceptable (**Gonzalez *et al.*, 2017).** The total plate count of the developed multi-nuts and seeds spread was 3.5×10^2 CFU/g. The yeast and mould count of the developed spread was 42 CFU/g. The result of the microbial analysis of total plate count came below 10^4 *which denotes that the spread was in acceptable quality.*

E.Cost Calculation of the Developed Multi-Nuts and Seeds Spread

The cost of each ingredient was calculated along with their manufacturing and selling cost. Packaging and labelling were also done. They were packed in a clean sterilized glass jar and labelled with required information.

i) Cost Calculation

The cost of the developed spread was calculated. It was calculated by addition of cost of each ingredient used to develop the spread. And it was multiplied by 1.66. The standard overhead method was employed to calculate the cost of the developed multi-nuts and seed spread. Table XXI represents the quantity of ingredients and their cost.

TABLE XXI

QUANTITY OF INGREDIENTS AND THEIR PRICES

S. No	Ingredients	Variation 5	Cost (Rs.)
1	Almond	40g	28
2	Walnut	30g	25
3	Cashew	40g	46
4	Pumpkin seeds	46g	40
5	Watermelon Seeds	20g	14
6	Flax seeds	36g	7
7	Dates and Dates seed	60g+8g	24
8	Honey	20ml	12

Total Yield- 220g

Total cost – Rs.196

Overhead charge- 196 x 1.66 = Rs.325

The overall cost of the developed spread was calculated. The yield of the product was 220 g. The quantity of the ingredients used is mentioned in the table XX. The total cost of the developed spread was three hundred twenty-five rupees. The cost of the spread was quite high because the ingredients used here were nuts and seeds loaded with high nutritional composition and provided various health benefits. It is a value-added product with multi nuts and seeds. The developed spread demanded a high cost. But compared to commercially available other nuts and seeds spread costed high than this developed multi-nuts and seeds spread. So, it is an affordable one, compared to others.

ii) Packaging and Labelling:

The multi-nuts and seeds spread was developed and packed in an airtight glass jar. Glass jar was sterilized, and the spread was packed for better storage. For labelling, product name was given. The ingredients used to develop the spread were mentioned. Instruction for storage, price of the spread, net quantity, date of manufacture, and its batch number were mentioned. Plate 13 depicts the packaging and labelling of the developed multi-nuts and seeds spread.

Plate 13: Packaging and Labelling of the Developed Multi-Nuts and Seeds Spread

SUMMARY AND CONCLUSION

In recent days, consumer demand for ready to eat food products has increased. The lifestyle pattern, work time and the food habit changes of today has brought rapid changes from buying process till the consumption process. Modernization and lack of time has lead to frequent usage of ready-to-cook and ready-to-eat food products. The availability of nutritious ready-to-eat products are lesser compared to other food products. Consuming plant based foods like nuts and seeds increases the nutritional value of the diet and may help to avoid chronic diseases. Nuts and seeds form a healthier option for all age groups. Different nuts and seeds have different health promoting factors. The market growth for nuts and seeds based spread in the world has increased to 6.2% of annual growth during 2004-2009. Commercially nuts spread and combination of nuts and seeds spread are also available in the market

As known, different commercial nuts and seeds spreads are available in the market but they are loaded with excess added oils, additives and artificial preservatives. Health concerns are increasingly influencing people's dietary preferences as the world is threatened by lifestyle diseases like Obesity, diabetes, cardiovascular and different types of cancer which is on the lead. Nuts and seeds are rich in protein, fats like unsaturated fatty acids, calcium, iron, vitamins namely A, D, E, K,C. Nuts and seeds are known for their antioxidant capacity. They are low in sodium and high in potassium. Phytochemicals namely, phenolic compounds like flavonoids, Tannin, saponin. Sterols are also present which provides various health benefits.

The study entitled "Formulation and Development of Value-Added Multi-Nuts and Seeds Spread" was carried out with the objective to develop a nutrient rich multi-nuts and seeds spread as a healthy option. The multi-nuts and seeds spread was developed with five variations. The nuts including almond, walnut, cashew nut and seeds namely pumpkin seeds, watermelon seeds, flax seeds, dates seeds were used. Other ingredients like dates and honey were added for the better consistency and sweetness of the spread. These ingredients were used to develop the multi-nuts and seed spread.

For the development and standardization of multi-nuts and seeds spread, nuts and seeds were selected based on the nutritional composition and their health promoting properties. By changing the quantity of the certain ingredients five variations were developed. For the development of multi-nuts and seeds spread various pre-preparation and preparation techniques were employed. For the acceptability test, the organoleptic evaluation of nine-point hedonic

scale was used to assess the overall acceptability of the developed spread. It was assessed by the semi trained panel members. The variation with higher acceptability score was selected for standardization of recipe. Variation 5 got the higher acceptability score and thus this particular variation was taken for standardization. The recipe was repeated a number of times until the same quality and quantity attributes were obtained. Then the developed spread was analyzed for nutritional content namely energy, carbohydrate, protein, total fat, unsaturated fat, calcium, iron, vitamin- A, D, E, K and C. Antioxidant assay, phytochemical analysis and viscosity test was performed. The shelf-life study was also carried out and observed for15 days under room temperature and 15 days under refrigeration conditions the spread was analyzed for shelf life. At last, packaging and labelling of the developed multi-nuts and seeds spread were done.

The Salient Findings of the Study are,

- The multi-nuts and seeds spread was developed using different nuts namely almond, walnut, cashew nut, and seeds like pumpkin seeds, flax seeds, watermelon seeds, and dates seeds. Other ingredients like dates and honey were used.
- The initial process for the preparation of spread involved roasting of nuts and seeds, Nuts were roasted in the oven at 175° C for 10 minutes and the seeds were roasted at 175° C for 5 minutes. Dates seeds took 20 minutes 175° C for better roasting.
- Five different variations were formulated by changing the quantity of the ingredients used to develop the value-added multi-nuts and seeds spread.
- Nine-point hedonic scale was used to assess the overall acceptability of the developed spread. From the scores obtained, mean score and standard deviations were calculated.
- Variation 1: For the variation 1, the sensory attributes like appearance, color, flavour, texture and taste got the scores of 8.0, 8.0, 7.5, 7.2, 7.6 respectively. The overall acceptability of this variation was 7.7.
- Variation 2: The overall acceptability of variation 2 was 7.7. The sensory attributes of appearance, Colour, flavour, texture and taste got the score of 8.5, 8.3, 7.3, 7.6, 7.0 respectively.
- Variation 3: In organoleptic evaluation, the criteria of appearance, colour, flavour, texture, and taste got the score of 8.3, 8.1, 7.7, 7.6, 7.6 respectively. The overall acceptability of this variation scored 7.8.
- Variation 4: The appearance, Colour, flavour, texture and taste of the spread scored 8.2, 8.2, 7.4, 7.4, 7.0 respectively in sensory evaluation. The overall acceptability of this variation was 7.6.

- Variation 5: In sensory evaluation, the criteria namely appearance, Colour, flavour, texture and taste scored 8.4, 8.4, 7.7, 7.5, 7.5 respectively. The overall acceptability of the variation 5 got the score of 7.9.
- Variation 5 of developed multi-nuts and seeds spread had the highest acceptability score of 7.92, whereas variation 4 of the developed multi-nuts and seeds spread got the lowest acceptability score of 7.68.
- The nutrients namely energy, carbohydrate, protein, total fat, unsaturated fat, calcium, iron and vitamins of A, D, E, K, C were analyzed. The spread's viscosity, antioxidant capacity and phytochemical analysis were carried out.
- The macronutrients namely 618.9 Kcal of energy, 20.7g of carbohydrate, 22.2g of protein, 49.7g of total fat and 38.2g of unsaturated fat were present in 100g of developed multi-nuts and seeds spread.
- The micronutrients present in the developed spread where 815 mcg of vitamin A, 96.7 mg of vitamin C, 0.12 mcg of vitamin D, 0.22 mcg of vitamin K, 38.78 mg of iron, 6.0 mg of vitamin E and 199 mg of calcium.
- In antioxidant analysis, 50 µl of concentration had the highest inhibition rate of 60.66%.
- In phytochemical analysis, the test showed a positive result indicating the presence of alkaloids, flavonoids, sterols, anthraquinone, carbohydrates, tannins and saponins.
- The physicochemical analysis of viscosity of the developed spread was done for all the five variations. As this spread was in semisolid state, it took more time to flow during the test. The viscosity of five variations were 484.7 cSt, 528.4 cSt, 524.7 cSt, 500.9 cSt, 738.6 cSt respectively. Variation 5 received the highest value for viscosity testing.
- The shelf-life study of the different variations of developed multi-nuts and seeds spread was performed by storing the developed spread under room temperature as well as in the refrigerator.
- The spread which was stored for 15 days under room temperature had oil separation formed as a layer on the top of the spread by 13^{th} day of storage and there was no visible microbial growth observed.
- The developed spread which was stored under refrigeration temperature for 15 days did not show any sensory changes with respect to appearance, colour, flavour, texture and taste profile. No microbial growth was also observed.
- The variation 5 which got the highest acceptability score was selected and the cost was calculated. The 220g of the developed multi-nuts and seed spread cost Rs. 325/-. Compared to other spreads available in the market, it is affordable and economical.

- The developed multi-nuts and seeds spread was packed in a airtight glass container. The labelling multi-nuts and seeds spread included the name of the spread, net weight, vegetarian symbol, ingredients used, allergen alert, nutritional facts, price, packaging date and batch number.

Conclusion:

The fast-moving world demands for healthier options of convenience food products which are available at a very low quantity with high selling price which cannot be affordable by all different groups of consumers. Keeping these aspects in mind, the multi-nuts and seeds spread was developed with various nuts and seeds, which had good nutrient content and affordability. The developed spread was free of additives and chemical preservatives. The added dates seeds gave new flavour to the developed spread. The developed spread is rich in antioxidants and phytochemicals, and it is also lactose and gluten free product, which can be consumed by all age groups. Compared to commercially available spreads, it is more affordable and economical.

Scope for Future Research:

- Developing different combinations of nuts and seeds spread.
- Incorporation of greens with nuts and seeds spread.
- Developing energy bar using different seeds

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ANNEXURE-I

Human Ethical Committee Certificate

INSTITUTIONAL HUMAN ETHICS COMMITTEE

Avinashilingam
Institute for Home Science and Higher Education for Women
(Deemed to be university under Category 'A' by MHRD, Estd. u/s 3 of UGC Act 1956) Re-accredited with 'A^{++}' Grade by NAAC.
Recognised by UGC Under Section 12 B
Coimbatore- 641043, Tamil Nadu, India

Chairman
Dr. Sudha Ramalingam
Director – Research and Innovation
Professor- Community Medicine,
PSG Institute of Medical Sciences &Research, Coimbatore.

Member Secretary
Dr A Thirumani Devi
Professor
Department of Food Science and Nutrition

Members
Mr. K Arulmoli (Legal Expert)
Dr. Subashini K.Sripathi
Dr. A Saraswathy(Medical Officer)
Ms. D. Kavitha
Dr. A R Sudamani Ramasamy
Dr. G. Victoria Naomi
Dr. Judith Justin
Dr. Anitha Subash
Dr. K Sampath Rani

05.01.2023

To
Ms. S. Aathithya,
Department of Food Service Management and Dietetics
Avinashilingam Institute for Home Science and
Higher Education for Women
Coimbatore- 641043

Dear Aathithya,

Ref: Your proposal No. IHEC/22-23/FSMD-02 entitled "Formulation and Development of Value-Added Multi-nut and Seeds Spread" submitted for approval of IHEC 21.11.2022

The Institutional Human ethics Committee of our University hereby grants approval to your research proposal No. IHEC/22-23/ FSMD-02 entitled "Formulation and Development of Value-Added Multi-nut and Seeds Spread" submitted by you. The Approval number for the same is AUW/IHEC/FSMD- 22-23/XMT-02.

We wish you all the best in your research endeavours.

Regards

Dr. A Thirumani Devi 5.1.23
Member Secretary

Institutional Human Ethics Committee

ANNEXURE II

Procedure for Nutrient Analysis

1. Estimation of Energy

Test Method:

By Calculation

Lists the following energy conversion

Carbohydrates	17KJ/g, 4kcal/g
Fat	38 KJ/g, 9kcal/g
Protein	17 J/g, 4kcal/g

Energy (kcal/g) = (Carbohydrate X 4) + (Fat X 9) + (Protein X 4)

2. Estimation of Total carbohydrate by

Reagents:

Anthrone Reagent

- 2.5N HCl
- Anthrone reagent: Dissolve 200 mg anthrone in 100 ml of ice-cold 95% Sulphuric acid. Prepare fresh before use
- Standard Glucose (stock): Dissolve 100 mg in 100 ml distilled water
- Working standard: 10 ml of stock diluted to 100 ml with distilled water. Store refrigerated after adding a few drops of Toluene

Procedure

1. Weigh 10-100 mg of the sample in to a boiling tube
2. Hydrolyze by keeping it in a boiling water bath for 3 hours with 5 ml of 2.5 N HCl and cool to room temperature
3. Neutralize with solid Sodium carbonate until the effervescence ceases
4. Make up the volume to 100 ml and centrifuge
5. Collect the supernatant and take 0.5 and 1 ml aliquots for analysis
6. Prepare the standards by taking 0, 0.2, 0.4, 0.6, 0.8 and 1 ml of the working standard, ‘0’ serves as blank
7. Make up the volume to 1 ml in all the tubes including the sample tubes by adding distilled water

8. Then add 4 ml of Anthrone reagent
9. Heat for 8 minutes in a boiling water bath
10. Cool rapidly and read the green to dark green colour at 630 nm
11. Draw a standard graph by plotting concentration of the standard on the X-axis versus absorbance on the Y-axis
12. From the graph calculate the amount of carbohydrate present in the sample tube

Calculation

$$\text{Concentration of the Carbohydrate (\%)} = \frac{\text{OD (test)}}{\text{OD (std)}} \times \frac{\text{Conc (std)}}{\text{Aliquot (test)}} \times 100$$

3) Determination of Total Protein by Lowry's Method

Reagents

- 2% Sodium carbonate in 0.1 N Sodium hydroxide (Reagent A)
- 0.5% Copper sulphate ($CuSO_4.5H_2O$) and 1% Potassium sodium tartarate in 100 ml distilled water (Reagent B)
- Alkaline copper solution: Mix 50 ml of A and 1 ml of B prior to use (Reagent C)
- Folin-Ciocalteau Reagent
- Protein Solution (Stock Standard) - Weigh accurately 50 mg of bovine serum albumin and dissolve in distilled water and make up to 50 ml in a standard flask
- Working Standard- Dilute 10 ml of the stock solution to 50 ml with distilled water in a standard flask. 1 ml of this solution contains 200 µg protein

Procedure

- Extraction of Protein from sample: Extraction is usually carried out with buffers used for the enzyme assay. Weigh 500 mg of the sample and grinded well with a pestle and mortar in 5-10 ml of the buffer. Centrifuged and used the supernatant for protein estimation
- Pipette 0.2, 0.4, 0.6, 0.8 and 1 ml of the working standard into a series of test tubes
- Pipette 0.1 ml and 0.2 ml of the sample extract in two other test tubes
- Make up the volume to 1 ml in all the test tubes. A tube with 1 ml of water serves as the blank
- Add 5 ml of reagent C to each tube including the blank. Mix well and allow standing for 10 minutes
- Then add 0.5 ml of reagent D, mix well and incubated at room temperature in the dark for 30 minutes. Blue colour is developed

- Take the readings at 660 nm
- Draw a standard graph and calculate the amount of protein in the sample and express the amount of protein in mg/g or 100 g sample

Calculation

Concentration of the Protein (%) = $\frac{\text{OD (test)}}{\text{OD (std)}} \times \frac{\text{Conc (std)}}{\text{Aliquot (test)}} \times 100$

3) Determination of Total Fat

Procedure

- Weigh, accurately 5-10 g (W_1) of dry sample into a thimble and keep a cotton plug on top of it
- Place the thimble in a **Soxhlet apparatus** and add ½ volumes of Ether into a pre-weighed flat- bottom flask (W_2) and distilled for 16 hours (Cool the apparatus and filter the solvent into a pre- weighed conical flask (W_2)
- Rinse the flask of the apparatus with small quantities of Ether and then added washings to the above flask)
- Remove Ether by evapouration and dried the flask with fat at 80-100°C, cool in a desiccator and weigh (W_3)

Calculation

Fat content (g/ 100%)= (W_3-W_2) = XW1

Where, W1- Weight of dry matter taken for extraction

W2- Weight of flat bottom flask, W3- Weight of flask with fat

4) STANDARD OPERATING PROCEDURE FOR TESTING OF IRON IN SAMPLE

Apparatus:

- ✓ Atomic absorption spectrophotometer with air acetylene flame
- ✓ Cathode Lamp-Fe – 248.3 nm.

Reagent:

- Fe (*NIST traceable)*
- Nitric acid (1:499).
- $CaCl_2$ solution: Dissolved 630 mg $CaCO_3$, 50 ml of 20% v/v HCL, if required boil gently to obtained complete solution. Cool and dilute to 1000 ml with distilled water.

Procedure:

- Take 100 ml standard flask

- Prepare Iron standards (*Nist traceable*) to 0.05,0.1, 0.125,0.15,0.20&0.25 mg/l
- in nitric acid (1:499) from 1000 ppm solution.
- Prepare a blank solution in 100ml distilled water.
- Pipette out 100 ml of sample in a beaker and digest with 0.5 ml. of conc.
- Nitric acid and add 25 ml $CaCl_2$ till the volume reduced to three fourth
- Make up to 100 ml. with distilled water.
- Process the blank also in the above manner.
- Set the AAS as per the specific work instruction.
- Aspirate the blank, standards and digested food sample solutions.
- Measure the absorbance of the iron at 248.3nm.

Calculation:

- Draw the standard calibration graph by plotting the absorbance Vs standard conc. for each standard
- Process one quality check standard at 0.05 mg/l along with each batch of samples.

5) Estimation of Calcium

Procedure

- Weigh accurately about 2g of sample in a porcelain dish.
- Ignite in furnace to carbon free ash, but avoid fusing.
- Boil the residue in 40ml HCl (1+3) and few drops of HNO_3.
- Cool and transfer to a 250ml standard flask, dilute to volume and mix.
- Pipette 25ml clear liquid into a beaker, dilute to 100ml and add 2drops of methyl red.
- Add NH_4OH (1+1) drop wise to pH 5.6 (brownish orange colour).
- If overstepped add HCl (1+3) with dropper to orange.
- Add two more drops of HCl to pink and pH 2.5-3.0
- Dilute to 150ml and boil.
- Add slowly with constant stirring 10ml of hot saturated (4.2%) solution of ammonium oxalate.
- If red changes to orange or yellow, add HCl drop wise until pink

- Let stand overnight for precipitate to settle.
- Filter the supernatant through Whatman no.40 and wash the precipitate thoroughly with NH_4OH (1+50).
- Place the paper in original beaker and add a mixture of 125ml water
- And 5ml H_2SO_4.
- Heat to 70˚C and titrate against 0.02M $KMnO_4$(0.1N) to slight pink Color.

Calculation

$$\text{Calcium (as Ca)} = \frac{\text{Titre volume} \times \text{normality of } KMnO_4 \times 100 \times 28 \times 40}{\text{Sample weight} \times 1000 \times 56}$$

6) Estimation of β-carotene: Vitamin A

- ✓ β-carotene was estimated following approved method as described below.
- ✓ sample was taken in 150 ml glass stoppered Erlenmeyer flask and 40 ml water saturated butanol (WSB) was added. The contents of the flasks were mixed vigorously for 1 minute and kept overnight (16-18 hrs) at room temperature under dark for complete extraction of β-carotene. Next day, the contents were shaken again and filtered completely through the Whatman no.1 filter paper into a 100 ml volumetric flask. The optical density of the clear filtrate was measured at 440 nm using spectrophotometer.
- ✓ Pure WSB was used as blank. The β-carotene content was calculated from calibration curve from known amount of β-carotene as discussed below and expressed as parts per million (ppm). Standard solution of β-carotene (Sigma) was prepared in water saturated butanol (WSB) at the concentration of 5 µg/ml. WSB is prepared by mixing n-butanol with distilled water in 8:2 ratios.
- ✓ Calibration curve is made from known amounts of pure β-carotene from 0.25 µg/ml to 1.5 µg/ml which are prepared after suitable dilutions of original stock with WSB in calibrated 10 ml volumetric flasks (from 0.5 ml to 3 ml of standard solution in 10 ml). Absorbance of each dilution is measured, and a calibration curve is established. β-carotene content of unknown samples is calculated from standard curve

7) Estimation of Vitamin C

Procedure:

a) Take 1gm sample and dissolved with 50ml of water into a 250 mL conical flask and add about 100 mL of distilled water and 1 mL of starch indicator solution.

b) Titrate the sample with 0.005 mol L^{-1} iodine solution. The endpoint of the titration is identified as the first permanent trace of a dark blue-black colour due to the starch-iodine complex.

c) Repeat the titration with further aliquots of sample solution until you obtain concordant results (titres agreeing within 0.1 mL)

Calculation

a) Calculate the average volume of iodine solution used from your concordant titres.
b) Calculate the moles of iodine reacting.
c) Using the equation of the titration (below) determine the number of moles of ascorbic acid reacting.
d) Calculate the concentration in mol L−1 of ascorbic acid in the solution obtained from the Sample.

1ml of Iodine mol/L equivalent to 0.88 mg ascorbic acid or vitamin C

At the end point of titrationC1 V1 of iodine =C2V2 of ascorbic acid

Weight of ascorbic acid (mg/100g)

$$\text{Weight of ascorbic acid (mg/100g)} = \frac{\text{Volume(ml) X Concentration X Molecular weight of ascorbic acid x } 100}{\text{Weight of the sample in m}}$$

ANNEXURE III

Antioxidant Assay

Procedure

The sample was dissolved in ethanol. The sample were prepared into several final concentrations of 10, 50, 150, 250, 350,500, 750 ppm for being used subsequently in antioxidant activity assay.

Preparation of Ascorbic Acid Standard

10 mg of ascorbic acid (SAP Chemical) were dissolved in 100 mL methanol (BRATACO Chemical) to obtain a solution with a concentration of 100 ppm. Solution was then prepared into several final concentrations of 0, 5, 15, 30, 45 and 60 ppm for being used subsequently in antioxidant activity assay.

2-diphenyl-1-picrylhydrazyl (DPPH) Radical Scavenging Assay

The free radical scavenging activity of the three extracts (methanol, ethyl acetate and n-hexane) of P. retrofractum fruit was analyzed using 2,2-diphenyl-1-picryl-hydrazyl (DPPH) according to15. The

DPPH solution was prepared in methanol and subsequently added to various concentrations of the extracts (5, 15, 30, 45 and 60 ppm). The absorbance changes were measured at 517 nm. Ascorbic acid was used as standart. These measurements were performed in duplicate and percentage of inhibition (Pi) was calculated using the following equation:

$$\mathbf{Pi = Ab\text{-}As/Ab\ X\ 100\%}$$

Ab is the absorbance of control and As is the absorbance of the extract. The IC50 values were calculated using linear regression analysis and used to indicate antioxidant capacity.

The IC50 Value of DPPH Radical Scavenging Activity

The IC50 value was calculated to determine the concentration of the sample required to inhibit 50% of radical. The lower the IC50 value, the higher the antioxidant activity of the sample. Extracts which possess IC50 values ranging from 50 to 100 mg / mL is considered to exhibit intermediate antioxidant activity. Meanwhile, extracts with IC50 value ranging between 10 to 50 mg / mL is considered to possess strong antioxidant activity.

ANNEXURE IV

Phytochemical Analysis

Test	Procedure	Observation	
Detection of alkaloids			
Dragendroff's/ Kraut's test	Few mL filtratea + 1-2 mL Drageoir's reagents	A reddish-brown precipitate	
Mayer's/ Bertrand's/ Valser's test	Few mL filtratea + 1-2 drops of Mayer's reagent (Along the sides of test tube)	A creamy white/yellow precipitate	
Detection of Flavonoids			
Alkaline reagent test	1mL extract + 2mL of 2% NaOH solution (+ few drops dil. HCl)	An intense yellow colour, becomes colourless on addition of diluted acid	
Lead acetate test	1mL plant extract + few drops of 10% lead acetate solution	A yellow precipitate	
Shinoda's test	Plant extract is dissolved in 5mL alcohol + Fragments of magnesium ribbon + few drops of conc. HCl	A pink to crimson coloured solution {flavonal glycosides}	
Conc. H2SO4 test	Plant extract + conc. H2SO4	An orange colour	
Detection of Terpinoides			
	1) 2ml chloroform + 5mL plant extract, (evaporated on water bath) + 3mL conc. H2SO4 (boiled on water bath)	A grey coloured solution	
Detection of Terpenoids			
Borntrager's test	10mL 10% ammonia sol. + few ml filtrateg (shaken vigorously for 30 sec.)	A pink, violet, or red coloured solution	

Detection of Anthocyanin			
	HCl test 2mL plant extract + 2mL 2N HCl (+ Few mL ammonia)	Pink-red sol. which turns blue-violet after addition of ammonia	
Detection Of Protein			
Ninhydrin test	2mL filtrate + 2 drops of Ninhydrin solution (10mg ninhydrin + 200mL acetone)	A purple coloured sol. {Amino acids}	
Biuret test	2mL filtrate + 1 drop of 2% copper sulphate sol. + 1mL of 95% ethanol + KOH pellets	A pink coloured sol. (in ethanolic layer)	
Xanthoproteic test	Plant extract + Few drops of conc. Nitric acid	A yellow coloured sol.	
Detection of Phenolic Compounds			
Ferric chloride test	Extract aqueous solution + few drops 5% ferric chloride sol.	Dark green/bluish black colour	
Gelatin test	Plant extract is dissolved in 5mL distilled water + 1% gelatin solution + 10% NaCl	A white precipitate	
Ellagic Acid Test	Plant extract aqueous solution + 5% glacial acetic acid + 5% sodium nitrite solution	Solution turns muddy / Niger brown precipitate	
Detection of Quinones			
Alcoholic KOH test	1mL plant extract + few mL alcoholic potassium hydroxide	Red to blue colour	
Conc. HCl test	Plant extract + conc. HCl	A green colour	
Detection of Carbohydrate			
Molish's test	2mL filtrateb + 2 drops of alcoholic α–naphthol + 1mL conc.H2SO4 (along the sides of test tube)	A violet ring	
Fehling's test	1mL each of Fehling's solution A & B + 1mL filtrateb +boiled in water bath	A red precipitate	

Detection of Tannin			
Braymer's test	1mL filtrated + 3mL distilled water + 3 drops 10% Ferric chloride solution	Blue-green colour	
Gelatin test	Plant extract is dissolved in 5mL distilled water + 1% gelatin solution + 10% NaCl	A white precipitate	
10% NaOH test	0.4mL plant extract + 4mL 10% NaOH + shaken well	Formation of emulsion	
Detection of Saponins			
Foam test	0.5gm plant extract + 2mL water (vigorously shaken)	Persistent foam for 10 min.	
Detection of Phytosterols			
Libermann-Burchard's test	50gm extract is dissolved in 2mL acetic anhydride + 1-2 drops of conc. H_2SO_4 (along the side of test tube)	An array of colour change	

ANNEXURE V

Procedure for Viscosity Analysis

1)Viscosity Analysis

Ford Cup:

The **Ford viscosity cup** is a simple gravity device that permits the timed flow of a known volume of liquid passing through an orifice located at the bottom. Under ideal conditions, this rate of flow would be proportional to the kinematic viscosity (expressed in stokes and centistokes) that is dependent upon the specific gravity of the draining liquid. However, the conditions in a simple flow cup are seldom ideal for making true measurements of viscosity. It is important when using a Ford Cup and when retesting liquids that the temperature of the cup and the liquid is maintained, as ambient temperature makes a significant difference to viscosity and thus flow rate.

Calculation:

Equations† where t=flow time in seconds n=kinematic viscosity in mm^2/s	**Drain time (sec)**		**Approximate kinematic viscosity (cSt)**	
	Min	Max	Min	Max
n = 0.49 (t−35.0)	55	100	10	35
n = 1.44 (t−18.0)	40	100	25	120
n = 2.31 (t−6.58)	20	100	49	220
n = 3.85 (t−4.49)	20	100	75	370
n = 12.1 (t−2.00)	20	100	200	1200

ANNEXURE VI

Questionnaire on Sensory Evaluation

(Nine-point Hedonic Scale)

Score Card for the Sensory Evaluation of Developed Variations of Multi-Nuts and Seeds Spread

Name: **Contact Number:**

Date: **Email Id :**

Variation:

Sensory Evaluation

The sensory evaluation is done using nine-point hedonic scale for all the developed variations of multi-nuts and seeds spread. You are requested to rate the given product for appearance, colour, flavour, texture, taste, and overall acceptability.

Characteristics	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)
Appearance									
Colour									
Flavour									
Texture									
Taste									
Overall acceptability									

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

ANNEXURE VII

Nutrient Analysis Test Results

Greenlink Analytical and Research Laboratory (India) Private Ltd.
S.F. No. 414/1, Tex Park Road, Opp. Good Luck Syndicate,
Civil Aerodrome Post, Coimbatore - 641 014. Tamilnadu, INDIA.
Tel : +91 422 2901999 | Mob : +91 95245 81999, +91 95249 81999
Email : enquiry@greenlinklabs.com, info@greenlink.in

NABL ISO / IEC 17025:2017 ISO 9001:2015

TEST REPORT

Report No.	GLARL/TRE/1605	Date	10.04.2023

Details of Customer	
Customer Name and Address	Ms. S. Aathithya Avinashilingam Institute for Home Science and Higher Education Coimbatore.
Customer Reference	-

Details of Sample			
Sample Received Date	28.03.2023	**Sample-By**	Customer
Nature of the sample	Food Product	**Description**	Spread
Sample Code	GLARL/F/03/23/1605	**Received condition**	Packed in a Sterile container
Analysis Started on	29.03.2023	**Analysis Completed on**	08.04.2023

Result of Analysis

S.No	Characteristic	Test Method	Unit	Results
1.	Energy	FSSAI/IS	Kcal	618.9
2.	Protein		g/100g	22.2
3.	Carbohydrate		g/100g	20.7
4.	Iron		mg/100g	38.78
5.	Total Fat		g/100g	49.7
6.	Unsaturated Fat		g/100g	38.2
7.	Vitamin K		mcg/100g	0.22
8.	Vitamin A		mcg/100g	815
9.	Vitamin C		mg/100g	96.7
10.	Vitamin D		mcg/100g	0.12
11.	Calcium		mg/100g	199
12.	Total Plate Count	IS 5402	CFU/g	3.5×10^2
13.	Yeast & Mould	IS 5403	CFU/g	42

****End of Report****

CBE - 14

Authorized Signatory
(M.Amsaveni)
Technical Manager

Viscosity Analysis

Greenlink Analytical and Research Laboratory (India) Private Ltd.
S.F. No. 414/1, Tex Park Road, Opp. Good Luck Syndicate,
Civil Aerodrome Post, Coimbatore - 641 014. Tamilnadu, INDIA.
Tel : +91 422 2901999 | Mob : +91 95245 81999, +91 95249 81999
Email : enquiry@greenlinklabs.com, info@greenlink.in

NABL ISO / IEC 17025:2017 ISO 9001:2015

TEST REPORT

Report No.	GLARL/TRE/149	Date	06.05.2023

Details of Customer	
Customer Name and Address	Mr. S. Aathithya Avinashilingam University, Coimbatore.
Customer Reference	-

Details of Sample			
Sample Received Date	28.04.2023	Sample-By	Customer
Nature of the sample	Food Product	Description	Spread
Sample Code	GLARL/F/04/23/149	Received condition	Good. Packed in a PET jar
Analysis Started on	28.04.2023	Analysis Completed on	29.04.2023

Result of Analysis

S. No	Characteristic	Parameters	Unit	Results
1.	Variation 1	Viscosity	cSt	484.7
2.	Variation 2		cSt	528.4
3.	Variation 3		cSt	524.7
4.	Variation 4		cSt	500.9
5.	Variation 5		cSt	738.6

****End of Report****

Authorized Signatory
(M.Amsaveni)
Technical Manager

CBE - 14

Avinashilingam Institute for Home Science and Higher Education for Women
(Deemed to be University Estd. u/s 3 of UGC Act 1956, Category A by MHRD)
Re-accredited with A++ Grade by NAAC. CGPA 3.65/4, Category I by UGC
Coimbatore - 641 043, Tamil Nadu, India

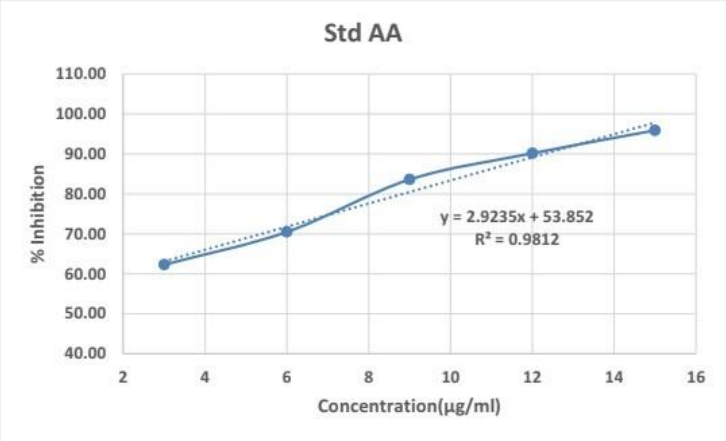
Bharat Ratna Prof.CNR Rao Research Centre

Results of Antioxidant Assay of samples

Method: DPPH Assay

Standard: Ascorbic acid

Concentration (µg/ml)	% Inhibition
3	62.30
6	70.49
9	83.61
12	90.16
15	95.90



Sample Code – NS

Concentration (µl)	% Inhibition
10	50.82
50	60.66
150	54.92
250	50.82
350	43.44
500	38.52
750	34.43

The results of Antioxidant Assay of samples submitted by S.Aathithya, M.Sc.FSMD, of our Institution are given in the above Table and Photographs.

Attested by

7/4/2023

Bharat Ratna Prof.C.N.R Rao Research Centre
Avinashilingam Institute for Home Science and Higher Education for Women,
Coimbatore-641043

Dr.P.Lalitha
Professor of Chemistry
Dean i/c, Research and Development Cell
& Co-ordinator, Bharat Ratna Prof C.N.R Rao Research Centre

Avinashilingam Institute for Home Science and Higher Education for Women
(Deemed to be University *Estd.u/s* 3 of UGC Act 1956, Category A by MHRD)
Re-accredited with 'A++' Grade by NAAC.
Recognised by UGC Under Section 12 B Coimbatore-641 043, TamilNadu, India

Bharat Ratna Prof.C.N.R Rao Research Centre

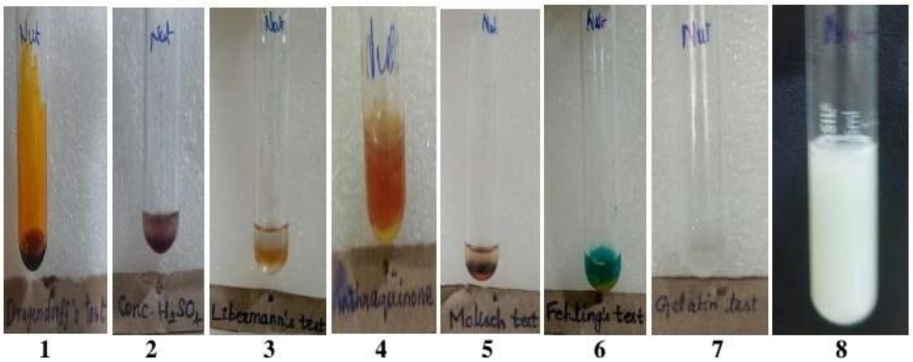
Results of Phytochemical Screening of samples

Sample code: Nuts and Seeds spread

S.No.	Metabolite	Test performed	Observation	Results	Figure No.
1.	Alkaloids	+Mayer's reagent	Absence of Cream coloured precipitate	-	
		+ Dragendorff's reagent	Presence of reddish brown precipitate	+	1
2.	Flavonoids	Alkaline test	No colour change	-	
		+H_2SO_4	Presence of reddish Orange colour	+	2
		+lead acetate	Absence of white Precipitate	-	
		Shinoda test	Absence of crimson Pink colour	-	
3.	Sterols (Libermann test)	+$CHCl_3$+ Acetic anhydride +Conc.H_2SO_4	Presence of reddish brown ring	+	3
4.	Terpenoids (Libermann test)	+ $CHCl_3$+ Acetic anhydride + Conc. H_2SO_4	Absence of green colour	-	
5.	Anthraquinone (Borntrager's test)	+ $FeCl_3$ + Conc.HCl+diethyl ether +Ammonia	Presence of reddish orange colour	+	4
6.	Anthocyanin	HCl Test	No Colour change	-	
7.	Proteins	+2%Ninhydrin reagent	Absence of Purple colour	-	
		+2%$CuSO_4$+ 95%ethanol+KOHpellet	Absence of blue colour	-	
		+conc. HNO_3	Absence of Yellow Colouration	-	
8.	Phenolic compounds	+5% neutral $FeCl_3$	Absence of bluish green coloured solution	-	

		Gelatin test	Absence of white precipitate	-	
		Ellagic acid test	Absence of nigger brown precipitate	-	
9.	Quinones	Conc.HCl	Absence of yellow precipitate	-	
		Alcoholic KOH	Absence of reddish solution	-	
10.	Carbohydrates	Molisch's test	Presence of Violet ring	+	**5**
		Fehling's test	Presence of Red precipitate	+	**6**
11.	Tannin	Braymer's test	Absence of bluish green colour	-	
		+Gelatin test	Presence of white precipitate	+	**7**
		10% NaOH test	Absence of emulsion	-	
12.	Saponins	Shaken with water	Presence of foam	+	**8**
13.	Cardiac glycosides	+Baljet reagent	Absence of yellow orange colour	-	
		Bromine water test	Absence of yellow precipitate	-	
		Keller-killani test	Absence of brown ring	-	
14.	Glycoside's test	Borntrager's test	Absence of pink coloured solution	-	
		Aq.NaOH test	Absence of yellow coloured solution	-	
15.	Lignin	+Gallic acid	Absence of olive-green colour	-	
16.	Coumarins	Fluorescence test	No yellow fluorescence	-	
		+10%NaOH + $CHCl_3$	Absence of yellow colour	-	
17.	Volatile oils	Fluorescence test	No fluorescence	-	

Figures



1 2 3 4 5 6 7 8

The results of Phytochemical Screening of sample submitted by S. Aathithya, II M.Sc FSMD of our institution are given in the above table and photographs.

Attested by

14/4/2023

Bharat Ratna Prof.C.N.R Rao Research Centre
Avinashilingam Institute for Home Science and
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