STANDARDISATION AND QUALITY EVALUATION OF NUTRI SPREADS

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(2016-16-002)

THESIS

Submitted in partial fulfilment of the requirement for the degree of

Master of Science in Community Science
(FOOD SCIENCE AND NUTRITION)

Faculty of Agriculture

Kerala Agricultural University
DEPARTMENT OF COMMUNITY SCIENCE
COLLEGE OF HORTICULTURE
VELLANIKKARA, THRISSUR – 680 656
KERALA, INDIA
2018

DECLARATION

I, hereby declare that the thesis entitled "**Standardisation and quality evaluation of nutri spreads**" is a bonafide record of research work done by me during the course of research and the thesis has not previously formed during the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

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CERTIFICATE

Certified that the thesis entitled **"Standardisation and quality evaluation of nutri spreads"** is a bonafide record of research work done independently by **Ms. Rammya Molu K.** under my guidance and supervision and that it has not been previously formed the basis for the award of any degree, diploma, fellowship or associateship to her.

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ACKNOWLEDGEMENT

Nothing to great significance can be accomplished without the assistance, words of encouragement and gestures of help from our fellow beings. And so comes the time to look back on the path traversed during the endeavor and to remember those who whole heartedly extended their assistance.

It is with immense pleasure, I express my deep sense of gratitude, indebtedness and heartfelt thanks to my guide ***Dr. Aneena E. R.*** *Assistant Professor, Department of Community Science, who with her enthusiasm, inspiration and effort to explain things clearly and simply, throughout my thesis period. Under her guidance I successfully overcame many difficulties in my research work.*

I am very much obliged and grateful to ***Smt. Norma Xavier****, Assistant Professor and Head,* ***Dr. Seeja Thomachan Panjikkaran,*** *Assistant Professor and* ***Dr. Sharon C. L.*** *Assistant Professor, Department of Community Science, College of Horticulture, Kerala Agricultural University, Vellanikkara and member of my advisory committee for unwavering encouragement, well timed support and critical scrutiny of the manuscript which has helped a lot for the preparation of the thesis.*

With great pleasure I extend my sincere thanks to ***Dr. B. Suma****, Professor and Head, Cocoa Research Center, College of Horticulture, Kerala Agricultural University, Vellanikkara and member of my advisory committee for the valuable guidance, support and encouragement.*

I wish to express my heartfelt thanks to ***Dr. S. Krishnan,*** *Professor and Head, Department of Agriculture Statistics, College of Horticulture for the immense help extended, towards the statistical analysis and interpretation.*

I convey my special praise and heartfelt thanks to my seniors ***Remya, Shahanas, Revathy, Chandraprabha, Ajisha, Reshma and Sruthy*** *and also my juniors* ***Tessa, Sruthy, Aiswarya, Lovely, Simla, Athira, Meera and Riya*** *for their assistance. I also thank* ***Kumari Chechi*** *of Department of Community Science, for their support and help rendered during my study.*

Words seem inadequate to express my deep sense of gratitude and sincere thanks to my beloved friends, ***Amitha, Surumi, Joice, Rashidha, Lekshmy, Subesh, Arun Babu, Jithin, Akshatha, Rima, Divya, Nimisha, Doncy, Sophia, Laya and Abid,*** *for their generous help rendered to me during the research work.*

I express my sincere thanks to the ***Department of Soil Science, Cocoa Research Center, Radio Tracer Laboratory, Department of Processing Technology, Department of Food engineering (KCAET, Tavanur) and Department of Animal Nutrition (College of Veterinary and Animal Science, Mannuthy)*** *for all the facilities provided, for their cooperation and support during the conduct of the research. I convey my sincere gratitude to* ***Dr. A. T. Francis,*** *Librarian for the support and guidance in organising research materials.*

My special thanks to ***Mr. Santhosh*** *and* ***Mr. Aravind*** *Student's Computer Club. I convey my earnest thanks to my beloved batch mates and all the seniors, juniors and well wishers who directly or indirectly helped me, successfully complete this project.*

I am thankful to ***Kerala Agricultural University*** *for technical and financial assistance rendered in pursuit of my study and research work.*

Words have no power to express my love towards my most affectionate and beloved parents, ***Mr. B. V. Rajan*** *and* ***Mrs. Narayani K*** *for being the pillars of unfailing encouragement. Their everlasting faith, love and mere presence in every aspect of my life, has meant everything to me and will always be cherished.*

Rammya Molu K.

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Introduction

1. INTRODUCTION

Convenience foods have become a part of modern life for people who lead demanding and hectic lifestyles. In modern living, food is no longer consumed for satisfaction of hunger alone, but for promoting nutrition and health, coupled with enjoyment. The consumption of fast foods and snacks has increased significantly in recent years revealing a trend of change in lifestyle of the society. As a result, the convenience food sector has grown over 70 per cent creating a huge market (Lee and Lin, 2013). Because of the growing consumer demand for healthy, natural and convenient foods, attempts are being made to improve the nutritional value of snack foods. In general, most of the convenience foods available in market are devoid of balanced nutrients and mainly offer empty calories for the consumers (Tarar, 2013).

Spreads are one of the popular ready to eat convenient foods with long shelf life occupying larger space in the consumer market which not only satisfy the hunger, but has been proven as a quality source of nutrients. They have good sensory and nutritional characteristics due to their soft texture, high energy value and are used as food adjunts.

Spreads are concentrated foods with high nutritional value and are favourites of youngsters, sportists and also of adults (Raljic *et al.*, 2013). Peanut spread is one among the most popular sandwich spreads across the world. Nut spreads provide energy, protein, essential fatty acids, vitamins and minerals in the diet. Nut spreads are popular and widely accepted by consumers due to its good flavour, nutritional value and suitability for consumption either alone or in combination with a variety of other foods. Nut spread refers to a spreadable product having at least 40 per cent nut ingredients and are made from ground paste of nuts. The basic formulation of nut spread usually contains dry roasted nuts, sweetners, vegetable oils, emulsifiers, protein sources and flavourings (Liedl and Rowe, 2007). Nut spreads are the products made usually from nuts like almond, cashew, hazelnut, macadamia nut, peanut, pecan, pistachio and walnut (Shakerardekani *et al.*, 2013). Spreads are prepared with chocolate also. Chocolate spread, is also known as breakfast chocolate with some containing nut pastes like hazelnut, ground nut almond, etc.

Children are the most popular users of spreads, its nutritional qualities requires special attention. Chocolate spreads are very popular among children. But most of the commercially available spreads contain more than 30 per cent fat and 40 per cent sugar, which may lead to several health problems. Moreover the cost of these spreads are also very high.

Groundnuts or peanuts are commonly called the poor man's nut. Today it is an important oilseed and food crop. Peanuts, which are a rich source of protein and essential amino acids, can help in preventing malnutrition Moreover, peanuts contain lipids and carbohydrates which are energy rich compounds, capable of complementing the basic energy demands of the human body (Pelto and Klemesu, 2011).

Jackfruit seed flour is a nutritious ingredient which is having favourable properties for extensive food applications. Jackfruit seed flour was found to be rich in proteins, carbohydrates and minerals. The fat content of the seed flour was negligible, making it a good constituent in functional foods which can be consumed safely. It showed better results for water absorption, oil absorption, swelling power etc. and can be utilised in various food formulations (Abraham and Jayamuthunagai, 2014). Islam *et al.* (2015) reported that jackfruit seeds contain 15.88 per cent moisture, 2.49 per cent crude fiber, 5.78 per cent protein and a low fat of 1.77 per cent.

Fat content of different types of spreads is between 20 and 60 per cent. Fats are an important raw material which determine the quality characteristics of the spreads like taste, melting, mouth feel, texture, other physical characteristics, and also their nutritive value (Pajin *et al.,* 2006).

Obesity is increasing speedily in developing countries undergoing fast nutrition and lifestyle transition, and it usually coexists with under-nutrition. The rising prevalence of obesity in developing countries is basically because of rapid urbanization and mechanization that has led to reduction within the energy expenditure beside an improvement in energy intake due to increased purchasing power and accessibility of high fat, energy-dense fast foods (Bhardwaj *et al.*, 2008).

With increasing health awareness among people, much consumer attention has focused on low fat, low sugar and nutrient enriched spreads which provide certain functional properties. Nutri spreads can be considered as a healthy alternative to commercial high fat spreads. These types of products will provide considerable scope for the processing industry to diversify its processing operation and to satisfy the need for value addition in the rapidly changing socio-economic scenario. Ready to eat foods like bread, sandwiches etc. are commonly used now a days and hence the demand has come up for cost effective, nutritious spreads based on locally available resources. Hence, a study on development of nutri spreads which is nutritionally superior and cost effective was proposed with the following objectives.

1. To standardise nutritionally superior spreads.
2. To evaluate the quality attributes and shelf life of the products.

Review of Literature

2. REVIEW OF LITERATURE

The literature pertaining to the study entitled "Standardisation and quality evaluation of nutri spreads" is presented under the following sub headings,

2.1. Spreads- Novel convenient foods

2.2. Composition of spreads

2.3. Health and nutrional benefits of spreads

2.4. Storage and keeping qualities of spreads

2.1. Spreads- Novel convenient foods

Convenience food products are items that help people to economise on time of planning and preparation of meals. According to Arya (1984) convenience foods are heterogeneous group of foods varying in composition, shape, size and method of processing and even with their function in diet. Convenience foods are all food products which have undergone secondary processing including ready meals, processed meats, pizzas, pies, savoury products, ice cream, confectionery products, dairy desserts, soups and other prepared consumer ready products (Ryan *et al.*, 2002). Simelane (2008) defined convenience foods as the foods designed to save consumers time and to reduce cost due to spoilage. Brunner *et al.* (2010) define convenience foods as these that help consumers to minimalize time as nicely as minimum bodily and mental efforts required for food preparation, consumption and clean-up. Emphasis is not solely put on time and physical efforts.

Devarya (1996) reported that convenience foods are three types. They are, solid foods including bakery items, confectionaries, freeze dried products, concentrates like jams, jellies, *shrikhand*, condensed milk, yoghurt, fruit pulp concentrates and liquids like fruit juices, soups and sterilized milk. Among various types of convenient foods, spreads are comparatively a novel food item, which is widely accepted nowadays,

Spread is an emulsion; in which the fat source is either from milk or from vegetable (Zillen, 1977). According to Moran (1993), spread is of oil-in-water type emulsion having fat content less than 15 per cent and normally of water-in-oil type of emulsion having above 15 per cent fat.

Spreads are concentrated food with high energy and nutritive value, and are favourite of children, sportists, but also of healthy grown-ups (Gavrilović, 2003). Leaflet *et al.* (2004) reported that table spreads include a variety of spreadable semi-solid products such as fat spreads, cheese spread, peanut butter etc.

According to CODEX (2007) the spread contains milk fat content not more than 3 per cent of the total fat content. The added amount of vegetable fat content should be less than 80 per cent. Tanaka *et al.* (2009) reported that spread is an edible paste put on other foods which is generally consumed on breads and toasts, or similar preparations. It is a water in oil (W/O) emulsion with different formulation consisting of fat, water, emulsifiers, stabilizers, salt, antioxidants, and other ingredients.

According to Loncarevic *et al.* (2014) spread is a confectionery product based on powdered sugar, vegetable fat, cocoa powder, milk powder and other ingredients. Its physical and sensory properties are strongly influenced by the behaviour of fat phase. Spread contains over 30 per cent of fat phase. Spreadable creams are solid-oil suspensions, a mix of fats represents the oil phase, the dispersed phase consisting usually of sugar, cocoa powder, milled and roasted nuts, dried milk and whey.

Spreads are classified mainly into three types based on fat content, like milk fat spreads, mixed fat spreads and vegetable fat spreads. FSSAI (2006) has defined three types of spreads *viz.* milk-fat spreads, mixed fat spreads (mixture of milk-fat vegetable oils/fats) and vegetable fat spreads. The fat content in each case being 40-80 per cent.

According to FSSAI (2015) spread is a product in the form of water in oil emulsion, of an aquous phase and a fat phase of edible oils. The individual oil and fat used in the spread shall conform to the respective standards.

Nut spreads are spreadable products having at least 40 per cent nut ingredients, which can be added in various forms, such as whole or pieces of nuts, a paste, or a slurry (Liedl and Rowe, 2007). They are made by grinding roasted nuts into a paste that can be spread like a true butter. The main ingredients of nut spreads are nuts (such as almond, cashew, hazelnut, macadamianut, peanut, pecan, pistachio, or walnut), sweeteners (such as natural or artificial sweeteners), vegetable oils (such as palm oil) and protein sources like soy protein isolate [SPI] (Nielsen, 2010).

Cocoa cream spread is a confectionary product based on powdered sugar, vegetable fat, cocoa powder, milk powder and other ingredients. Its physical and sensory properties are strongly influenced by the behaviour of fat phase (Loncarevic *et al.*, 2014).

Confectionary table spreads are defined by the EFSA (2004) as fat-based or made from fruits and vegetables. This definition includes products such as margarine, cheese and butter and those obtained from fruits and vegetables such as jams, preserves and marmalades. Cheeses which are made from curd produced from the coagulation of souring of milk by rennin constitute another type to spread. Butter is a kind of table spread, which is made from milk or cream and should contain at least 80 per cent fat (w/w).

According to Weckel (1965), the term 'low-fat dairy spreads' are the products, which contains only dairy ingredients, and has less fat. Dairy spreads contain generally butter fat whereas non-dairy spreads contain vegetable fat (Zillen, 1977). According to Deshmukh *et al.* (2003) good quality low fat spread was prepared from safflower oil and buffalo milk fat mix (50:50) with addition of 1.5 per cent common salt, 1.0 per cent emulsifier (trisodium citrate) and 100 per cent

aged cheese and pH adjusted to 5.5. This result in a product with vital increase in scores of various sensory attributes.

Spreads with 41-60 per cent fat are known as 'reduced fat spreads', those with 40 per cent or less as 'low fat spreads', products containing 5-15 per cent fat or less fat as 'very low fat spreads' and the spreads with extremely low fat content are sometimes called 'ultra-low-fat spreads' (Dostalova, 2003).

Fruit blended spreads were developed by Shahanas (2014) blending tender coconut pulp with other fruit pulp in different proportions.

2.2. Composition of spreads

The composition of spreads and margarine has evolved over the few decades. Several attempts to formulate low fat spreads with totally different ingredients with a large variation in their composition has been carried out globally (Downs *et al.*, 2013).

Kharb and Thompkinson (2007) reported that the table spreads contain 38 per cent moisture, 35 per cent fat, 15.58 per cent protein, 11.50 per cent carbohydrate and 3.20 per cent ash.

Fat is the major ingredients in any table spread that governs its consistency, spreadability, flavour and nutritional characteristics. The most important function of fat is to provide structure, energy, mouthfeel and act as a carrier of flavour and vitamins and a source of essential fatty acids and fat-soluble vitamins. There are various sources of fat, which can be utilized for producing spreads. The stability of emulsion depends on the scale of the oil droplets and contributes toward the viscosity and body of the spread. The degree of unsaturation in the constituent fatty acids is the criteria for oil choice (Formo *et al.*, 1979).

Spreadability is a rheological property and is dependent on morphology, crystal network and its interactions at a given temperature (Campos *et al.*, 2002). The main reward of the spread include good spreadability at refrigeration temperature and contain low fat, low calorie and more protein and other optional ingredients (Kumar *et al.*, 2010).

Kulkarni and Rama Murthy (1988) replaced 30 per cent of milk fat in butter with sunflower oil and found improvement in spreadability at low temperature. A mixture containing 20-50 per cent of vegetable oil and 0-50 per cent butter oil has been used for the production of spread with plasticity (Schaap, 1993). Soybean oil is the most popular oil for spreads as its application improves the stability and flavour and makes the emulsion stronger as compared to vegetable oil (Spios and Szuhuj, 1996).

Rousseau *et al.* (1996) studied that the effect of using mixed fat mix of milk fat and canola oil on property of spread and reported that the hardness index of spread reduced with increase the proportion of oil in the mix. A table spread with good body and texture was prepared by Deshpande (1998) using a fat blend containing 70 per cent groundnut oil and 30 per cent milk fat. Lee (2001) assessed the stability of mayonnaise and salad dressing and found that at 75 per cent concentration, viscosity was high and oil droplets size was uniform.

Gujarat Cooperative Milk Federation (Anon., 2004) launched mixed fat spread containing 10 per cent milk fat and 49 per cent vegetable oil. Kumar and Rao (2006) reported that milk fat was replaced with vegetable oils (soybean, corn and sunflower) at 25 per cent was acceptable with improved body, texture and spreadability.

Proteins are added to the spreads to enhance their organoleptic, functional and nutritional properties. They impart creamy taste thereby rising consumer acceptability, desirable consistency, water holding capacity, thereby rising emulsion stability throughout process and storage (Charteris, 1995).

Bullock and Kenney (1969) suggested use of calcium reduced skimmed milk powder as an ingredient in low fat spread, owing to its strong binding characteristics. Patel and Gupta (1988) reported that the addition of 5-10 per cent SMP increased flavour and texture characteristics of the spread, however 15 per cent had associated adverse impact on its mouthfeel.

Low fat spreads are usually a water-in-oil emulsions. Formation of an emulsion needs the presence of surface-active agents (called emulsifiers or surfactants) to

facilitate the formation of dispersion of one immiscible liquid (water) in other (oil). Emulsifiers reduce the surface tension between the aqueous phase and oil phase thereby raising the stability of water-in-oil and oil-in-water emulsions (Dostalova, 2003). Low-fat spreads could contain 21-65 per cent moisture, 15-60 per cent fat, 1.6-17.5 per cent protein, 0.8-27 per cent carbohydrate, 0.5-1.8 per cent salt and 1-3.5 per cent ash (Raj and Khamrui, 2013).

Emulsifiers are the most important and essential ingredient in the composition of a spread. Guy *et al.* (1972) found that spreads containing emulsifiers were slightly stable and spreadable than those without emulsifiers. Spurgeon *et al.* (1970) determined that emulsifier initiate the oxidation of spread thus addition was not fascinating. The type and level of emulsifier is governed by the, nature of the other ingredients and processing conditions (Petrowski, 1976). Frede and Buchheim (1984) used dimodan as emulsifier to form cold stored emulsions (spread). The level of emulsifiers in spreads had been reported to vary from 0.1 to 1.5 per cent; the level of emulsifier decreases with increasing level of fat (Prajapati *et al.*, 1991). According to Devdhara *et al.* (1991) the use of 0.5 per cent distilled mono-glyceride (Dimodan PV) gave a moderately stable emulsion but at 2.5 per cent gave a poor mouthfeel, whereas at 1.5 per cent the emulsifier gave an emulsion with acceptable appearance and mouthfeel in low calorie spreads. Mono and diglycerides are the common emulsifiers used in w/o type low fat spreads (Verma *et al.*, 1998).

Uses of glycerol monostearate substantially enhanced the flowability of the spread during processing and reduce oiling off. However, higher level of emulsifier had destabilizing effect on emulsion (Madsen, 1976). Other emulsifiers tried in spreads are 2.0 per cent lecithin, phosphatides, centrophil, polynol-A and hymono-8803 (90%) monoglycerides (Steeg *et al.*, 2001).

Salt (Sodium chloride) added to spread not only enhances taste and palatability but also helps in inhibiting the growth of bacteria and fungi in spread and thereby, acts as a preservative (Deshpande and Thompkinson, 2000).

Rasic *et al.* (1976) observed that 0.5 per cent salt was sufficient to extend shelf life of table spreads. Prajapati *et al.* (1991) reported that higher salt levels (1.5 %) did not have a perceptible influence on firmness and stickiness of the spread. Flavour, spreadability and colour scores of the spread improved slightly, but body and texture scores decreased. Patange (2005) recommended 1 per cent salt addition for optimum sensorial attribute of table spreads.

Devdhara *et al.* (1991) reported that upon increasing the salt content in spread from 1.2 to 2.8 per cent, the stability of emulsion increased but reduced drastically as the salt content increased further. Addition of 1 to 1.5 per cent salt to the spread resulted in inhibition of microorganisms (Moran, 1993). Tossavainen *et al.* (1996) tried to prepare low fat spread using sodium caseinate without the addition of salt. But the spread was not stable and was partly in an oil in water form. The viscosity of aqueous phase was also lower at 5°C. Sodium chloride plays a significant role in increasing the viscosity of the spread containing casein. Flavour acceptability of the spread can generally be improved by the addition of 0.75-1.25 per cent common salt.

2.3. Health and nutrional benefits of spreads

Functional ingredients are added to spreads inorder to make it functional spread. Functional food is generally used to describe foods having the ability to deliver some health benefits beyond nutrition (Frewer *et al.*, 2003). Functional foods are those foods which improve the state of health or reduce the risk of diseases beyond imparting basic nutrition. Foods can be modified by the addition of phytosterol, bioactive peptides, dietary fiber, vitamins, mineral, pre and probiotic agents and omega-3/omega-6 polyunsaturated fatty acid to become functional.

Commercial spreads contain butter as a fat source. Butter has been criticised for the hypercholesterolemic attributes arising from its saturated fat and cholesterol content whereas fruit-based spreads such as jam, jelly, etc. mainly contain carbohydrates and lack adequate nutrition such as protein, fat, iron and calcium.

Hendriks *et al.* (1999) studied that daily intake of spreads enriched with plant sterols derived from commonly used edible oils decreased the total cholesterol by 0.15± 0.46mmol/L and LDL-cholesterol by 0.10±0.41 mmol/L as compared to control.

Albany (2002) reported that women who eat five tablespoons of peanut butter each week can reduce their risk of developing type 2 diabetes by over 20 per cent. Further, the relationship between consuming peanut butter, peanuts and other nuts and type 2 diabetes was found to be linear that is, higher consumption provided greater protective effect.

Amundsen *et al.* (2002) reported that in children with familial hypercholesterolemia, consuming a recommended diet, a daily intake of 1.6 g plant sterols as sterol ester enriched spread induced an additional reduction in LDL cholesterol of 10 per cent without any adverse effects. Sterol ester enriched spread may be an effective and safe tool in the treatment of serum cholesterol in children with familial hypercholesterolemia.

Bhardwaj *et al.* (2017) reported that 20 per cent incorporation of the vegetable oils in spreads resulted in decrease of saturated fatty acid content in the total fat. The mono unsaturated fatty acids and poly unsaturated fatty acids were found to increase by about 14 and 10 per cent respectively.

Wilson and David (2017) reported that the addition of sunfiber and soya protein isolate, produce a cost effective soya spread which was a good source of isoflavones. It was also a low fat spread useful for people with obesity and heart diseases.

Manary *et al.* (2004) reported that a spread in the form of ready-to-use therapeutic food (RUTF). RUTF is a generic term including different types of foods, such as spreads or compressed products suitable for feeding severely malnourished children.

The use of date seed soluble fiber concentrate and date seed insoluble fiber concentrate in chocolate spread enhanced their oil binding capacity and the sensory

qualities. The functional date seed fibre spread was developed to reduce cardiovascular diseases (Liu *et al.*, 2000).

According to Nesma *et al.* (2011) a high quality functional chocolate spread was able to be produced by replacing the butter fat with red palm olein at 20 per cent level. The formulated chocolate spread possessed 3.7 times additional tocopherols and tocotrienols and 19.8 times more carotenes. These spreads act as the most effective means for overcoming vitamin A deficiency, which is prevailing in developing countries, particularly in children. Moreover, this spread contains high concentrations of natural antioxidants that possess health benefits.

2.4. Storage and keeping qualities of spreads

Storage stability is an important feature of foods and is a matter of concern to all, including the food manufacture, wholesaler, retailer and consumer. Storage stability of the spread depends on the composition of the product, type of treatment applied to the product, type and quantity of the preservative added, etc. Usually, low-fat spreads have lower amount of fat and higher level of water and protein. Hence, these products have a limited shelf life, especially when the product is subjected to temperature variation during storage and distribution (Donald, 1996). Low-fat spreads have a shelf life varying from 60 to 90 days under refrigeration. At ambient temperature spreadable products do not have any appreciable shelf stability. Like all other food products table spreads undergo chemical and microbiological spoilage during storage. Shelf life of a product is the period between packaging of the product and the point at which it becomes unacceptable under defined environmental conditions (Patil, 2001).

Usually the moisture content of the spread varies from 30-50 per cent and consequently their shelf-life ranges from few weeks to few months. Water activity of any food system is one among the vital factors affecting shelf-life (Scott, 1975). Basically table spreads endure chemical and microbiological spoilage at ambient temperature. Microorganisms that cause spoilage in butter are involved with spoilage

of table spread. But vegetables oils are usually more resistant to lipolytic breakdown than milk fat (Vernam and Sutherland, 1994).

It is well known that the lower the storage temperature, the higher the period of time for most food products. Spreads and similar products need cold storage, as at ambient temperature these products do not have any considerable shelf stability. The presence of proteins and carbohydrates within the aqueous phase promotes the growth microorganism once the storage temperature permits and thereby reduces shelf life (Bullock and Kenney, 1969). Spreads were discovered to have shelf life of 10, 20 or more than 90 days at 30, 20 and 4-6°C storage temperatures, respectively (Rasic *et al.*, 1976). The keeping quality of a low-fat (o/w) soy spread was for much longer (10 weeks) at 5°C than at 17°C (3 days) as determined by Patel and Gupta (1988).

Packaging each in design and material, will have major influence on the shelf life of the product. Packaging fulfils a number of functions as well as protection of product from physical harm and from modification within the surroundings and thus, packaging will influence the shelf life of product. The type of packaging material is important factor as it influences the water vapor-transmission rate, oxygen transmission rate etc. thereby influencing the microbiological, biochemical and sensory changes in the product throughout the storage (Patil, 2001).

According to Shakerardekani and Karim (2013) flexible plastic packaging materials may be used effectively for packaging of edible nut at high ratio condition (85–100%) at 22–25 °C. Considering the moisture absorption and aflatoxin level, the suitable storage time of pistachio nut in plastic films as well as LDPE, food-grade PVC, nylon, PA/PP and PET were about 4, 4, 4 and 5–6 months, respectively. The suggested packaging material for packaging of pistachio nut butter is PET.

The natural spread had satisfactory physicochemical qualities, microorganism safety however lacks in aerophilic stability and textural qualities. The aerobic stability was achieved among the primary week at 25 and 35 °C storage and can be prolonged to 12 weeks at 10 °C storage. The textural quality measurements were more superior than commercial samples once stored below 6 weeks at 25 and 35 °C, and similar to commercial samples at 10 °C storage up to 8 weeks. The product

is stable in terms of water activity that promotes product resistance towards microbial contamination. The oil separation analysis conformed to changes in peroxide value, spreadability and firmness of natural spread. Storage time and temperature gave a lot of significance on the shelf life of natural peanut butter than grinding time and peanut variety was dependent on storage temperature (Rozail *et al.*, 2016).

The overall quality of nut spread is the quality of nut paste that is employed as the main ingredient. The quality of nut paste is influenced by raw kernel quality, process conditions like roasting temperature and time and storage conditions (Felland and Koehler, 1997). Abegas and Kerr (2006) reported that the shelf life of nut spread depends on the type of ingredients added to the nut paste during production of the spread.

Lipid oxidation is initiated by compounds known as sensitizers which include heat, light and metal ions. Lipid oxidation produces undesirable flavors, aromas and compromises the nutritional quality of fats and oils leading to the production of toxic compounds (Frankel, 1991).

Storage stability of spread is the main concern for consumer acceptability due to its high polyunsaturated fatty acids (PUFA). Lipid oxidation is one of the indicators of measurement of oxidative rancidity in oils and fats (Li *et al.* 2013) and therefore the peroxide value (PV) may be a measure of the concentration of peroxides and hydroperoxides formed during the initial stages. Storage stability of various butter and spread using peroxide value as indicator has been applied for oilseed butter from sunflower kernels (Muttagi *et al.*, 2014)

Since most nut spreads are rich in oil, oil separation is one of the problems faced by this industry. The separated oil contaminates the packaging material and affected the quality and appearance of nut spreads (Ereifej *et al.*, 2005). Gunesar and Zorba (2011) reported that stabilizing against oil separation is of utmost necessary to enhance the acceptability and marketability of spreads.

The microbiological quality of dairy based spreads depends on the physico-chemical determinants of microbic survival and growth. Microbial growth in spreads is especially confined to the aqueous phase and determined by the moisture droplet

size, nutrient composition, pH and the presence of preservatives. The microflora of spreads reflects the quality of the ingredients, the sanitary condition of the equipments used in the manufacturer and therefore the environmental and hygienic conditions during packaging, storage and handling. Pasteurization of the aqueous phase prior to emulsification and of the emulsion throughout process causes a major reduction in the number of most heat resistant microorganism (Charteris, 1995).

The major commercial spoilage risk with low fat spreads was that of moulds, particularly by the species of *Penicillium* and *Cladosporium* that grows below wide range of storage conditions (Sea and Spurgeon, 1975). The development of yeast and moulds on the product surface cause discoloration and generate flavour defects. Recontamination during packaging would typically result in the growth of yeast and moulds within the product (Robinson, 1986).

Deshpande (1998) observed that gradual increase of yeast and mould count from 1.7 to 2.5 log cycle between 7 to 35 days of storage. Babubhai (1999) found that increase in yeast and mould count of spread throughout the whole period of storage both at 4±2°C and 30°C. Patange (2005) also reported increase in mould counts from 26 cfu/g to 71 cfu/g throughout 4 weeks of storage. Whereas the spread containing preservative remained acceptable up to 11 week and count was 33 cfu/g.

Materials and Methods

3. MATERIALS AND METHODS

The study entitled 'Standardisation and quality evaluation of nutri spreads' was carried out with the objective of standardising nutritionally superior spreads. The study also aimed to evaluate the nutritional, organoleptic and shelf life qualities of the developed nutri spreads. The methods followed and materials used are given under the following headings.

3.1. Collection and processing of raw ingredients

3.2. Standardisation of nutri spreads

3.3. Quality evaluation of the selected nutri spreads

3.4. Enrichment of the developed spreads with protein sources

3.5. Cost of production of the selected nutri spreads

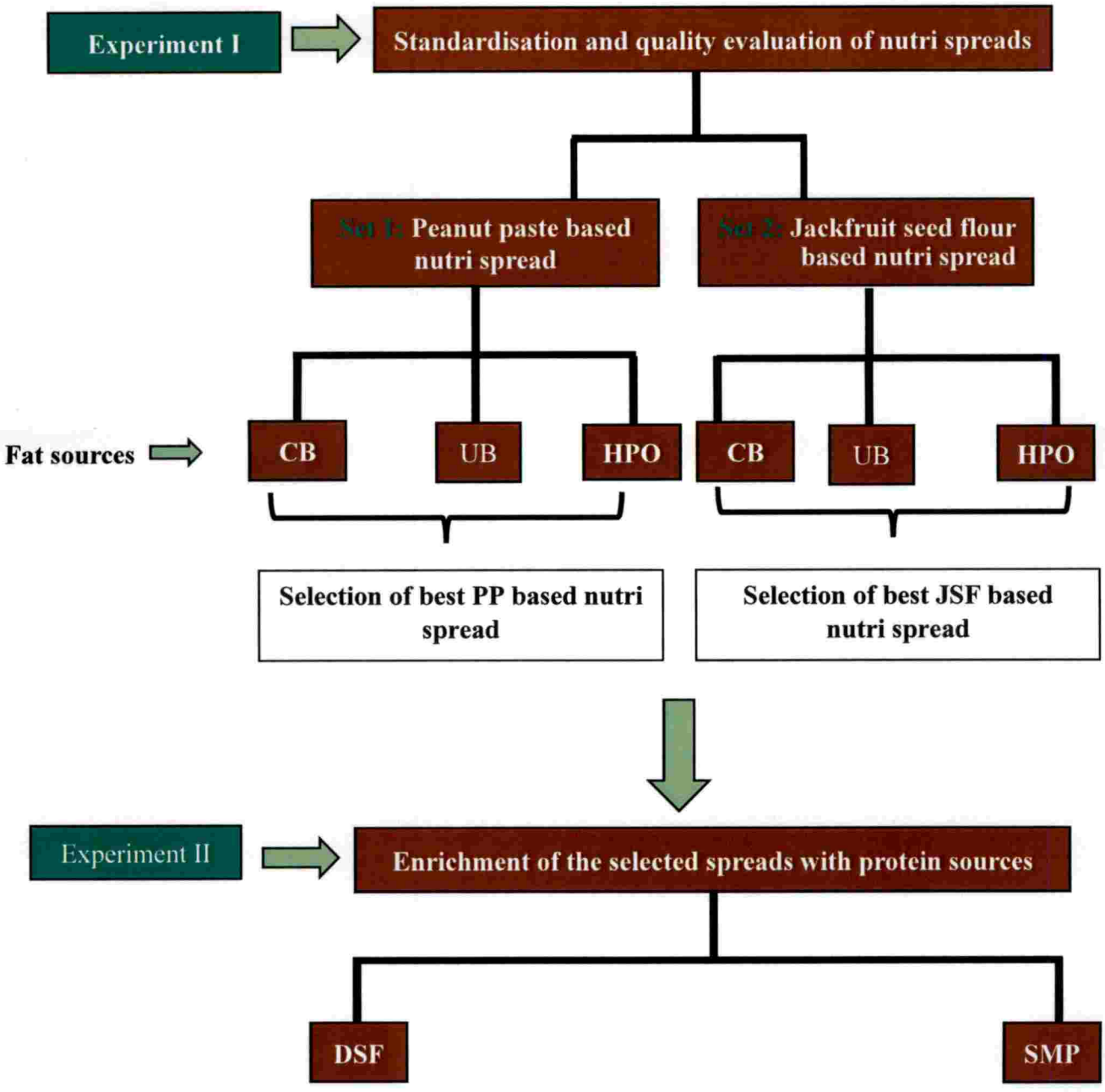
3.6. Statistical analysis of the data

3.1. Collection and processing of raw ingredients

Peanuts and jackfruit seeds were used as the major ingredients. Jackfruit seeds were collected from homesteads. Cocoa powder and cocoa butter were procured from Cocoa Research Centre of Kerala Agricultural University. Peanuts and all other raw ingredients needed for the study were purchased from the local market.

3.2. Standardisation of nutri spreads

Two sets of nutri spreads, one based on peanut paste (PP) and another one based on jackfruit seed flour (JSF) were standardised. Cocoa powder, cane sugar, salt and soya lecithin were the other ingredients used in nutri spreads. The amount of other ingredients were kept in a fixed proportion of 20 per cent as detailed below



Schematic diagram of the technical programme

CB- Cocoa butter, UB- Unsalted butter, HPO- Hydrogenated palm oil, PP- Peanut Paste, JSF- Jackfruit seed flour, DSF- Defatted soya flour, SMP- Skimmed milk powder

Cocoa powder - 4%

Cane sugar -12%

Salt -1%

Soya lecithin -3%

20% Other ingredients

3.2.1. Set 1. Peanut paste (PP) based nutri spreads

The peanut paste was prepared by following the procedure standardised by Woodroof (1983) and is detailed below.

Cleaning and shelling of peanuts

⇩

Grading

⇩

Blanching (60^0C-80^0C for 2-3 min.)

⇩

Roasting (160^0C at 20 min.)

⇩

Dehusking

⇩

Grinding

Three sets of nutri spreads were prepared using peanut paste (PP) as the base, in varying proportions ranging from 70 per cent to 50 per cent added with three different fat sources. Three different fat sources used were cocoa butter (CB), unsalted butter (UB) and hydrogenated palm oil (HPO). Cocoa butter and unsalted butter are natural and highly valued fat sources that contributes to the desirable

textural and sensory properties of confectionery products. Hydrogenated palm oil is stable against oil separation at room temperature (30°C) and increase the spreadability and mouthfeel of spreads. The experiment was conducted in a Completely Randomised Design (CRD) with 18 treatment combinations with three replications. The details of treatments and combinations are detailed below.

Table 1. Details of combinations of peanut paste based nutri spreads

Treatments	**Combinations**
PT_1	75% PP + 5% CB
PT_2	70% PP + 10% CB
PT_3	65% PP + 15% CB
PT_4	60% PP + 20% CB
PT_5	55% PP + 25% CB
PT_6	50% PP + 30% CB
PT_7	75% PP + 5% UB
PT_8	70% PP + 10% UB
PT_9	65% PP + 15% UB
PT_{10}	60% PP + 20% UB
PT_{11}	55% PP + 25% UB
PT_{12}	50% PP + 30% UB
PT_{13}	75% PP + 5% HPO
PT_{14}	70% PP + 10% HPO
PT_{15}	65% PP + 15% HPO

PT_{16}	60% PP + 20% HPO
PT_{17}	55% PP + 25% HPO
PT_{18}	50% PP + 30% HPO

*PP- Peanut Paste, CB- Cocoa butter, UB- Unsalted butter, HPO- Hydrogenated palm oil

3.2.2. Set 2. Jackfruit seed flour based nutri spreads

Jackfruit seed flour was prepared using standard procedure suggested by Pandeay (2004).

Jackfruit seeds

⇩

Removal of outer peel

⇩

Pressure cooking (20 min.)

⇩

Slicing

⇩

Drying (60^0C for 12 hrs)

⇩

Milling, sieving and packing

This type of nutri spreads were prepared using jackfruit seed flour (JSF) added with three different fat sources like cocoa butter, unsalted butter and hydrogenated palm oil. The set of treatments for peanut paste based nutri spreads (T_1- T_{18}) were repeated by replacing peanut paste with jackfruit seed flour in various proportions starting from 25 per cent to 50 per cent. The details of treatments and combinations are detailed below (Table 2.).

Table 2. Details of combinations of jackfruit seed flour based nutri spreads

Treatments	**Combinations**
JT_1	50% JSF + 30% CB

JT_2	45% JSF + 35% CB
JT_3	40% JSF + 40% CB
JT_4	35% JSF + 45% CB
JT_5	30% JSF + 50% CB
JT_6	25% JSF + 55% CB
JT_7	50% JSF + 30% UB
JT_8	45% JSF + 35% UB
JT_9	40% JSF + 40% UB
JT_{10}	35% JSF + 45% UB
JT_{11}	30% JSF + 50% UB
JT_{12}	25% JSF + 55% UB
JT_{13}	50% JSF + 30% HPO
JT_{14}	45% JSF + 35% HPO
JT_{15}	40% JSF + 40% HPO
JT_{16}	35% JSF + 45% HPO
JT_{17}	30% JSF + 50% HPO
JT_{18}	25% JSF + 55% HPO

*JSF- Jack fruit seed flour, CB- Cocoa butter, UB- Unsalted butter, HPO- Hydrogenated palm oil

The experiment was conducted in a Completely Randomised Design (CRD) with 18 treatment combinations with three replications.

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3.2.3. Organoleptic evaluation

Organoleptic evaluation of the standardised nutri spreads were conducted using score card by a panel of 15 judges.

3.2.3.1 Selection of judges

A series of organoleptic evaluation were done by using simple triangle test at laboratory level to select a panel of 15 judges between the age group of 18-35 years as suggested by Jellinek (1985).

3.2.3.2 Preparation of score card

Score card containing six quality attributes such as appearance, colour, flavour, texture, taste and overall acceptability was used for the evaluation of the developed nutri spreads. Each of the above mentioned qualities were assessed by a nine point hedonic scale. The score cards used for the evaluation of nutri spreads are given in Appendix I.

3.2.4. Selection of nutri spreads

The most acceptable combination of one peanut paste (PP) based spread and one jackfruit seed flour (JSF) based spread from each fat sources were selected for further studies. One best combinations from treatments with three different fat sources from both peanut paste (PP) based and jackfruit seed flour (JSF) based nutri spreads were selected seperately through sensory evaluation. Kendall's coefficient of concordance (W) which expresses the degree of association among the fifteen judges were carried out for each treatment. Thus, three treatments from peanut paste based nutri spreads (PP) and three treatments from jackfruit seed flour based nutri spreads (JSF) were studied in detail.

3.3. Quality evaluation of the selected nutri spreads

The selected nutri spreads were packed in PET containers and kept in ambient and refrigerant conditions for a period of three months. The quality

evaluation of the selected nutri spreads were done initially and at monthly intervals till the end of the storage period.

3.3.1. Evaluation of physico- chemical qualities of the selected nutri spreads

The physico- chemical qualities of nutri spreads were carried out initially and at monthly intervals of the storage period using standard procedures. The analysis was carried out in triplicate samples.

3.3.1.1. Texture Analysis

Texture is an important quality parameter which affects the consumer acceptability of spreads and was determined using Texture Analyser (Stable Micro Systems, UK). The instrument had a microprocessor regulated texture analysis system interfaced to a personal computer. The instrument consists of two separate modules; the test bed and the control console (keyboard). Both are linked by a cable which route low voltage signal and power through it. The texture analyser measures force, distance and time and hence provide a three-dimensional product analysis. Forces may be measured to achieve set distances and distances may be measured to achieve set forces.

The sample was kept on the flat platform of the instrument and was subjected to double compression by a cylindrical probe with 5mm diameter. The test was conducted at a speed of 10 mm/s using 50 N load cell. The sample was allowed for double compression of 40 per cent with trigger force of 0.5 kg during various textural parameters were determined from the force deformation curve, the gel strength, rupture strength, brittleness and adhesiveness were determined.

3.3.1.2. pH

The pH of the products were measured using food grade pH meter. The solution for reading pH was prepared in a ratio of 1:10 (Berwal *et al.*, 2004).

3.3.1.3. Moisture

Moisture content of selected nutri spreads were estimated by the method of A.O.A.C (1980). To determine moisture content of the sample, ten grams of the sample was taken in a petridish and dried in a hot air oven at 60^0C to 70^0C, cooled in a desicator and weighed. The process of heating and cooling was repeated till

constant weight was achieved. The moisture content of the sample was calculated from the loss in weight during drying.

3.3.1.4. Reducing sugar

Twenty five gram of nutri spread was ground with 100 ml of distilled water and transferred to a conical flask. It was neutralised with 1N sodium hydroxide in the presence of phenolphthalein. For the clarification of the neutralised mixture, 2 ml of lead acetate was added followed by addition of 2 ml of potassium oxalate to neutralise the excess amount of lead acetate. It was then allowed to stand for 10 minutes for the settlement of the precipitate. Filtered the solution through Whatman's No.1 filter paper which was made upto 250 ml. Aliquot of the solution was titrated against a boiling mixture of fehlings solution A and B using methylene blue as indicator until the appears of brick red colour indicator (Ranganna, 1986). The reducing sugars present in nutri spreads were computed using the formula as follows.

$$\text{Reducing sugar (\%)} = \frac{\text{Fehling's factor x dilution x 100}}{\text{Titre value x weight of the sample}}$$

3.3.1.5. Total sugar

The total sugar was determined using the method given by Ranganna (1986). From the clarified solution used for the estimation of reducing sugar, 50 ml was taken and boiled gently after adding citric acid and water. It was then neutralised with sodium hydroxide and the volume was made up to 250 ml. An aliquot of this solution was titrated against Fehling's solution A and B. The total sugar content was expressed as percentage.

$$\text{Total sugars (\%)} = \frac{\text{Fehling's factor x 250 x dilution x 100}}{\text{Titre value x 50 x weight of the sample}}$$

3.3.1.6. Fat

The fat content of the selected nutri spreads were estimated using the method given by Sadasivam and Manickam (1997). Five gram of sample was taken

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in a thimble and plugged with cotton. The material was extracted with petroleum ether for six hours without interruption by gentle heating in a soxhlet apparatus. Extraction flask was then cooled and ether was removed by heating and the weight was taken. The fat content was expressed in gram per 100 g of the sample.

3.3.1.7. Protein

The protein content of nutri spreads were estimated using Lowry's method given by Sadasivam and Manickam (1997). A sample of 500 mg was extracted using 5 to 10 ml of buffer (Tris buffer GR – tris hydroxymethyl amino methane) and centrifuged. An aliquot 0.1 ml from the supernatant was taken in a test tube, 5 ml alkaline copper solution was mixed well and allowed to stand for 10 minutes. Folin-Ciocalteau reagent of 0.5 ml was added and incubated at room temperature in the dark for 30 minutes and the developed blue colour was read at 660nm (OD). A standard graph was prepared using alkaline copper solution and Folin-Ciocalteau reagent by applying serial dilutions. From the standard graph, the amount of total protein present in sample was estimated and expressed in gram per 100 g of sample.

3.3.1.8. Energy

The energy content of selected nutri spreads were calculated according to Gopalan *et al.* (1989) and expressed as kilocalories (Kcal). The energy present in sample was calculated as per the formula given below.

Energy = (4 x Protein) + (4 x Total carbohydrates) + (9 x Fat)

3.3.1.9. Total ash

The ash content of the nutri spreads were estimated using the method given by ISI (1980). Five gram of sample was taken in a crucible and then was ignited at 550- 600°C in a muffle furnace for 5-6 hours. Cooled in a desiccator at room temperature and weighed. The ash content of sample was expressed in percentage.

3.3.1.10. Calcium

The calcium content of the selected nutri spreads were estimated by atomic absorption spectrophotometric method using the diacid extract prepared from the sample (Perkin-Elmer, 1982). A sample of 0.20 g was predigested with 10 ml of 9:4 mixture of nitric acid and perchloric acid and made up the volume to 50 ml and used directly in atomic absorption spectrophotometer for the estimation of calcium and expressed in mg 100 g^{-1} of sample.

3.3.1.11. Iron

Iron content present in selected nutri spreads were determined using method suggested by Perkin – Elmer (1982). One gram of the nutri spread was pre-digested using 10 ml of 9:4 ratio of nitric and percholoric acid. The prepared diacid extract of the nutrispread sample was used for estimation of iron in Atomic Absorption Spectrophotometer. Iron content present in the sample was expressed as mg 100 g^{-1} of sample.

3.3.1.12. Phosphorus

The phosphorous content was analysed calorimetrically (Jackson, 1973), which gives yellow colour with nitric acid vanadate molybdate reagent. To five ml of pre-digested aliquot, five ml of nitric acid vandate molybdate reagent was added and made up to 50 ml with distilled water. After 10 minutes, the OD was read at 420 nm.

A standard graph was prepared using serial dilution of standard phosphorus solution. The phosphorus content of the sample was estimated from the standard graph and expressed in mg 100g^{-1} of sample.

3.3.1.13. Zinc

The amount of zinc present in the selected nutri spreads were determined by using the method suggested by Perkin – Elmer (1982). One gram of the nutri spread was pre-digested using 10 ml of 9:4 ratio of nitric and percholoric acid. The diacid

extract of the nutri spread sample was used for estimation of zinc in Atomic Absorption Spectrophotometer. The amount of zinc present in the nutri spread was expressed as mg $100g^{-1}$.

3.3.1.14. Sodium

The sodium content of the selected nutri spreads were determined by using flame photometer as suggested by Jackson (1973). The diacid extract prepared was directly read in the flame photometer and sodium content was expressed in mg 100 g^{-1} of sample.

3.3.1.15. Potassium

The potassium content of the product was estimated using the same procedure used for estimation of sodium suggested by Jackson (1973) and the content was expressed in mg 100 g^{-1} of the nutri spread.

3.3.2. Organoleptic evaluation

Organoleptic evaluation was carried out for the selected products as described in 3.2.3. Organoleptic evaluation of the selected products were conducted by using score card by a panel of 15 judges. Quality attributes like appearance, colour, flavour, texture, taste and overall acceptability were evaluated. Each of the above mentioned attributes was assessed initially and at monthly intervals for a period of three months of storage.

3.3.3. Enumeration of total microflora

The microbial population present in the nutri spreads were estimated using serial dilution plate count method as suggested by Agarwal and Hasija (1986). The microbial analysis was carried out in selected nutri spreads initially and at monthly intervals of storage.

The sample was prepared by mixing 90 ml of distilled water with 10 g of nutri spread and shaken well using a shaker to obtain suspension. The serial dilutions were carried out in the prepared water blank. To 9 ml of water blank

transfer one ml of the prepared suspension with a dilution of 10^{-2}. This is then diluted to 10^{-3} followed by 10^{-4}, 10^{-5} and 10^{-6} using serial dilution techniques. Bacteria, fungi and yeast count were assessed using Nutrient Agar (NA) for bacteria, Potato Dextrose Agar (PDA) for fungi and Sabouraud's Dextrose Agar (SDA) media for yeast respectively and results were given as cfu/g.

3.3.3.1. Enumeration of bacterial colony

Total number of bacterial colony was enumerated in 10^{-5} dilution in nutrient agar medium. In a sterile petriplate, pour one ml of 10^{-5} dilution using a micropipette. To petriplate pour about 20 ml of the nutrient agar medium which is uniformly spread in petriplate by rotating in clockwise and anticlockwise directions. For bacterial colony the enumerated petriplates were incubated for 48 hrs at room temperature. The total number of bacterial colonies were counted and expressed as cfu/g.

3.3.3.2. Enumeration of fungal colony

Total number of fungal colony was enumerated in 10^{-3} dilution in Martin Rose agar medium. In a sterile petriplate, pour one ml of 10^{-3} dilution using a micropipette. To petriplate pour about 20 ml of the Potato Dextrose Agar medium is uniformly spread. For fungal colony enumeration the petriplates were incubated for 4 to 5 days at room temperature. The total number of fungal colonies were counted and expressed as cfu/g.

3.3.3.3. Enumeration of yeast colony

Total number of yeast colony was enumerated in 10^{-3} dilution in Sabouraud's Dextrose Agar medium. In a sterile petriplate, pour one ml of 10^{-3} dilution using a micropipette. To petriplate pour about 20 ml of the Sabouraud's Dextrose Agar medium which is uniformly spread in the petriplate by rotating. For enumeration of yeast population, the petriplates were incubated for 4 to 5 days in room temperature. The total number of yeast colonies were counted and expressed as cfu/g.

3.3.3.4. Selection of nutri spreads for enrichment

Based on organoleptic, nutritional and storage qualities, two best combinations of spreads with the most suitable fat source, one each from peanut paste (PP) and jackfruit seed flour (JSF) were selected for further studies.

3.4. Enrichment of the developed spreads with protein sources

The selected two combinations one each from PP and JSF were enriched using two protein sources *viz.* defatted soya flour (DSF) and skimmed milk powder (SMP). Defatted soya flour and skimmed milk powder are good sources of protein and hence these were selected for enrichment. These protein sources were incorporated to the base material in both selected spreads in varying percentage levels (10%, 20%, 30%, 40% and 50%).

In the selected peanut paste based nutri spreads, defatted soya flour (DSF) was incorporated in varying percentages from 10 per cent to 50 per cent (T_1- T_5). In treatments T_6 to T_{10}, instead of defatted soya flour (DSF), skimmed milk powder (SMP) was added. The selected peanut paste based nutri spread without enrichment serves as the control (T_0). The experiment was conducted in a Completely Randomised Design (CRD) with 11 treatment combinations with three replications. The details of treatments and combinations are detailed below (Table 3.).

Table 3. Combinations of protein enriched nutri spreads

Treatments	Combinations
PT_0	Control
PT_1	90% PP + 10% DSF
PT_2	80% PP + 20% DSF
PT_3	70% PP + 30% DSF
PT_4	60% PP + 40% DSF
PT_5	50% PP + 50% DSF

PT_6	90% PP + 10% SMP
PT_7	80% PP + 20% SMP
PT_8	70% PP + 30% SMP
PT_9	60% PP + 40% SMP
PT_{10}	50% PP + 50% SMP

*PP- Peanut paste based nutri spread, DSF- Defatted soya flour, SMP- skimmed milk powder

The same set of treatments, T_0- T_{10} were done by replacing peanut paste with jackfruit seed flour. The selected jackfruit seed flour based nutri spread without enrichment serves as the control.

3.4.1. Sensory evaluation of enriched nutri spreads

Sensory evaluation for the enriched spreads were conducted as mentioned in 3.2.3. The score cards used for the evaluation of nutri spreads are given in Appendix II.

3.4.2. Selection of enriched nutri spreads

Four best protein enriched combinations of spreads, two each from peanut paste (one with defatted soya flour and one with skimmed milk powder) and two each from jackfruit seed flour (one with defatted soya flour and one with skimmed milk powder) were selected based on the organoleptic qualities through sensory evaluation. Kendall's coefficient of concordance (W) which expresses the degree of association among the fifteen judges were carried out for each treatment. Thus two enriched nutri spreads each from peanut paste and jackfruit seed flour were studied in detail.

3.4.3. Quality evaluation of the selected enriched nutri spreads

The selected enriched nutri spreads were packed in PET containers and kept in ambient and refrigerant condition for a period of three months. The quality

evaluation of enriched nutri spreads were done initially and at end of the storage period.

3.4.3.1. Evaluation of physico- chemical qualities of enriched nutri spreads

The physico- chemical qualities of enriched nutri spreads were carried out initially and at the end of storage period using standard procedures. The analysis was carried out in triplicate samples. The analysis were carried out for the selected products as described in 3.3.1.

3.4.3.1.1. Peroxide value

Peroxide value of nutri spreads were determined to assess to the rate of rancidity during storage. It was estimated by the method suggested by Sadasivam and Manickam (1997).

To one gram of the sample taken in a boiling tube, one gram of potassium iodide and 20 ml solvent mixture (glacial acetic acid and chloroform) was added. The tube was placed in boiling water for 30 seconds and transferred the contents to a conical flask containing 20 ml of 5 per cent potassium iodide solution. The tubes were washed twice with 25 ml water and collected in a conical flask. This was titrated against sodium thiosulphate solution until the disappearance of yellow colour. Later 0.5 ml of starch solution was added and titrated till the appearance of blue colour. A blank solution was also prepared and peroxide value was computed and expressed in milliequivalent per kg of the sample.

3.4.4. Organoleptic evaluation

Organoleptic evaluation was carried out for the selected products as described in 3.2.3.

3.4.5. Enumeration of total microflora

The microbial population present in the nutri spreads were estimated as described in 3.3.3. The microbial enumeration was carried out in enriched nutri spreads initially and at monthly intervals of storage.

3.5. Cost of production for the selected nutri spreads

The cost of production of 100 g of the selected nutri spreads were computed using the market price of raw materials incurred for the product preparation along with labour charge, fuel charge, electricity charge and packaging cost.

3.6. Statistical analysis of the data

The data were recorded and analysed as completely randomised design (CRD). Based on organoleptic evaluation, the best treatment was identified using Kendall's Coefficient of Concordance (W).The physico- chemical qualities and shelf life qualities of the each treatment were compared using ANOVA.

Results

4. RESULTS

The results of the present study entitled 'Standardisation and quality evaluation of nutri spreads' are presented under following headings.

4.1. Standardisation of nutri spreads

4.1.1. Organoleptic evaluation of peanut paste based nutri spreads

4.1.2. Organoleptic evaluation of jackfruit seed flour based nutri spreads

4.2. Quality evaluation of the selected nutri spreads

4.2.1. Evaluation of physico- chemical qualities of the selected nutri spreads

4.2.2. Organoleptic evaluation of the selected nutri spreads

4.2.3. Enumeration of total microflora

4.3. Enrichment of the developed spreads with protein sources

4.3.1. Sensory evaluation of enriched nutri spreads

4.3.2. Quality evaluation of the selected enriched nutri spreads

4.3.2.1. Evaluation of physico- chemical qualities of enriched nutri spreads

4.3.3. Organoleptic evaluation of enriched selected spreads

4.3.4. Enumeration of total microflora

4.4. Cost of production for the selected nutri spreads

4.5. Statistical analysis of the data

4.1. Standardisation of nutri spreads

Two sets of nutri spreads, one based on peanut paste (PP) and another one based on jackfruit seed flour (JSF) were standardised. Cocoa powder, cane sugar, salt and soya lecithin were the other ingredients used in nutri spreads. The amount of other ingredients were kept in a fixed proportion of 20 per cent.

4.1.1. Organoleptic evaluation of peanut paste (PP) based nutri spreads

Nutri spreads were prepared using peanut paste as the base adding three different fat sources like cocoa butter (CB), unsalted butter (UB) and hydrogenated palm oil (HPO). Organoleptic evaluation of the standardised peanut paste based nutri spreads were carried out seperately. The peanut paste (PP) based nutri spread prepared with three fat sources are shown in Plate 1.

4.1.1.1. Organoleptic evaluation of peanut paste based nutri spreads (PP) with cocoa butter (CB) as fat source

The mean scores obtained for various quality attributes of peanut paste (PP) based nutri spreads prepared with cocoa butter (CB) are presented in Table 4. The different quality attributes were ranked based on their mean score using Kendall's coefficient (W) test.

The mean scores obtained for the organoleptic evaluation varied from 6.73 (PT_1) to 8.26 (PT_4) for appearance. The colour and flavour had a mean score ranging from 8.04 (PT_1) to 8.57 (PT_4) and 7.68 (PT_1) to 7.82 (PT_2 and PT_4) respectively. The texture and taste of the PP nutri spreads prepared with CB obtained a mean scores of 6.80 (PT_1) to 8.42 (PT_4) and 6.91 (PT_1) to 8.75 (PT_4) respectively. The mean scores for overall acceptability varied from 7.20 (PT_1) to 8.28 (PT_4). The mean rank scores varied from 1.43(PT_1) to 4.97 (PT_4) for appearance, 2.27 (PT_1) to 4.37 (PT_4) for colour, 3.13 (PT_1) to 3.80 (PT_4) for flavour, 1.17 (PT_1) to 4.97 (PT_4) for texture, 1.13 (PT_1) to 5.40 (PT_4) for taste and 1.63 (PT_1) to 4.90 (PT_4) for overall acceptability.

The treatment PT_4 with the highest mean score of 8.26 (appearance), 8.57 (colour), 7.82 (flavour), 8.42 (texture), 8.75 (taste) and 8.28 (overall acceptability) was selected as the best treatment and was selected for further studies.

The highest total score for organoleptic qualities was obtained for treatment PT_4 (60 % peanut paste + 20 % of cocoa butter + 20% other ingredients). Hence, the peanut paste based nutri spread (PP) prepared with cocoa butter (CB) (PT_4) was selected for further studies and is shown in Plate 1.

Table 4. Mean scores for organoleptic evaluation of peanut paste based nutri spreads (PP) prepared with cocoa butter (CB)

Treatments	Appearance	Colour	Flavour	Texture	Taste	Overall acceptability	Total score
PT_1 (75%PP+5%CB)	6.73 (1.43)	8.04 (2.27)	7.68 (3.53)	6.80 (1.17)	6.91 (1.13)	7.20 (1.63)	43.36
PT_2 (70%PP+10%CB)	7.91 (2.83)	8.26 (3.47)	7.82 (3.40)	7.66 (2.47)	7.68 (2.73)	7.55 (2.50)	46.88
PT_3 (65%PP+15%CB)	8.08 (4.43)	8.17 (3.07)	7.73 (3.13)	8.31 (4.47)	8.24 (4.13)	7.75 (3.17)	48.28
PT_4 (60%PP+20%CB)	8.26 (4.97)	8.57 (4.37)	7.82 (3.80)	8.42 (4.97)	8.75 (5.40)	8.28 (4.90)	49.33
PT_5 (55%PP+25%CB)	7.97 (3.70)	8.51 (4.27)	7.82 (3.77)	8.15 (4.03)	8.13 (3.70)	8.24 (4.47)	48.82
PT_6 (50%PP+30%CB)	7.86 (3.63)	8.44 (3.57)	7.75 (3.37)	8.13 (3.90)	8.17 (3.90)	8.17 (4.33)	48.52
Kendall's W value	.506*	.200*	.027*	.637*	.661*	.510*	

Value in parentheses are mean rank scorec based on Kendall's W

** Significant at 1% level

The Kendall's value showed a significant agreement among the judges for all quality attributes of peanut paste based nutri spreads prepared with cocoa butter as the fat source.

4.1.1.2. Organoleptic evaluation of peanut paste based nutri spreads (PP) with unsalted butter (UB) as fat source

Nutri spreads (PP) were prepared with unsalted butter (UB) as the fat source and the organoleptic qualities were evaluated. The mean scores obtained for various quality attributes of peanut paste based nutri spreads prepared with unsalted butter are presented in Table 5. The different quality attributes were ranked based on their mean score using Kendall's coefficient (W) test.

The mean scores obtained for the organoleptic evaluation varied from 5.6 (PT_7) to 8.13 (PT_9) for appearance. The colour and flavour had mean scores ranging from 7.48 (PT_7) to 8.40 (PT_9) and 6.48 (PT_7) to 7.37 (PT_9) respectively. The texture and taste of the peanut paste based nutri spreads prepared with unsalted butter obtained mean scores of 5.28 (PT_7) to 7.44 (PT_9) and 5.62 (PT_7) to 6.86(PT_9) respectively. The mean scores for overall acceptability differs from 5.97 to 7.37. Based on the mean rank scores treatment varied from 1.00 to 5.60 for appearance, 1.13 to 5.27 for colour, 1.27 to 5.20 for flavour, 1.17 to 4.49 for texture, 1.13 to 5.47 for taste and 1.00 to 4.80 for overall acceptability.

The treatment PT_9 had the highest mean score of 8.13 (appearance), 8.4 (colour), 7.37 (flavour), 7.44 (texture), 6.86 (taste) and 7.37 (overall acceptability). The total score of organoleptic qualities was also highest (45.57). Hence, PT_9 which contained 65 per cent peanut paste, 15 per cent of unsalted butter and 20 per cent of other ingredients was selected for further studies. The best selected peanut paste based nutri spread prepared with unsalted butter (PT_9) is shown in Plate 1.

The Kendall's value showed a significant agreement among the judges for all quality attributes of peanut paste based nutri spreads prepared with unsalted butter as a fat source.

Table 5. Mean scores for organoleptic evaluation of peanut paste based nutri spreads prepared with unsalted butter

Treatments	Appearance	Colour	Flavour	Texture	Taste	Overall acceptability	Total score
PT_7 (75%PP+5%UB)	5.60 (1.00)	7.48 (1.13)	6.48 (1.27)	5.28 (1.17)	5.62 (1.13)	5.97 (1.00)	36.43
PT_8 (70%PP+10%UB)	8.00 (5.30)	8.15 (4.30)	7.15 (4.40)	6.91 (2.47)	6.68 (4.80)	7.11 (3.80)	44.00
PT_9 (65%PP+15%UB)	8.13 (5.60)	8.40 (5.27)	7.37 (5.20)	7.44 (4.49)	6.86 (5.47)	7.37 (4.80)	45.57
PT_{10} (60%PP+20%UB)	7.37 (3.30)	8.12 (4.00)	6.86 (2.47)	7.37 (4.47)	6.53 (3.70)	7.24 (4.30)	43.49
PT_{11} (55%PP+25%UB)	7.26 (3.13)	8.06 (3.50)	7.00 (3.53)	7.33 (4.03)	6.48 (3.40)	7.15 (4.10)	43.28
PT_{12} (50%PP+30%UB)	7.11 (2.67)	7.91 (2.80)	7.11 (4.13)	7.17 (3.39)	6.13 (2.40)	7.06 (3.00)	42.49
Kendall's W value	.833*	.656*	.655*	.663*	.772*	.592*	

Value in parentheses are mean rank scores based on Kendall's W

** Significant at 1% level

4.1.1.3. Organoleptic evaluation of peanut paste based nutri spreads (PP) with hydrogenated palm oil (HPO) as fat source

Peanut paste (PP) based nutri spreads were prepared with hydrogenated palm oil (HPO) as the fat source and the organoleptic qualities were evaluated. The mean scores obtained for various quality attributes of peanut paste based nutri spreads prepared with hydrogenated palm oil are presented in Table 6. The different quality attributes were ranked based on their mean score using Kendall's coefficient (W) test.

For appearance, the mean scores obtained for the organoleptic evaluation varied from 5.08 (PT_{13}) to 8.08 (PT_{15}). The colour and flavour had a mean score ranging from 6.82 (PT_{13}) to 8.22 (PT_{15}) and 6.55 (PT_{13}) to 7.71 (PT_5) respectively. The texture and taste of the PP based nutri spreads prepared with HPO obtained a mean score of 5.53 (PT_3) to 8.08 (PT_{15}) and 5.91 (PT_{13}) to 8.04 (PT_{15}) respectively. The mean score for overall acceptability differs from 5.53 (PT_{13}) to 8.08 (PT_{15}). Based on the mean rank scores treatment varied from 1.00 to 5.90 for appearance, 1.00 to 4.80 for colour, 1.00 to 4.97 for flavour, 1.00 to 5.90 for texture, 1.13 to 4.80 for taste and 1.00 to 5.23 for overall acceptability.

The treatment PT_5 obtained the highest mean score of 8.08 (appearance), 8.22 (colour), 7.71 (flavour), 8.08 (texture), 8.04 (taste) and 8.08 (overall acceptability). The highest total score of 48.21 was obtained for PT_{15} which contained 65 per cent peanut paste, 15 per cent of hydrogenated palm oil and 20 per cent of other ingredients (Plate1.).

The Kendall's value showed a significant agreement among the judges for all quality attributes of peanut paste based nutri spreads prepared with hydrogenated palm oil as a fat source.

4.1.2. Organoleptic evaluation of jackfruit seed flour (JSF) based nutri spreads

Nutri spreads were prepared based on JSF added with three different fat sources like cocoa butter (CB), unsalted butter (UB) and hydrogenated palm oil (HPO). The jackfruit seed flour based nutri spread prepared with three fat sources are shown in Plate 2.

Table 6. Mean scores for organoleptic evaluation of peanut paste (PP) based nutri spreads prepared with hydrogenated palm oil (HPO)

Treatments	Appearance	Colour	Flavour	Texture	Taste	Overall acceptability	Total score
PT_{13} (75%PP+5%HPO)	5.08 (1.00)	6.82 (1.00)	6.55 (1.00)	5.53 (1.00)	5.91 (1.13)	5.53 (1.00)	35.42
PT_{14} (70%PP+10%HPO)	7.51 (2.87)	8.17 (4.47)	7.46 (3.63)	7.02 (2.00)	7.24 (2.40)	7.02 (2.00)	44.42
PT_{15} (65%PP+15%HPO)	8.08 (5.90)	8.22 (4.80)	7.71 (4.97)	8.08 (5.90)	8.04 (5.47)	8.08 (5.23)	48.21
PT_{16} (60%PP+20%HPO)	7.60 (3.40)	8.06 (3.67)	7.37 (2.70)	7.82 (4.70)	7.91 (4.80)	7.82 (4.70)	46.58
PT_{17} (55%PP+25%HPO)	7.60 (3.40)	8.04 (3.53)	7.48 (3.73)	7.68 (4.20)	7.75 (3.73)	7.68 (4.73)	46.23
PT_{18} (50%PP+30%HPO)	7.82 (4.43)	8.04 (3.53)	7.71 (3.97)	7.41 (3.20)	7.62 (3.43)	7.48 (3.33)	46.08
Kendall's W value	.849*	.629*	.794*	.958*	.772*	.902*	

Value in parentheses are mean rank scores based on Kendall's W

** Significant at 1% level

4.1.2.1. Organoleptic evaluation of jackfruit seed flour (JSF) based nutri spread with cocoa butter (CB) as fat source

The mean scores of the JSF nutri spread prepared with CB as fat source are presented in Table 7.

The mean score for the appearance of JSF nutri spreads prepared with CB varied from 4.31 (JT_1) to 7.26 (JT_6) with mean rank scores in the range of 1.53 to 6.00. Among different treatments tried for the preparation of JSF nutri spreads prepared with CB, the highest mean scores of 7.26 for appearance was noticed in JT_6 and the lowest in JT_1 (4.31).

The highest mean score for colour (7.73) was noticed in JT_6 and the lowest mean score for colour was observed in JT_1 (5.62). The mean rank scores of various treatments ranged between 1.47 and 5.53.

The mean score for flavour of nutri spreads based on JSF prepared with CB was 6.42 to 8.02 with the maximum in JT_6 (8.02) followed by JT_5 (7.86), JT_4 (7.15), JT_3 (7.06), JT_2 (6.75) and JT_1 (6.42).

The mean score for the texture of JSF nutri spreads prepared with CB varied from 3.97 to 5.13 with mean rank scores in the range of 1.40 to 5.80. Among different treatments tried for the preparation of JSF nutri spreads prepared with CB, the highest mean scores (5.80) for texture was noticed in in JT_6 and the lowest in JT_3 (4.31). Comparatively lower scores were obtained for texture of nutri spreads prepared with JSF added with cocoa butter as fat source.

The mean score for taste of different JSF nutri spreads prepared with CB ranged from 4.86 (JT_1) to 6.40 (JT_6). The treatments JT_3, JT_4, JT_5 and JT_2 obtained mean scores of 6.08, 6.02, 6.00 and 5.55 respectively.

Among the different treatments tried for the preparation of JSF nutri spreads adding CB, the highest mean score of 6.35 (5.20) for overall acceptability was noticed in JT_6 prepared with 25 per cent JSF with 55 per cent CB. The lowest mean score (5.17) with mean ranking score of 1.87 was noticed for treatment JT_1. Based

Table 7. Mean scores for organoleptic evaluation of JSF nutri spreads prepared with cocoa butter (CB)

Treatments	Appearance	Colour	Flavour	Texture	Taste	Overall acceptability	Total scores
JT_1 (50%JSF+30%CB)	4.31 (1.93)	5.62 (1.47)	6.42 (1.27)	3.97 (1.40)	4.86 (1.00)	5.17 (1.87)	30.35
JT_2 (45%JSF+35%CB)	5.22 (1.53)	6.86 (2.00)	6.75 (2.53)	4.28 (2.53)	5.55 (3.03)	5.35 (2.40)	34.01
JT_3 (40%JSF+40%CB)	6.08 (3.00)	7.40 (3.07)	7.06 (3.00)	4.31 (2.83)	6.02 (4.10)	5.75 (3.50)	36.59
JT_4 (35%JSF+45%CB)	6.62 (3.80)	7.55 (4.47)	7.15 (3.73)	4.65 (3.70)	6.00 (3.87)	5.86 (3.90)	37.83
JT_5 (30%JSF+50%CB)	6.93 (4.73)	7.55 (4.47)	7.86 (5.13)	4.80 (4.73)	6.08 (4.20)	6.02 (4.13)	39.24
JT_6 (25%JSF+55%CB)	**7.26 (6.00)**	**7.73 (5.53)**	**8.02 (5.33)**	**5.13 (5.80)**	**6.40 (4.80)**	**6.35 (5.20)**	**40.89**
Kendall's W value	**.885****	**.863****	**.728****	**.744****	**.546****	**.429****	

Value in parentheses are mean rank scores based on Kendall's W

** Significant at 1% level

on total scores obtained for organoleptic qualities, JT_6 was selected for further studies and is shown in plate 2.

Based on Kendall's (W) value, there was agreement among judges in the evaluation of different organoleptic qualities of JSF based nutri spreads.

4.1.2.2. Organoleptic evaluation of jackfruit seed flour (JSF) based nutri spread with unsalted butter (UB) as fat source

JSF nutri spreads were prepared with unsalted butter as the fat source and the organoleptic qualities were evaluated. The mean scores obtained for various quality attributes of JSF nutri spreads prepared with UB are presented in Table 8. The different quality attributes were ranked based on their mean score using Kendall's coefficient (W) test.

The mean score for the appearance of JSF nutri spreads prepared with UB varied from 4.15 (JT_8) to 6.97 (JT_{12}) with mean rank scores in the range of 1.77 to 4.73.

The highest mean score for colour (7.15) was noticed in JT_{12} followed by JT_{10} (7.13), JT_{11} (6.95), JT_9 (5.08), JT_7 (5.28) and JT_8 (4.95). The mean rank scores for colour ranged between 1.53 (T8) and 5.23 (JT12).

The mean score for flavour of nutri spreads based on JSF prepared with unsalted butter was 5.75 to 7.80 with maximum in JT_{12} and minimum in JT_7. The treatments JT_{11}, JT_{10}, JT_8 and JT_9 obtained mean scores of 7.44, 6.55, 6.06 and 5.91 for flavour respectively.

The mean score for the texture of JSF nutri spreads prepared with UB varied from 4.11 to 7.28 with mean rank scores in the range of 1.53 to 5.77. Among different treatments tried for the preparation of JSF nutri spreads prepared with unsalted butter, the highest mean scores (5.80) for texture was noticed in JT_{12} and the lowest in JT_7 (4.31).

For taste, the mean score for taste of different JSF based nutri spreads prepared with unsalted butter ranged from 4.73 (1.70) to 7.42 (5.73) with highest in JT_{12} and the lowest in JT_8. Treatments JT_7, JT_9, JT_{10} and JT_{11} obtained mean score

Table 8. Mean score for organoleptic evaluation of JSF nutri spreads prepared with unsalted butter (UB)

Treatments	Appearance	Colour	Flavour	Texture	Taste	Overall acceptability	Total score
JT_7 (50%JSF+30%UB)	4.33 (2.30)	5.28 (2.53)	5.75 (1.60)	4.11 (1.53)	5.28 (2.07)	4.80 (2.07)	29.55
JT_8 (45%JSF+35%UB)	4.15 (1.77)	4.95 (1.53)	6.06 (2.60)	4.26 (2.00)	4.73 (1.70)	4.93 (1.97)	29.08
JT_9 (40%JSF+40%UB)	4.44 (1.93)	5.08 (1.93)	5.91 (2.13)	4.57 (2.47)	5.08 (2.23)	4.93 (1.97)	30.01
JT_{10} (35%JSF+45%UB)	6.31 (4.27)	7.13 (5.07)	6.55 (4.77)	5.40 (4.00)	6.57 (4.47)	6.11 (4.00)	38.07
JT_{11} (30%JSF+50%UB)	6.46 (4.70)	6.95 (4.70)	7.44 (4.80)	7.11 (5.23)	6.80 (4.80)	6.80 (5.27)	41.56
JT_{12} (25%JSF+55%UB)	6.97 (4.73)	7.15 (5.23)	7.80 (5.10)	7.28 (5.77)	7.42 (5.73)	7.26 (5.73)	43.88
Kendall's W value	**.898****	**.898****	**.754****	**.962****	**.854****	**.903****	

Value in parentheses are mean rank scores based on Kendall's W

** Significant at 1% level

of 5.28, 5.08, 6.57 and 6.8 with mean rank scores of 2.07, 2.23, 4.47 and 4.80 respectively.

Among the different treatments adopted for the preparation of JSF nutri spreads prepared with UB, the highest mean score of 7.26 for overall acceptability was noticed in JT_{12} followed by JT_{11} (6.8), JT_{10} (6.11), JT_8 and JT_9 (4.93) and JT_7 (4.80) respectively. The composition of JT_{12} include 25 per cent JSF and 55 per cent UB with 20 per cent other ingredients. Based on total scores obtained for organoleptic qualities, JT_{12} was selected for further studies and is shown in plate 2.

Based on Kendall's (W) value, there was agreement among judges in the evaluation of different organoleptic qualities of JSF nutri spreads prepared with unsalted butter.

4.1.2.2. Organoleptic evaluation of jackfruit seed flour (JSF) based nutri spread with hydrogenated palm oil (HPO) as fat source

JSF based nutri spreads prepared with hydrogenated palm oil were subjected to sensory evaluation and the results are detailed in Table 9.

The mean scores for the appearance of JSF nutri spreads prepared with HPO varied from 5.44 to 8.88 with mean rank scores in the range of 1.00 to 5.37. Among different treatments tried for the preparation of JSF nutri spreads prepared with HPO, the highest mean scores (8.88) for appearance was noticed in JT_{16} and the lowest in JT_{13} (5.44).

The highest mean score for colour (9.00) was noticed in JT_{16} and the lowest observed in JT_{13} (7.44). The mean rank scores ranged between 1.30 and 5.33.

The mean score for flavour of nutri spreads on JSF prepared with HPO was 6.66 (JT_{13}) to 8.11(JT_{16}). Treatments JT_{17}, JT_{18}, JT_{15} and JT_{14} obtained mean scores and mean rank scores of 7.97 (4.93), 7.77 (3.87), 7.48 (3.27) and 7.33 (2.80) respectively.

The mean score for the texture of JSF nutri spreads prepared with HPO varied from 5.24 (JT_{13}) to 7.97 (JT_{16}) with mean rank scores in the range of 1.00 to 5.13. Among different treatments tried for the preparation of JSF nutri spreads

Table 9. Mean score for organoleptic evaluation of JSF based nutri spreads prepared with hydrogenated palm oil

Treatments	Appearance	Colour	Flavour	Texture	Taste	Overall acceptability	Total score
JT_{13} (50%JSF+30%HPO)	5.44 (1.00)	7.44 (1.30)	6.66 (1.00)	5.24 (1.00)	5.28 (1.00)	5.95 (1.00)	36.01
JT_{14} (45%JSF+35%HPO)	7.13 (2.23)	8.66 (3.17)	7.33 (2.80)	6.26 (2.27)	6.31 (2.00)	7.31 (2.73)	43.00
JT_{15} (40%JSF+40%HPO)	7.48 (2.77)	8.51 (2.23)	7.48 (3.27)	6.42 (2.73)	6.82 (3.00)	7.00 (2.27)	43.71
JT_{16} (35%JSF+45%HPO)	**8.88 (5.37)**	**9.00 (5.33)**	**8.11 (5.13)**	**7.97 (5.13)**	**8.73 (5.57)**	**8.66 (5.37)**	**51.35**
JT_{17} (30%JSF+50%HPO)	8.82 (5.07)	8.8 (4.53)	7.97 (4.93)	7.88 (4.93)	8.64 (5.43)	8.46 (5.17)	50.57
JT_{18} (25%JSF+55%HPO)	8.48 (4.57)	8.84 (4.43)	7.77 (3.87)	7.57 (4.93)	8.31 (4.00)	8.11 (4.47)	49.08
Kendall's W value	**.963****	**.755****	**.692****	**.899****	**.997****	**.964****	

Value in parentheses are mean rank scores based on Kendall's W

** Significant at 1% level

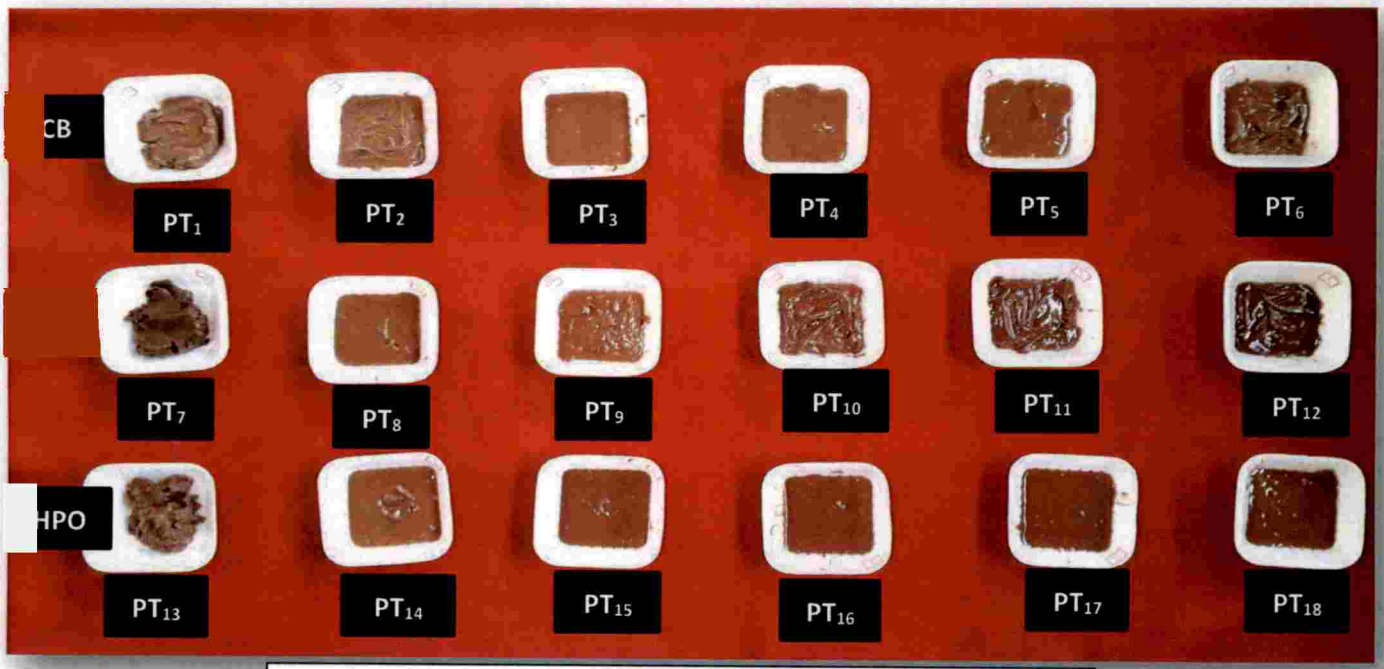


Plate 1. Nutri spreads (Peanut paste) prepared with various fat sources

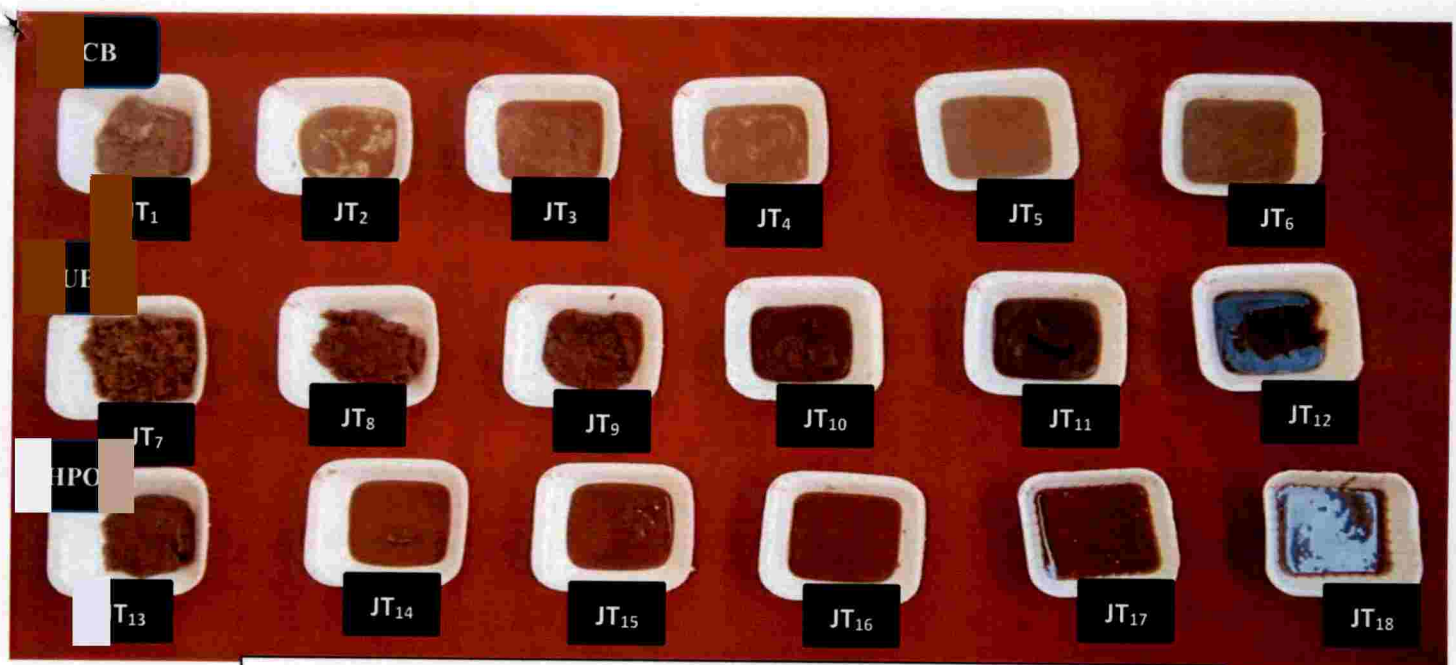


Plate 2. Nutri spreads (Jackfruit seed flour) prepared with various fat sources

CB- Cocoa butter, UB- Unsalted butter, HPO- Hydrogenated palm oil

prepared with HPO, the highest mean scores (7.97) for texture was noticed in in JT_{16} followed by JT_{17}, JT_{18}, JT_{15}, JT_{14} and JT_{13}.

The mean score for taste of different JSF nutri spreads prepared with HPO ranged from 5.28 (1.00) to 8.73 (5.57) with highest in JT_{16} followed by JT_{17} (8.64), JT_{18} (8.31), JT_{15} (6.82), JT_{14} (6.31) and JT_{13} (5.28).

Among the different treatments tried for the preparation of JSF nutri spreads prepared with HPO, the highest mean score of 8.66 (5.37) for overall acceptability was noticed in JT_{16} followed by JT_{17} (8.46), JT_{18} (8.11), JT_{14} (7.31), JT_{15} (7.00) and JT_{13} (5.95) and is shown in plate 2. Based on total scores obtained for organoleptic qualities, JT_{16} was selected for further studies.

Based on Kendall's (W) value, there was agreement among judges in the evaluation of different organoleptic qualities of JSF nutri spreads prepared with HPO.

4.2. Quality evaluation of the selected nutri spreads

Three treatments of peanut paste (PP) based nutri spreads added with three different fat sources selected were PT_4, PT_9 and PT_{15} (Table 10.). In nutri spreads prepared based on JSF, poor textural qualities were obtained for prepared by adding cocoa butter as a fat source. As cocoa butter was found to be unsuitable for developing a nutri spread in combination with JSF, only two treatments (JT_{12} and JT_{16}) were selected for further studies. The selected three treatments of PP based nutri spreads from each fat sources and two treatments from JSF based nutri spreads (Table 10.) were packed in polyethylene terephthalate containers and kept in ambient and refrigerated conditions for a period of three months. The quality evaluation of the stored nutri spreads were assessed initially and at monthly intervals for a period of three months. The selected three treatments of PP based nutri spreads from each fat sources and two treatments from JSF based nutri spreads are shown in plate 3 and 4 respectively.

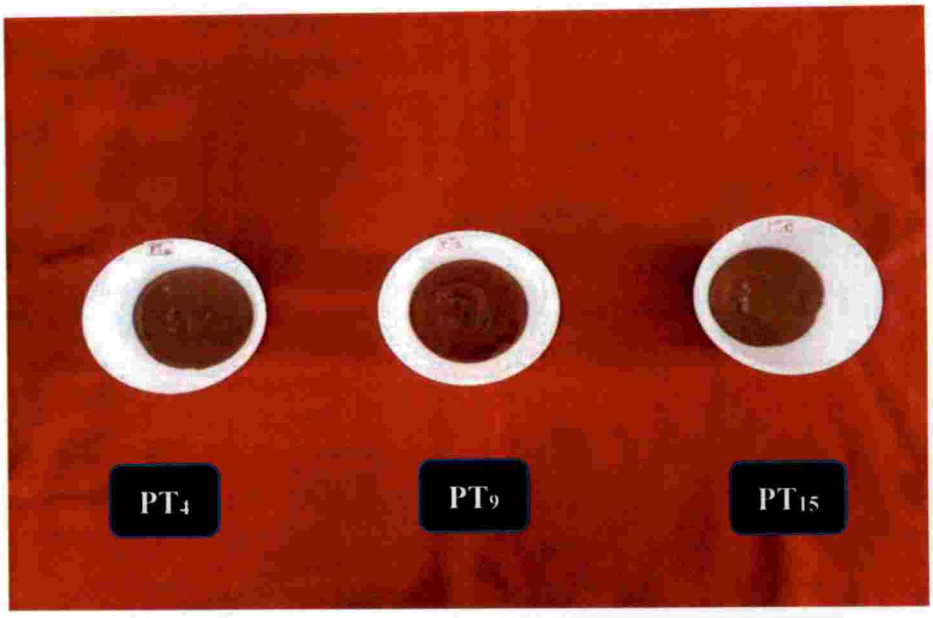


Plate 3. Selected combinations of Peanut paste based nutri spreads

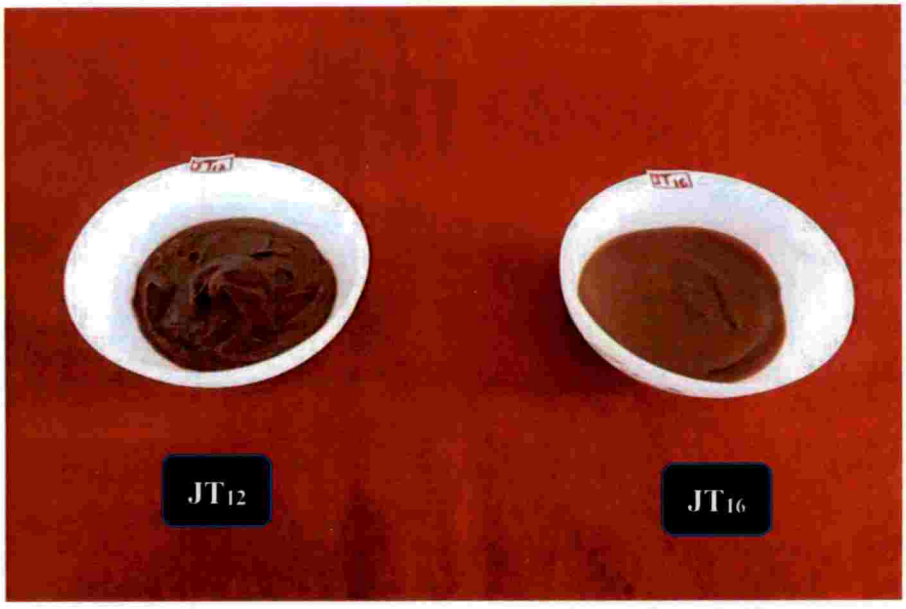


Plate 4. Selected combinations of jackfruit seed flour based nutri spreads

Table 10. Selected nutri spreads for storage

Treatments	Combinations
PT_4 – PP + CB	60% peanut paste + 20% Cocoa butter + 20% Other ingredients
PT_9 – PP + UB	65% peanut paste + 15% Unsalted butter + 20% Other ingredients
PT_{15} – PP + HPO	65% peanut paste + 15% Hydrogenated palm oil + 20% Other ingredients
JT_{12} – JSF + UB	25% JSF + 55% Unsalted butter + 20% Other ingredients
JT_{16} - JSF + HPO	35% JSF + 45% Hydrogenated palm oil + 20% Other ingredients

4.2.1. Evaluation of physico- chemical qualities of selected nutri spreads

The physico- chemical qualities of the stored nutri spreads (in ambient and refrigerated condition) were carried out initially and at monthly intervals of the storage period using standard procedures. The analysis was carried out in triplicate samples. The physico- chemical qualities of nutri spreads such as textural properties, pH, moisture, reducing sugar, total sugar, fat, protein, energy, total ash, calcium, iron, phosphorus, zinc, sodium and potassium of the selected nutri spreads were evaluated.

4.2.1.1. Texture Analysis

. The textural properties of the selected spreads were evaluated in freshly prepared nutri spreads. The results of the textural quality parameters such as gel strength, adhesiveness, brittleness and rupture strength of the nutri spreads were observed and the results are detailed in Table 11.

Table 11. Textural properties of selected nutri spreads

Treatments	Gel strength (N)		Rupture strength(N)		Brittleness (mm)		Adhesiveness(N)	
	A	R	A	R	A	R	A	R
PT4 – 60% PP +20% CB	1.057	6.017	12.844	22.586	21.756	3.298	144.131	0.508
PT9- 65% PP +15% UB	1.851	1.504	12.728	14.232	18.705	26.62	25.903	23.943
PT15- 65% PP & 15% HPO	2.083	8.794	12.844	5.67	25.808	16.451	19.329	3.018
C.D (0.05)	**0.001***	**0.001***	**0.001***	**0.007***	**0.001***	**0.007***	**0.666***	**0.001***
JT12- 25% JSF + 55% UB	2.388	2.777	10.456	35.031	19.756	0.334	2.789	3.818
JT16- 35% JSF + 45% HPO	4.975	6.711	5.438	5.554	24.373	21.632	7.855	2.514
C.D (0.05)	**0.001***	**0.001***	**0.001***	**0.001***	**0.001***	**0.001***	**0.001***	**0.001***

PP- Peanut paste, CB- Cocoa butter, UB- Unsalted butter, HPO- Hydrogenated palm oil, JSF- Jackfruit seed flour, A- Ambient, R- Refrigerated

The gel strength of the nutri spread varied from 2.083N to 1.057N. The highest value for gel strength of nutri spread was noticed in the spread PT_{15} (65 % PP + 15 % HPO) and the lowest value was noticed in PT_4 (65% PPe+ 15% CB). Among the nutri spreads, the maximum adhesiveness was recorded in PT_{15} (65% PP + 15% HPO). The lowest adhesiveness was recorded for the nutri spread prepared using 60 per cent PP and 20 per cent of CB (PT_4). The adhesiveness of the products decreased with decreasing proportion of PP. The brittleness of the PP based nutri spreads varied from 18.705 mm to 25.808 mm with the maximum brittleness of 18.705 was recorded in PP nutri spread prepared using 65 per cent PP and 15 per cent of UB (PT_9) and the lowest brittleness was noticed for 65 per cent of PP and 15 per cent hydrogenated palm oil (PT_{15}). The maximum rupture strength of 12.844 N was recorded in PT_{15} and PT_4. The lowest rupture strength of 12.728 N was noticed in PT_9 (65 % PP + 15 % UB).

Under refrigerated condition, the strength of the selected PP based nutri spreads were varied from1.504 N to 8.794 N. The highest value for gel strength of nutri spread was noticed in the spread PT_{15} (8.794N) and the lowest value was noticed in PT_9 (1.504N). The maximum adhesiveness was recorded in PT_9 (23.943N). The lowest adhesiveness was recorded for the PT_4 (0.508N). The brittleness of the PP based nutri spreads varied from 3.298 mm to 26.62 mm with the maximum brittleness of 26.62 mm was recorded in PT_9 and the lowest brittleness was noticed in PT_4. The maximum rupture strength of 22.586 N was recorded in PT_4. The lowest rupture strength of 5.67 N was noticed in PT_{15}.

The gel strength of the selected JSF based nutri spreads obtained 2.388N in JT_{12} (25% JSF + 55% UB) and 4.975N in JT_{16} (35% JSF + 45% HPO). The adhesiveness was recorded in JT_{12} was 2.789 N and in JT_{16} was 7.855N. The brittleness of the JSF based nutri spreads recorded in JT_{12} was 19.756 mm and in JT_{16} was 24.373 mm. Among the nutri spreads based on JSF, the rupture strength of 10.456 N was recorded in JT_{12} and the rupture strength of 5.438 N was noticed in JT_{16}.

Under refrigerated condition, the strength of the selected JSF based nutri spreads obtained 2.388N in JT_{12} (25% JSF + 55% UB) and 4.975N in JT_{16} (35% JSF + 45% HPO). The adhesiveness was recorded in JT_{12} was 3.818 N and in JT_{16} was 2.514N. The brittleness of the JSF based nutri spreads recorded in JT_{12} was 0.334 mm and in JT_{16} was 21.632 mm. Among the nutri spreads based on JSF, the rupture strength of 35.031 N was recorded in JT_{12} and the rupture strength of 5.554 N was noticed in JT_{16}.

4.2.1.2. pH

The pH obtained for selected treatments of nutri spreads are presented in Table 12.

In PP based nutri spreads, stored at ambient temperature, the pH varied from 4.98 (PT_4) to 5.1 (PT_9) initially, the pH was highest in PT_9 (5.10). A gradual increase in pH was observed in all treatments at the end of 3rd month of storage with maximum pH of 5.31 in PT_9 followed by 5.29 (PT_4) and 5.19 (PT_{15}). In the selected JSF based nutri spreads, stored at ambient temperature the pH noticed 5.33 (JT_{12}) and 5.1 (JT_{16}) initially. After 3rd month of storage an increase in pH of the selected JSF nutri spreads was observed which are 5.62 (JT_{12}) and 5.35 (JT_{16}). A gradual increase in pH was observed in all treatments on storage.

Under refrigerated condition, after first month of storage no change in pH was observed for PP nutri spread added with CB as fat source. But a considerable increase in pH was observed in the case PT_9 when compared to the other two treatments. After 2nd month of storage, the highest pH of 5.13 was observed in PT_9, followed by 5.02 and 5.13 in PT_9 and PT_{15} respectively. The JSF nutri spreads the pH recorded were 5.33 (JT_{12}) and 5.1 (JT_{16}) initially. After 3rd month of storage an increase in pH was observed which are 5.40 (JT_{12}) and 5.16 (JT_{16}). A gradual increase in pH was observed in all treatments during storage.

4.2.1.3. Moisture

The moisture content of selected PP nutri spreads packed in PET containers during storage is given in Table 12. Initially, the moisture content of selected PP

Table 12. pH and Moisture content (%) of selected nutri spreads

Treatments	pH							Moisture (%)						
	Initial	1st month		2nd month		3rd month		Initial	1st month		2nd month		3rd month	
		A	R	A	R	A	R		A	R	A	R	A	R
PT_4 – 60% PP +20% CB	4.98	5.12	4.98	5.23	4.96	5.29	5.01	2.05	2.12	2.06	2.16	2.07	2.73	2.12
PT_9- 65% PP +15% UB	5.10	5.14	5.11	5.21	5.13	5.31	5.16	2.97	3.03	3.00	3.05	3.02	3.08	3.04
PT_{15}- 65% PP + 15% HPO	4.99	5.09	5.00	5.19	5.02	5.27	5.03	1.81	1.86	1.82	1.89	1.83	1.92	1.85
C.D (0.05)	**0.013***	**0.021***	**0.013***	**0.01***	**0.021***	**0.021***	**0.013***	**0.016***	**0.012***	**0.016***	**0.012***	**0.012***	**0.012***	**0.642***
JT_{12}- 25% JSF + 55% UB	5.33	5.41	5.35	5.50	5.37	5.62	5.4	3.35	3.41	3.35	3.43	3.38	3.82	3.39
JT_{16}- 35% JSF + 45% HPO	5.10	5.16	5.11	5.21	5.14	5.35	5.16	1.71	1.79	1.74	1.80	1.76	1.83	1.77
C.D (0.05)	**0.021***	**0.013***	**0.013***	**0.021***	**0.019***	**0.026***	**0.021***	**3.697***	**0.013***	**0.009**	**0.009***	**0.009***	**0.013***	**0.013***

PP- Peanut paste, CB- Cocoa butter, UB- Unsalted butter, HPO- Hydrogenated palm oil, JSF- Jackfruit seed flour, A- Ambient, R- Refrigerated

nutri spreads varied from 1.81 per cent (PT_{15}) to 2.97 per cent (PT_9). The moisture content of PP nutri spread prepared with UB was comparatively higher. The maximum moisture content was noticed in PT_9 (3.08%) after third month of storage. The lowest moisture content after third month of storage was noticed in PT_{15} (1.92%). Initially, the moisture content of selected JSF nutri spreads are 6.35 per cent (JT_{12}) and 1.71 per cent (JT_{16}). The moisture content of JSF nutri spread prepared with UB was comparatively higher. The moisture content noticed in JT_{12} was 10.45 per cent after third month of storage followed by JT_{16} (1.83%).

At refrigerated condition, after first month of storage, the moisture content of the selected PP nutri spreads varied from 1.82 percent (PT_{15}) to 3.00 per cent (PT_9). The moisture content of PP nutri spread prepared with UB was comparatively higher. The maximum moisture content was noticed in PT_9 (3.04%) after third month of storage. The minimum moisture content after third month of storage was noticed in PT_{15} (1.85%). An increasing moisture content was observed during storage. In JSF nutri spreads, the moisture content noticed in JT_{12} was 6.39 per cent after third month of storage. The moisture content after third month of storage noticed in JT_{16} was 1.77 per cent.

On the basis of ANOVA, the variation noticed in the moisture content of selected PP based nutri spreads was found to be statistically significant in all the treatments throughout the the storage study.

4.2.1.4. Reducing sugar

The reducing sugar content of the selected nutri spreads stored at both ambient and refrigerated conditions are furnished in Table 13.The nutri spread PT_9 recorded the highest reducing sugar content (0.30%) and the lowest reducing sugar content observed in PT_4 (0.25%). Among different treatments, the nutri spread prepared using 35 per cent JSF and 45 per cent HPO (JT_{16}) recorded the highest reducing sugar content during throughout the storage period, which varied from 0.22 to 0.28 per cent. The reducing sugar content of JT_{12} varied from 0.21 to 0.29

Table 13. Reducing sugar and total sugar content (%) of selected nutri spreads

Treatments	Reducing sugar (%)							Total sugar (%)						
	Initial	1st month		2nd month		3rd month		Initial	1st month		2nd month		3rd month	
		A	R	A	R	A	R		A	R	A	R	A	R
PT_4 – 60% PP +20% CB	0.247	0.26	0.24	0.28	0.25	0.30	0.28	12.95	13.16	12.98	13.35	13.02	13.95	13.06
PT_9- 65% PP +15% UB	0.303	0.31	0.29	0.33	0.31	0.34	0.32	11.96	12.09	12.01	12.28	12.02	12.73	12.1
PT_{15}- 65% PP + 15% HPO	0.257	0.27	0.25	0.30	0.26	0.31	0.28	11.67	11.93	11.70	12.52	11.73	12.95	11.78
C.D (0.05)	**0.012***	**0.012***	**0.012***	**0.012***	**0.012***	**0.012***	**0.012***	**0.012***	**0.012***	**0.012***	**0.012***	**0.012***	**0.012***	**0.012***
JT_{12}- 25% JSF + 55% UB	0.21	0.23	0.22	0.29	0.23	0.29	0.24	9.54	9.98	9.56	10.17	9.57	10.64	9.61
JT_{16}- 35% JSF + 45% HPO	0.22	0.25	0.23	0.28	0.25	0.28	0.26	8.97	9.26	8.99	9.89	9.01	10.54	9.1
C.D (0.05)	**0.013***	**0.013***	**NS**	**NS**	**0.013***	**NS**	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***	**0.021***	**0.021***

PP- Peanut paste, CB- Cocoa butter, UB- Unsalted butter, HPO- Hydrogenated palm oil, JSF- Jackfruit seed flour, A- Ambient, R- Refrigerated

per cent. After third month of storage, the reducing sugar content observed in both treatments were found to be on par each other.

Under refrigerated condition, significant variation in the initial values of reducing sugar content was observed. In PT_9 (65% PP +15% UB) recorded the highest reducing sugar content throughout the storage, which varied from 0.30 to 0.32 per cent. In JSF nutri spreads, JT_{16} (35% JSF+ 45 % HPO) recorded the highest reducing sugar content throughout the storage study. An increasing trend was observed in reducing sugar during storage. Reducing sugar content of JSF nutri spread stored at refrigerated condition increased to the range of 0.24 per cent (JT_{16}) to 0.28 per cent (JT_{12}) by the end of the storage.

Based on one way ANOVA, significant variation in the initial values of reducing sugar content was observed under both ambient and refrigerated conditions throughout the storage period.

4.2.1.5. Total sugar

The total sugar content of the selected nutri spreads during storage in PET containers and stored at ambient and refrigerant condition are furnished in Table 13. Initially, the total sugar content of PP nutri spreads varied from 11.67 to 12.95 per cent with the highest in PT_4 (60% PP+ 20% CB) and the lowest in PT_{15} (65% PP+ 15% HPO). An increase in total sugar content was observed in the PP nutri spreads during the storage period at ambient condition. The total sugar content observed by the end of storage was 12.73 per cent (PT_9), 12.95 per cent (PT_{15}) and 13.95 per cent (PT_4) In JSF nutri spreads, initially, the total sugar content of JSF nutri spreads are 9.54 (JT_{16}) and 8.97 (JT_{12}). During storage period, an increase in total sugar was observed and the total sugar content of JT_{12} and JT_{16} increased to 10.64 per cent and 10.54 per cent respectively by the end of storage.

Under refrigerated condition, a slight increase in total sugar content was observed in the PP nutri spreads during storage period. After the three months of storage, the highest total sugar content observed in PT_4 (13.06) and lowest in PT_{15} (11.78). A slight increase in total sugar content was observed in the JSF nutri spreads also during storage period. The total sugar content of JT_{12} and JT_{16} varied from 9.56 to 9.61 per cent and 8.99 to 9.1 per cent respectively during storage.

4.2.1.5. Fat

The fat content present in the selected nutri spreads were estimated and presented in Table 14.

Initially the fat content present in the selected PP based nutri spreads were 28.32 (PT_9), 31.08 (PT_4) to 40.49 g/100 g (PT_{15}). The fat content observed in PP nutri spreads at the end of storage was 27.98 (PT_9), 30.98 (PT_4) and 40.41 g/100 g (PT_{15}). Among PP nutri spreads, there was a decrease in fat content for all the treatments during storage. Initially, the fat content present in the JSF nutri spreads were 31.09 (JT_{12}) and 46.02 g/100 g (JT_{16}). At end of the storage period, the fat content were 30.95 (JT_{12}) and 45.95 g/100 g (JT_{16}).

Under refrigerated condition, there was a decrease in fat content for all the treatments during storage. At end of the storage period, the fat content of PP nutri spreads varied from 28.26 (PT_9) to 40.44 g/100 g in PT_{15}. In JSF nutri spreads, at end of the storage period, the fat content were 31.01 (JT_{12}) and 45.94 g/100 g (JT_{16}).

4.2.1.6. Protein

The protein content in selected PP nutri spreads varied from 15.08 (PT_{15}) to 19.03 (PT_9) g/100 g initially (Table 14). The highest protein content was noticed in PT_9 prepared with 65 per cent of PP and 15 per cent of UB and the lowest protein content was noticed in PT_{15} prepared with 65 per cent of PP and 15 per cent of HPO initially. At end of the storage period, the protein content varied from 14.98 (PT_{15}) to 18.92 (PT_9) g/100 g. There was a decrease in protein content for all the treatment during storage. Initially the protein content present in the selected JSF based nutri spreads were 5.93 (JT_{12}) and 6.60 g/100 g (JT_{16}). At end of the storage period, the protein content decreased to 5.25 (JT_{12}) and 6.47 g/100 g (JT_{16}).

Under refrigerated condition, among PP nutri spreads, the highest protein content of 18.96 g/100 g was noticed in PT_9 (65% PP+ 15% unsalted butter) after storage. The lowest protein content of 15.04 g/100 g was noticed in PT_{15} (65% PP + 15% HPO). The protein content present in PP nutri spreads decreased on storage. At end of the storage period, the protein content decreased to 18.96 in PT_9, 18.17

Table 14. Fat and protein content (g/100 g) of nutri spreads

Treatments	Fat (g/100 g)							Protein (g/ 100g)						
	Initial	1st month		2nd month		3rd month		Initial	1st month		2nd month		3rd month	
		A	R	A	R	A	R		A	R	A	R	A	R
PT_4 – 60% PP +20% CB	31.08	31.03	31.07	31.01	31.04	30.97	31.04	18.22[b]	18.18[b]	18.21[b]	18.17[b]	18.19[b]	18.14[b]	18.17[b]
PT_9- 65% PP +15% UB	28.32	28.29	28.31	28.24	28.29	27.98	28.26	19.03 [a]	18.96[a]	19.02[a]	18.95[a]	18.99[a]	18.92[a]	18.96[a]
PT_{15}- 65% PP + 15% HPO	40.49	40.46	40.48	40.43	40.47	40.41	40.44	15.08 [c]	15.02 [c]	15.06[c]	15.00[c]	15.06[c]	14.98[c]	15.04
C.D (0.05)	**0.012***	**0.009***	**0.012***	**0.012***	**0.007***	**0.007***	**0.012***	**0.012***	**0.012***	**0.012***	**0.012***	**0.007***	**0.009***	**0.012***
JT_{12}- 25% JSF + 55% UB	31.09	31.03	31.07	30.98	31.05	30.95	31.01	5.93	5.89	5.92	5.39	5.90	5.25	5.89
JT_{16}- 35% JSF + 45% HPO	46.02	45.98	45.98	45.97	45.97	45.95	45.94	6.60	6.52	6.58	6.50	6.55	6.47	6.53
C.D (0.05)	**0.009***	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***	**0.009***	**0.013***	**0.009***	**0.013***	**0.013***

PP- Peanut paste, CB- Cocoa butter, UB- Unsalted butter, HPO- Hydrogenated palm oil, JSF- Jackfruit seed flour, A- Ambient, R- Refrigerated

in PT_4 and 15.04 in PT_{15}. In JSF nutri spreads, the protein content decreased to 5.89 (JT_{12}) and 6.53 (JT_{16}) at the end of the storage.

4.2.1.7. Carbohydrates

The carbohydrate content in selected PP nutri spreads varied from 21.95 (PT_4) to 23.62 g/100 g (PT_{15}) initially (Table 15). Initially the highest carbohydrate content was noticed in PT_{15} prepared with 65 per cent of PP and 15 per cent of HPO and the lowest carbohydrate content was noticed in PT_4 prepared with 60 per cent of PP and 20 per cent of CB. At end of the storage period, the carbohydrate content varied from 21.88 (PT_4) to 23.57 g/100 g (PT_{15}). There was a decrease in carbohydrate content for all the treatments during storage. Initially the carbohydrate content present in the selected JSF based nutri spreads were 36.78 (JT_{12}) and 19.86 g/100 g (JT_{16}). At end of the storage period, the carbohydrate content decreased to 36.70 (JT_{12}) and 19.76 g/100 g (JT_{16}).

Under refrigerated condition, among PP nutri spreads, the highest carbohydrate content of 23.59 g/100 g was noticed in PT_{15} (65% PP+ 15% HPO) after storage. The lowest carbohydrate content of 21.90 g/100 g was noticed in PT_4 (60% PP + 20% CB). The carbohydrate content present in PP nutri spreads decreased on storage. At end of the storage period, the carbohydrate content decreased to 22.71 in PT_9, 21.90 in PT_4 and 23.59 g/100 g in PT_{15}. In JSF nutri spreads, the carbohydrate content decreased to 36.73 (JT_{12}) and 19.80 g/100 g (JT_{16}) at the end of the storage.

4.2.1.8. Energy

The calorific value of the selected nutri spreads is given in Table 15. In PP nutri spreads, lower calorific value was noticed in PT_9. Initially, the calorific value in PP nutri spreads varied from 422.00 Kcal (PT_9) to 519.21 Kcal (PT_{15}) which decreased during storage. On third month of storage the calorific value varied from 418.26 Kcal to 517.89 Kcal. In JSF nutri spreads, the calorific value was observed in JT_{12} (450.65 Kcal) and in JT_{16} (520.02 Kcal). End of the storage, the calorific value was observed in JT_{12} is 458.35 Kcal and in JT_{16} was 518.65 Kcal.

Table 15. Carbohydrate content (g/100 g) and calorific value (Kcal) of selected nutri spreads

Treatments	Carbohydrate (g/ 100g)							Energy (Kcal)						
	Initial	1st month		2nd month		3rd month		Initial	1st month		2nd month		3rd month	
		A	R	A	R	A	R		A	R	A	R	A	R
PT_4 – 60% PP +20% CB	21.95	21.94	21.94	21.90	21.92	21.88	21.90	440.40	439.75	440.23	439.37	439.80	438.81	439.64
PT_9- 65% PP +15% UB	22.75	22.73	22.73	22.70	22.72	22.69	22.71	422.00	421.37	421.79	420.76	421.57	418.26	421.02
PT_{15}- 65% PP + 15% HPO	23.62	23.61	23.61	23.59	23.60	23.57	23.59	519.21	518.66	519.00	518.23	518.87	517.89	518.45
C.D (0.05)	**0.012***	**0.012***	**0.012***	**0.009***	**0.012***	**0.012***	**0.012***	**0.012***	**0.012***	**0.012***	**0.012***	**0.203***	**0.012***	**0.012***
JT_{12}- 25% JSF + 55% UB	36.78	36.75	36.77	36.72	36.75	36.70	36.73	450.65	449.83	450.39	449.26	450.05	458.35	449.57
JT_{16}- 35% JSF + 45% HPO	19.86	19.83	19.85	19.79	19.83	19.76	19.80	52.02	519.22	519.54	518.89	519.25	518.65	518.78
C.D (0.05)	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***	**0.009***	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***

PP- Peanut paste, CB- Cocoa butter, UB- Unsalted butter, HPO- Hydrogenated palm oil, JSF- Jackfruit seed flour, A- Ambient, R- Refrigerated

Under refrigerated condition, there was a decrease in calorific value for all the treatments during storage. At end of the storage period, the calorific value of PP nutri spreads varied from 421.02 Kcal (PT_9) to 518.45 Kcal in PT_{15}. In JSF nutri spreads, at end of the storage period, the calorific value were 449.57 Kcal (JT_{12}) and 518.78 Kcal (JT_{16}).

Based on ANOVA, significant variation in calorific value of selected nutri spreads were noticed throughout the period of storage in both ambient and refrigerated condition.

4.2.1.9. Total ash

The total ash content of the selected nutri spreads is given in Table 16. Initially the total ash content in the selected PP nutri spreads were 1.86 (PT_4), 2.38 (PT_4) and 2.19 (PT_{15}) per cent. The total ash content observed in PP nutri spreads at the end of storage was 1.76 (PT_4), 2.31 (PT_9) and 2.08 (PT_{15}). Among PP nutri spreads, there was a decrease in total ash content for all the treatments during storage. Initially, the total ash content present in the JSF nutri spreads were 1.21 (JT_{12}) and 0.90 per cent (JT_{16}). At end of the storage period, the total ash content were 1.13 (JT_{12}) and 0.83 per cent (JT_{16}).

Under refrigerated condition, there was a decrease in total ash content for all the treatments during storage. At end of the storage period, the total ash content of PP nutri spreads varied from 1.81 (PT_9) to 2.32 per cent in PT_{15}. In JSF nutri spreads, at end of the storage period, the total ash content were 1.18 (JT_{12}) and 0.85 per cent (JT_{16}).

Based on ANOVA, significant variation in total ash content of selected nutri spreads were noticed throughout the period of storage in both ambient and refrigerated condition.

4.2.1.10. Calcium

The calcium content of selected nutri spreads were estimated and their results were tabulated and given in Table 17.

Table 16. Total ash content (%) of selected nutri spreads

Treatments	Total ash (%)						
	Ambient				Refrigerated		
	Initial	1st month	2nd month	3rd month	1st month	2nd month	3rd month
PT4 – 60% PP +20% CB	1.86	1.82	1.79	1.76	1.83	1.82	1.81
PT9- 65% PP +15% UB	2.38	2.34	2.32	2.31	2.37	2.34	2.32
PT15- 65% PP + 15% HPO	2.19	2.13	2.11	2.08	2.17	2.16	2.15
C.D (0.05)	**0.007***	**0.007***	**0.020***	**0.016***	**0.012***	**0.012***	**0.012***
JT12- 25% JSF + 55% UB	1.21	1.19	1.16	1.13	1.20	1.19	1.18
JT16- 35% JSF + 45% HPO	0.90	0.87	0.85	0.83	0.89	0.87	0.85
C.D (0.05)	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***

PP- Peanut paste, CB- Cocoa butter, UB- Unsalted butter, HPO- Hydrogenated palm oil, JSF- Jackfruit seed flour, A- Ambient, R- Refrigerated

Initially among all the treatments, the highest calcium content was observed in PT_9 (13.08 mg 100 g^{-1}) and the lowest in PT_4 (5.08 mg 100 g^{-1}). After third month of storage, the calcium content varied from 4.57 mg 100 g^{-1} (PT_4) to 12.75 mg 100 g^{-1} (PT_9). In JSF nutri spreads, initially among all the treatments, the calcium content was observed in JT_{12} (12.1 mg 100 g^{-1}) and in JT_{16} (16.5 mg 100 g^{-1}). After third month of storage, the calcium content was 11.26 mg 100 g^{-1} (JT_{12}) and 15.86 mg 100 g^{-1} (JT_{16}).

Under refrigerated condition, after third month of storage, the calcium content in PP nutri spreads varied from 4.98 mg 100 g^{-1} (PT_4) to 12.98 mg 100 g^{-1} (PT_9). In JSF nutri spreads, the calcium content was 11.89 mg 100 g^{-1} (JT_{12}) and 16.36 mg 100 g^{-1} (JT_{16}).

There was a significant difference between all the treatments for the calcium content initially and during the storage period.

4.2.1.11. Iron

The iron content of the selected PP based nutri spreads were estimated and their results are given in Table 17.

Initially among all the treatments, the highest iron content was observed in PT_{15} (2.59 mg 100 g^{-1}) and the lowest in PT_4 (1.67 mg 100 g^{-1}). A decrease in iron content of storage was observed. The iron content varied from 0.90 mg 100 g^{-1} (PT_4) to 1.69 mg 100 g^{-1} (PT_{15}). Among various JSF nutri spreads, the highest iron content was observed in JT_{12} (2.01 mg 100 g^{-1}) followed by JT_{16} (1.86 mg 100 g^{-1}. After third month of storage, the iron content was 1.30 mg 100 g^{-1} (JT_{12}) and 1.00 mg 100 g^{-1} (JT_{16}).

Under refrigerated condition, a slight decrease in iron content was observed during storage. The iron content decreased from 1.62 to 1.55 mg 100 g^{-1} (PT_4), 2.33 to 2.31 mg 100 g^{-1} (PT_9) and 2.58 to 2.53 mg 100 g^{-1} (PT_{15}) by the end of second month of storage. After third month of storage, the iron content varied from 1.55 mg 100 g^{-1} (PT_4) to 2.49 mg 100 g^{-1} (PT_9) in PP based nutri spreads. In JSF nutri spreads, after first and second months of storage, the iron content were 1.99 mg

Table 17. Calcium and iron content (mg 100 g^{-1}) of selected nutri spreads

Treatments	Calcium (mg $100g^{-1}$)							Iron (mg $100g^{-1}$)						
	Initial	1st month		2nd month		3rd month		Initial	1st month		2nd month		3rd month	
		A	R	A	R	A	R		A	R	A	R	A	R
PT_4 – 60% PP +20% CB	5.09	4.87	5.05	4.64	5.01	4.5	4.98	1.67	1.43	1.62	1.19	1.59	0.9	1.55
PT_9- 65% PP +15% UB	13.09	12.98	13.07	12.83	13	12.76	12.95	2.36	2.03	2.33	1.82	2.31	1.69	2.25
PT_{15}- 65% PP + 15% HPO	5.13	5.01	5.10	4.94	5.08	4.89	5.03	2.59	2.35	2.58	2.13	2.53	0.92	2.49
C.D (0.05)	**0.012***	**0.012***	**0.016***	**0.012***	**0.012***	**0.022***	**0.012***	**0.012***	**0.10***	**0.022***	**0.012***	**0.022***	**0.012***	**0.012***
JT_{12}- 25% JSF + 55% UB	12.1	11.85	11.96	11.51	11.92	11.26	11.89	2.01	1.82	1.99	1.58	1.94	1.30	1.88
JT_{16}- 35% JSF + 45% HPO	16.5	16.26	16.47	16.07	16.40	15.86	16.36	1.86	1.53	1.84	1.12	1.79	1.005	1.75
C.D (0.05)	**0.094***	**0.013***	**0.021***	**0.013***	**0.013***	**0.019***	**0.019***	**0.029***	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***	**0.019***

PP- Peanut paste, CB- Cocoa butter, UB- Unsalted butter, HPO- Hydrogenated palm oil, JSF- Jackfruit seed flour, A- Ambient, R- Refrigerated

100 g^{-1} (JT_{12}) and 1.84 mg 100 g^{-1} (JT_{16}), 1.94 mg 100 g^{-1} (JT_{12}) and 1.79 mg 100 g^{-1} (JT_{16}) respectively. After third month of storage, the iron content was 1.88 mg 100 g^{-1} (JT_{12}) and 1.75 mg 100 g^{-1} (JT_{16}). There was a reduction in iron content for all the selected nutri spreads on storage at refrigerated condition. There was a significant difference between all the treatments for the iron content initially and during the storage period.

4.2.1.12. Phosphorus

The phosphorus content of the selected nutri spreads were estimated and their results were tabulated and are given in Table 18.

Initially among all the treatments, the highest phosphorus content of 2.67 (PT_4), 2.03 (PT_9) and 3.05 mg 100 g^{-1} (PT_{15}) was observed in various treatments. After third month of storage, a decrease in phosphorus content was observed and it varied from 1.71 mg 100 g^{-1} (PT_9) to 2.74 mg 100 g^{-1} (PT_{15}). In JSF based nutri spreads, phosphorus content of 2.55 mg 100g^{-1} and 3.15 mg 100 g^{-1} was obtained in JT_{12} and JT_{16} respectively. After third month of storage, the decreased phosphorus content of 2.15 mg 100 g^{-1} (JT_{12}) and 2.53 mg 100 g^{-1} (JT_{16}).

Under refrigerated condition, a slight decrease in phosphorus content was observed during storage. The phosphorus content decreased to 2.65 to 2.61 mg 100 g^{-1} (PT_4), 2.00 to 1.99 mg 100 g^{-1} (PT_9) and 3.01 to 3.00 mg 100 g^{-1} (PT_{15}) by the end of second month of storage. After third month of storage, the iron content varied from 1.97 mg 100 g^{-1} (PT_9) to 2.49 mg 100 g^{-1} (PT_{15}) in PP nutri spreads. In JSF nutri spreads, after first and second months of storage, the phosphorus content were 2.52 mg 100 g^{-1} (JT_{12}) and 3.11 mg 100 g^{-1} (JT_{16}), 1.99 mg 100 g^{-1} (JT_{12}) and 3.09 mg 100 g^{-1} (JT_{16}) respectively. After third month of storage, the iron content was 1.95 mg 100 g^{-1} (JT_{12}) and 2.99 mg 100 g^{-1} (JT_{16}). There was a reduction in phosphorus content for all the selected nutri spreads on storage at refrigerated condition. There was a significant difference between the treatments for the phosphorus content initially and during the storage period.

Table 18. Phosphorus and zinc content (mg 100 g^{-1}) of selected nutri spreads

Treatments	Phosphorus (mg $100g^{-1}$)							Zinc (mg $100g^{-1}$)						
	Initial	1st month		2nd month		3rd month		Initial	1st month		2nd month		3rd month	
		A	R	A	R	A	R		A	R	A	R	A	R
PT_4 – 60% PP +20% CB	2.67	2.42	2.65	2.28	2.61	2.28	2.58	0.244	0.21	0.23	0.18	0.22	0.16	0.21
PT_9- 65% PP +15% UB	2.03	1.89	2.00	1.72	1.99	1.72	1.97	0.211	0.18	0.20	0.15	0.18	011	0.16
PT_{15}- 65% PP + 15% HPO	3.05	2.95	3.01	2.76	3.00	2.76	2.96	0.348	0.30	0.32	0.28	0.31	0.25	0.29
C.D (0.05)	**0.012***	**0.012***	**0.088***	**0.009***	**0.067***	**0.012***	**0.012***	**0.011***	**0.012***	**0.012***	**0.012***	**0.012***	**0.012***	**0.012***
JT_{12}- 25% JSF + 55% UB	2.55	2.48	2.52	1.99	2.28	1.95	2.15	0.433	0.40	0.41	0.37	0.39	0.33	0.38
JT_{16}- 35% JSF + 45% HPO	3.15	2.99	3.11	2.75	3.09	2.53	2.99	0.669	0.61	0.64	0.57	0.62	0.53	0.61
C.D (0.05)	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***	**0.0133***	**0.020***	**0.013***	**0.013***	**0.021***	**0.013***	**0.013***	**0.013***

PP- Peanut paste, CB- Cocoa butter, UB- Unsalted butter, HPO- Hydrogenated palm oil, JSF- Jackfruit seed flour

4.2.1.13. Zinc

The zinc content of the selected nutri spreads were estimated and their results were tabulated and are given in Table 18.

In PP nutri spreads, initially among all the treatments, the highest zinc content was observed in PT_{15} (0.345 mg 100 g^{-1}) and the lowest in PT_9 (0.21 mg 100 g^{-1}). After third month of storage, the zinc content varied from 0.11 mg 100 g^{-1} (PT_9) to 0.25 mg 100 g^{-1} (PT_{15}). In JSF nutri spreads, initially among all the treatments, the highest zinc content was observed in JT_{16} (0.67 mg 100 g^{-1}) followed by JT_{12} (0.43 mg 100 g^{-1}). After third month of storage, the zinc content was 0.33 mg 100 g^{-1} (JT_{12}) and 0.53 mg 100 g^{-1} (JT_{16}).

Under refrigerated condition, after first and second month of storage, the zinc content varied from 0.20 mg 100 g^{-1} (PT_9) to 0.32 mg 100 g^{-1} (PT_{15}) and 0.18 mg 100 g^{-1} (PT_9) to 0.31 mg 100 g^{-1} (PT_{15}) respectively. After third month of storage, the zinc content decreased to 0.21 mg 100 g^{-1} (PT_4), 0.16 mg 100 g^{-1}(PT_9) and 0.29 mg 100 g^{-1} (PT_{15}). In JSF nutri spreads, after first and second month storage, the zinc content was 0.41 mg 100 g^{-1} (JT_{12}) and 0.64 mg 100 g^{-1} (JT_{16}), 0.39 mg 100 g^{-1} (JT_{12}) and 0.62 mg 100 g^{-1} (JT_{16}) respectively. After third month of storage, the zinc content was 0.38 mg 100 g^{-1} (JT_{12}) and 0.61 mg 100 g^{-1} (JT_{16}). There was a significant difference between all the treatments for the zinc content initially and during the storage period.

4.2.1.14. Sodium

The sodium content of the selected nutri spreads were estimated and their results were tabulated and are given in Table 19.

Initially among all the treatments, the highest sodium content was observed in PT_4 (5.55 mg 100 g^{-1}) and the lowest in PT_9 (4.99 mg 100 g^{-1}). A decrease in sodium content of storage was observed. The sodium content varied from 4.99 mg 100 g^{-1} (PT_9) to 5.55 mg 100 g^{-1} (PT_4). Among various JSF nutri spreads, the highest sodium content was observed in JT_{12} (12.59 mg 100 g^{-1}) followed by JT_{16} (8.29 mg

Table 19. Sodium and potassium content (mg 100 g^{-1}) of selected nutri spreads

Treatments	Sodium(mg $100g^{-1}$)							Potassium (mg $100g^{-1}$)						
	Initial	1st month		2nd month		3rd month		Initial	1st month		2nd month		3rd month	
		A	R	A	R	A	R		A	R	A	R	A	R
PT_4 – 60% PP +20% CB	5.55	5.51	5.54	5.47	5.52	5.42	5.51	41.41	41.24	41.39	40.95	41.37	40.76	41.35
PT_9- 65% PP +15% UB	4.99	4.93	4.97	4.89	4.95	4.85	4.94	37.62	37.35	37.60	36.89	37.58	36.51	37.55
PT_{15}- 65% PP + 15% HPO	5.27	5.22	5.26	5.18	5.25	5.14	5.23	40.7	40.49	40.69	40.06	40.67	39.72	40.63
C.D (0.05)	**0.012***	**0.012***	**0.018***	**0.012***	**0.012***	**0.016***	**0.012***	**0.016***	**0.012***	**0.012***	**0.022***	**0.012***	**0.025***	**0.012***
JT_{12}- 25% JSF + 55% UB	12.59	12.54	12.58	5.49	12.56	5.43	12.53	33.59	33.02	33.57	32.73	33.55	32.24	33.52
JT_{16}- 35% JSF + 45% HPO	8.29	8.25	8.28	8.21	8.26	8.16	8.24	27.6	27.23	27.58	26.74	27.55	26.35	27.51
C.D (0.05)	**0.013***	**0.019***	**0.013***	**0.013***	**0.013***	**0.026***	**0.013***	**0.013***	**0.026***	**0.013***	**0.013***	**0.013***	**0.021***	**0.013***

PP- Peanut paste, CB- Cocoa butter, UB- Unsalted butter, HPO- Hydrogenated palm oil, JSF- Jackfruit seed flour

100 g^{-1}. After third month of storage, the iron content was 5.43 mg 100 g^{-1} (JT_{12}) and 8.16 mg 100 g^{-1} (JT_{16}).

Under refrigerated condition, a slight decrease in sodium content was observed during storage. The sodium content decreased to 5.54 to 5.52 mg 100 g^{-1} (PT_4), 4.97 to 4.95 mg 100 g^{-1} (PT_9) and 5.26 to 5.25 mg 100 g^{-1} (PT_{15}) by the end of second month of storage. After third month of storage, the sodium content varied from 4.94 mg 100 g^{-1} (PT_9) to 5.51 mg 100 g^{-1} (PT_4) in PP based nutri spreads. In JSF nutri spreads, after first and second months of storage, the sodium content were 12.58 mg 100 g^{-1} (JT_{12}) and 8.28 mg 100 g^{-1} (JT_{16}), 12.56 mg 100 g^{-1} (JT_{12}) and 8.26 mg 100 g^{-1} (JT_{16}) respectively. After third month of storage, the sodium content was 12.53 mg 100 g^{-1} (JT_{12}) and 8.24 mg 100 g^{-1} (JT_{16}). There was a reduction in sodium content for all the selected nutri spreads on storage at refrigerated condition. There was a significant difference between the treatments for the sodium content initially and during the storage period.

4.2.1.15. Potassium

The potassium content of the selected nutri spreads were estimated and their results were tabulated and are given in Table 19.

Initially among all the treatments, the highest potassium content was observed in PT_4 (41.41 mg 100 g^{-1}) and the lowest in PT_9 (37.62 mg 100 g^{-1}). A decrease in potassium content of storage was observed. The potassium content varied from 36.51 mg 100 g^{-1} (PT_9) to 40.76 mg 100 g^{-1} (PT_4). Among various JSF nutri spreads, the highest potassium content was observed in JT_{12} (33.59 mg 100 g^{-1}) followed by JT_{16} (27.60 mg 100 g^{-1}). After third month of storage, the potassium content was decreased to 32.24 mg 100 g^{-1} (JT_{12}) and 26.35 mg 100 g^{-1} (JT_{16}).

Under refrigerated condition, a slight decrease in potassium content was observed during storage. The potassium content decreased to 41.39 to 41.37 mg 100 g^{-1} (PT_4), 37.60 to 37.58 mg 100 g^{-1} (PT_9) and 40.69 to 40.67 mg 100 g^{-1} (PT_{15}) by the end of second month of storage. After third month of storage, the potassium content varied from 37.55 mg 100 g^{-1} (PT_9) to 41.35 mg 100 g^{-1} (PT_4) in PP based

nutri spreads. In JSF nutri spreads, after first and second months of storage, the potassium content were 33.57 mg 100 g^{-1} (JT_{12}) and 27.58 mg 100 g^{-1} (JT_{16}), 33.55 mg 100 g^{-1} (JT_{12}) and 27.55 mg 100 g^{-1} (JT_{16}) respectively. After third month of storage, the potassium content was 33.52 mg 100 g^{-1} (JT_{12}) and 27.51 mg 100 g^{-1} (JT_{16}). There was a reduction in potassium content for all the selected nutri spreads on storage at refrigerated condition. There was a significant difference between the treatments for the potassium content initially and during the storage period.

4.2.2. Organoleptic evaluation of selected nutri spreads

The organoleptic qualities of the selected PP nutri spreads during storage were tabulated and are given in Table 20 and 21.

At ambient condition, the mean scores for the appearance of PP nutri spreads initially varied from 8.08 (PT_4 & PT_{15}) to 7.91 (PT_9) which gradually decreased in the first, second and third month of storage to 7.37 (PT_4) to 7.79 (PT_9), 6.64 (PT_4) to 7.38 (PT_{15}) and 6.57 (PT_4) to 7.35(PT_9) respectively. In case of appearance, by the end of storage, PT_9 was observed to have a higher score (7.35) in selected peanut paste nutri spreads.

The colour of the selected peanut paste nutri spreads varied from 8.33(PT_9) to 8.55 (PT_{15}) initially. During first, second and third month of storage, treatment PT_{15} was found to have high mean scores of 8.25,8.22 and 8.17 whereas lowest mean scores was noted in PT_9, during first (8.15), second (7.73) and third (7.63) months of storage.

The highest mean scores for the flavour of selected peanut paste nutri spreads initially was 8.43 in PT_{15} and the lowest in PT_4 of 7.82. During first, second and third month of storage, treatment PT_{15} was found to have high mean scores of 8.31, 7.88 and 7.46 whereas lowest mean scores was noted in PT_4, during first (7.73), second (7.66) and third (6.82) months of storage

The texture and taste of selected peanut paste based nutri spreads were varied from 8.42 to 8.51 and 8.35 to 8.75 (initially), 7.02 to 8.35 and 7.68 to 8.53 (first month), 6.57 to 7.73 and 6.73 to 8.04 (second month) and 6.33 to 7.66 and 5.48 to 7.88 (third month) respectively. The texture and taste of selected peanut

Table 20. Mean scores for organoleptic evaluation of selected peanut paste (PP) based nutri spreads during storage at ambient condition

Treatments	Appearance				Colour				Flavour			
	Initial	1st month	2nd month	3rd month	Initial	1st month	2nd month	3rd month	Initial	1st month	2nd month	3rd month
PT_4 – 60% PP +20% CB	8.08	7.37	6.64	6.57	8.51	8.23	8.13	7.89	7.82	7.73	7.66	6.82
PT_9- 65% PP +15% UB	7.91	7.79	7.37	7.35	8.33	8.15	7.73	7.63	8.33	8.17	7.91	7.37
PT_{15}- 65% PP + 15% HPO	8.08	7.76	7.38	7.02	8.55	8.26	8.22	8.17	8.43	8.31	7.88	7.46

Treatments	Texture				Taste				Overall acceptability			
	Initial	1st month	2nd month	3rd month	Initial	1st month	2nd month	3rd month	Initial	1st month	2nd month	3rd month
PT_4 – 60% PP +20% CB	8.42	7.02	6.57	6.33	8.35	7.68	6.73	5.48	8.28	7.96	6.84	5.91
PT_9- 65% PP +15% UB	8.48	8.04	7.33	7.21	8.40	8.37	7.24	7.02	7.37	7.13	6.54	6.06
PT_{15}- 65% PP + 15% HPO	8.51	8.44	7.73	7.66	8.75	8.53	8.04	7.88	8.08	7.92	7.73	7.46

PP- Peanut paste, CB- Cocoa butter, UB- Unsalted butter, HPO- Hydrogenated palm oil

paste nutri spreads, showed that treatment PT_{15} have the highest mean score and PT_4 attained a lowest mean score throughout the storage.

The overall acceptability was high in treatment PT_{15} (8.08, 7.92, 7.73 and 7.46) and in PT_4 (8.28, 7.96, 6.84 and 5.91) initially as well as during first, second and third month of storage. Even though there was a gradual decrease in mean score during storage, all the treatments maintained a mean score within the acceptable levels.

Under refrigerated condition, the mean scores for the appearance of peanut paste based nutri spreads initially varied from 8.08 (PT_4 and PT_{15}) to 7.91 (PT_9) which gradually decreased in the first, second and third month of storage and was found to be in the range of 7.57 (PT_9) to 7.93 (PT_{15}), 7.28 (PT_9) to 7.91 (PT_{15}) and 7.08(PT_9) to 7.62 (PT_{15}) respectively. In case of appearance, PT_{15} was observed to have a higher score (7.62) in selected peanut paste nutri spreads at the end of storage under refrigerated condition.

The colour of the selected PP nutri spreads varied from 8.33 (PT_9) to 8.55 (PT_{15}) initially. During first, second and third month of storage treatment PT_{15} was found to have high mean scores of 8.04, 7.93 and 7.73 whereas lowest mean scores was noticed in PT_4, during first (7.84), second (7.77) and third (6.82) months of storage.

The highest mean scores for the flavour of selected PP nutri spreads initially was 8.43 in PT_{15} and lowest in PT_4 of 7.82. During first, second and third month of storage, treatment PT_{15} was found to have high mean scores of 7.78, 7.71 and 7.46 whereas lowest mean scores was observed in PT_4, during first (7.62), second (7.56) and third (6.55) months of storage.

The texture and taste of selected PP nutri spreads were varied from 8.42 to 8.51 and 8.40 to 8.75 (initially), 6.68 to 7.68 and 6.68 to 7.57 (first month), 6.51 to 7.57 and 6.02 to 7.55 (second month) and 5.53 to 6.78 and 5.91 to 6.86 respectively. The texture and taste of selected peanut paste nutri spreads, showed that treatment PT_{15} have the highest mean score and PT_4 attained a lowest mean score throughout the storage.

Table 21. Mean scores for organoleptic evaluation of selected peanut paste (PP) based nutri spreads during storage at refrigerated condition

Treatments	Appearance				Colour				Flavour			
	Initial	1st month	2nd month	3rd month	Initial	1st month	2nd month	3rd month	Initial	1st month	2nd month	3rd month
PT_4 – 60% PP +20% CB	8.08	7.73	7.62	7.51	8.51	7.84	7.77	6.82	7.82	7.62	7.56	6.55
PT_9- 65% PP +15% UB	7.91	7.57	7.28	7.08	8.33	7.86	7.86	7.67	8.33	7.80	7.68	7.37
PT_{15}- 65% PP + 15% HPO	8.08	7.93	7.91	7.62	8.55	8.04	7.93	7.73	8.43	7.78	7.71	7.46

Treatments	Texture				Taste				Overall acceptability			
	Initial	1st month	2nd month	3rd month	Initial	1st month	2nd month	3rd month	Initial	1st month	2nd month	3rd month
PT_4 – 60% PP +20% CB	8.42	6.68	6.51	5.53	8.35	6.68	6.02	5.91	8.28	7.85	7.23	6.95
PT_9- 65% PP +15% UB	8.48	6.95	6.80	6.57	8.40	6.91	7.00	6.48	7.37	7.33	7.20	7.08
PT_{15}- 65% PP + 15% HPO	8.51	7.68	7.57	6.78	8.75	7.57	7.55	6.86	8.08	7.46	7.44	7.17

PP- Peanut paste, CB- Cocoa butter, UB- Unsalted butter, HPO- Hydrogenated palm oil, JSF- Jackfruit seed flou

The overall acceptability was high in treatment PT_{15} (8.08, 7.46, 7.44 and 7.17) and lowest in PT_4 (8.24, 5.75, 7.00 and 6.95) during initial, first, second and third month of storage. Even though there was a gradual decrease in mean score during storage, all the treatments maintained a mean score within the acceptable levels.

The organoleptic qualities of the selected jackfruit seed flour based nutri spreads during storage were tabulated and are given in Table 22 and 23.

At ambient condition, the mean scores for the appearance of jackfruit seed flour (JSF) nutri spreads initially observed 6.64(JT_{12}) to 8.82(JT_{16}) which gradually decreased in the first, second and third month of storage to 6.57 (JT_{12}) and 8.47 (JT_{16}), 6.46 (JT_{12}) and 7.96 (JT_{16}) and 6.39 (JT_{12}) and 7.35 (JT_{16}) respectively. In case of appearance, JT_{16} was observed to have a higher score (7.35) in selected jackfruit seed flour based nutri spreads at the end of storage.

The colour of the selected JSF nutri spreads noticed 6.95 (JT_{12}) and 8.15 (JT_{16}) initially. During first, second and third month of storage treatment JT_{16} was found to have high mean scores of 8.11, 7.73 and 7.63 compared to JT_{12}.

Among selected JSF nutri spreads, JT_{16} obtained higher mean scores of 8.17 when compared to JT_{12} (7.73) for the flavour during first, second and third month of storage treatment JT_{16} was found to have high mean scores of 7.91, 7.62 and 7.37 in comparison with JT_{12} (7.66, 7.57 and 6.82).

The texture and taste of selected JSF nutri spreads were 8.04 (JT_{16}) and 7.11 (JT_{12}) and 8.37 (JT_{16}) and 6.80 (JT_{12}) (initial), 7.33 (JT_{16}) and 7.02 (JT_{12}), 7.42 (JT_{16}) and 6.68 (JT_{12}) (first month), 7.26 (JT_{16}) and 6.57 (JT_{12}) and 7.24 (JT_{16}) and 6.23 (JT_{12}) (second month) and 7.21 (JT_{16}) and 6.33 (JT_{12}) and 7.02 (JT_{16}) and 5.88 (JT_{12}) respectively. The texture and taste of selected jackfruit seed flour nutri spreads, showed that treatment JT_{16} have the highest mean score and JT_{12} attained a lowest mean score throughout the storage.

The overall acceptability was high in treatment JT_{16} (8.88, 8.13, 7.72 and 7.06) when compared to JT_{12} (7.26, 6.86, 6.45 and 5.91) during initial, first, second and third month of storage. Even though there was a gradual decrease in mean score

Table 22. Mean scores for organoleptic evaluation of selected jackfruit seed flour based nutri spreads during storage at ambient condition

Treatments	Appearance				Colour				Flavour			
	Initial	1st month	2nd month	3rd month	Initial	1st month	2nd month	3rd month	Initial	1st month	2nd month	3rd month
JT_{12}- 25% JSF + 55% UB	6.64	6.57	6.46	6.39	6.95	6.78	6.43	6.12	7.73	7.66	7.57	6.82
JT_{16}- 35% JSF + 45% HPO	8.82	8.47	7.96	7.35	8.15	8.11	7.73	7.63	8.17	7.91	7.62	7.37

Treatments	Texture				Taste				Overall acceptability			
	Initial	1st month	2nd month	3rd month	Initial	1st month	2nd month	3rd month	Initial	1st month	2nd month	3rd month
JT_{12}- 25% JSF + 55% UB	7.11	7.02	6.57	6.33	6.80	6.68	6.23	5.88	7.26	6.86	6.45	5.91
JT_{16}- 35% JSF + 45% HPO	8.04	7.33	7.26	7.21	8.37	7.42	7.24	7.02	8.88	8.13	7.72	7.06

JSF- Jackfruit seed flour, UB- Unsalted butter, HPO- Hydrogenated palm oil

during storage, all the treatments maintained a mean score within the acceptable levels.

At refrigerated condition, the mean scores for the appearance of JSF nutri spreads observed was 6.64 (JT_{12}) and 8.82 (JT_{16}) initially which gradually decreased in the first, second and third month of storage to 6.31 (JT_{12}) and 8.34 (JT_{16}), 5.98 (JT_{12}) and 7.87 (JT_{16}) and 5.44 (JT_{12}) and 7.24 (JT_{16}) respectively. In case of appearance, JT_{16} was observed to have a higher score in selected JSF nutri spreads.

The colour of the selected JSF nutri spreads noticed was 6.95 (JT_{12}) and 8.15 (JT_{16}) initially. During first, second and third month of storage treatment JT_{16} was found to have high mean scores of 7.88, 7.23 and 6.89 compared to JT_{12} (6.43, 5.99 and 5.43).

The mean scores for the flavour of selected JSF nutri spreads initially was 8.17 in JT_{16} and 7.73 in JT_{12}. During first, second and third month of storage treatment JT_{16} was found to have high mean scores of 7.95, 7.55 and 7.01 whereas mean scores were 7.51, 7.13 and 6.65 in JT_{12}.

The texture and taste of selected JSF nutri spreads were 8.04 (JT_{16}) and 7.11 (JT_{12}) and 8.37 (JT_{16}) and 6.80 (JT_{12}) (initially), 7.83 (JT_{16}) and 6.81 (JT_{12}) and 7.98 (JT_{16}) and 6.43 (JT_{12}) (first month), 7.25 (JT_{16}) and 6.34 (JT_{12}) and 7.52 (JT_{16}) and 6.01 (JT_{12}) (second month) and 6.97 (JT_{16}) and 5.89 (JT_{12}) and 7.03 (JT_{16}) and 5.89 (JT_{12}) respectively. The texture and taste of selected JSF nutri spreads, showed that treatment JT_{16} have comparatively high mean score than JT_{12} at the storage.

The overall acceptability was in treatment JT_{16} was (8.88, 8.72, 8.51 and 8.37) and in JT_{12} (7.26, 7.01, 6.94 and 6.71) during initial, first, second and third month of storage. Even though there was a gradual decrease in mean score during storage, all the treatments maintained a mean score within the acceptable levels.

4.2.3. Enumeration of total microflora

The selected nutri spreads were evaluated for microbial enumeration (bacteria, fungi and yeast) and the results are presented in Table 24 and Table 25.

The bacterial count present in selected nutri spreads not detected initially. The bacterial count of selected PP nutri spreads varied from 0.23 x 10^6 cfu/g to 0.37

Table 23. Mean scores for organoleptic evaluation of selected jackfruit seed flour based nutri spreads during storage at refrigerated condition

Treatments	Appearance				Colour				Flavour			
	Initial	1st month	2nd month	3rd month	Initial	1st month	2nd month	3rd month	Initial	1st month	2nd month	3rd month
JT_{12}- 25% JSF + 55% UB	6.64	6.31	5.98	5.44	6.95	6.43	5.99	5.43	7.73	7.51	7.13	6.65
JT_{16}- 35% JSF + 45% HPO	8.82	8.34	7.87	7.24	8.15	7.88	7.23	6.89	8.17	7.95	7.55	7.01

Treatments	Texture				Taste				Overall acceptability			
	Initial	1st month	2nd month	3rd month	Initial	1st month	2nd month	3rd month	Initial	1st month	2nd month	3rd month
JT_{12}- 25% JSF + 55% UB	7.11	6.81	6.34	5.89	6.8	6.43	6.01	5.89	7.26	7.01	6.94	6.71
JT_{16}- 35% JSF + 45% HPO	8.04	7.83	7.25	6.97	8.37	7.98	7.52	7.03	8.88	8.72	8.51	8.37

JSF- Jackfruit seed flour, UB- Unsalted butter, HPO- Hydrogenated palm oil,

x 10^6 cfu/g (first month), 0.36 x 10^6 cfu/g to 0.59 x 10^6 cfu/g (second month) and 0.73 x 10^6 cfu/g to 0.96 x 10^6 cfu/g (third month) respectively where bacterial load was high in PT_4 (0.37 to 0.96 x 10^6 cfu/g). In JSF based nutri spreads, the bacterial count present in selected nutri spreads not detected initially. In first, second and third month bacterial count of selected JSF were 0.43 x 10^6 cfu/g (JT_{12}) and 0.02 x 10^6 cfu/g (JT_{16}), 0.54 x 10^6 cfu/g (JT_{12}) and 0.24 x 10^6 cfu/g (JT_{16}) and 1.02 x 10^6 cfu/g (JT_{12}) and 0.47 x 10^6 cfu/g respectively where bacterial load was high in JT_{12} (0.43 to 1.02 x 10^6 cfu/g). There was increase in bacterial colony during third month of storage.

The initial and first month fungi count in the selected PP nutri spreads were not detected. During second month and third month fungal count with a range of 0.01 x 10^3 cfu/g to 0.04 x 10^3 cfu/g and 0.03 x 10^3 cfu/g to 0.09 x 10^3 cfu/g were noticed. In JSF based nutri spreads, the initial fungi count in the treatment JT_{12} was 0.45 x 10^3 and 2.67 x 10^3 in first month. In JT_{16} the fungal colonies are not detected in initially and first month. During second month and third month fungal count found 9.87 x 10^3 (JT_{12}) and 0.01 x 10^3 cfu/g (JT_{16}) and 15.66 x 10^3 (JT_{12}) and 0.1 x 10^3 cfu/g (JT_{16}) were noticed. The yeast count was not detected in any of the selected PP nutri spreads during the entire storage period.

At refrigerated condition, as revealed in Table 25, the bacterial count present in selected nutri spreads not detected initially and first month of storage period. In second and third month bacterial count of selected PP nutri spreads varied from 0.01x 10^6 cfu/g to 0.03 x 10^6 cfu/g and 0.03 x 10^6 cfu/g to 0.05 x 10^6 cfu/g respectively where bacterial load was high in PT_4 (0.37 to 0.96 x 10^6 cfu/g). In JSF nutri spreads, the bacterial count present in selected nutri spreads not detected initially and first month of storage period. There was increase in bacterial colony during third month of storage.

The fungi count was not detected in any of the selected PP and JSF based nutri spreads during the entire storage period. The yeast count was not detected in any of the selected nutri spreads during the entire storage period.

Table 24.Total microbial count of the selected nutri spreads during storage at ambient condition

Treatments	Microbial population (cfu/g)				
	Bacteria (10^6cfu/g)			Fungi (10^3cfu/g)	
	1st month	2nd month	3rd month	2nd month	3rd month
PT_4 – 60% PP +20% CB	0.37	0.59	0.96	0.02	0.06
PT_9- 65% PP +15% UB	0.36	0.43	0.86	0.04	0.09
PT_{15}- 65% PP + 15% HPO	0.23	0.36	0.73	0.01	0.03
JT_{12}- 25% JSF + 55% UB	0.43	0.54	1.02	0.83	1.02
JT_{16}- 35% JSF + 45% HPO	0.02	0.24	0.47	0.02	0.05

PP- Peanut paste, CB- Cocoa butter, UB- Unsalted butter, HPO- Hydrogenated palm oil, JSF- Jackfruit seed flour

Table 25. Total microbial count of the selected nutri spreads during storage at refrigerated condition

Treatments	Microbial population (cfu/g)			
	Bacteria (10^6cfu/g)			
	Initial	1st month	2nd month	3rd month
PT4 – 60% PP +20% CB	ND	ND	0.02	0.03
PT9- 65% PP +15% UB	ND	ND	0.01	0.03
PT15- 65% PP + 15% HPO	ND	ND	0.03	0.05
JT12- 25% JSF + 55% UB	ND	ND	0.02	0.04
JT16- 35% JSF + 45% HPO	ND	ND	0.02	0.03

PP- Peanut paste, CB- Cocoa butter, UB- Unsalted butter, HPO- Hydrogenated palm oil, JSF- Jackfruit seed flour

ND- Not detectable

4.3. Enrichment of the developed spreads with protein sources

The selected two combinations one each from PP and JSF were enriched using two protein sources *viz.* defatted soya flour (DSF) and skimmed milk powder (SMP). These protein sources were incorporated to the base material in both selected spreads in varying percentage levels (10%, 20%, 30%, 40% and 50%). The selected nutri spreads for enrichment

Table 26. Selected nutri spreads for enrichment

Treatments	Combinations
PT_{15} – PP + HPO	65% PP + 15% HPO + 20% other ingredients
JT_{16} - JSF + HPO	35% JSF + 45% HPO + 20% other ingredients

4.3.1. Sensory evaluation of enriched nutri spreads

Organoleptic evaluation of enriched PP based nutri spreads were carried out separately.

4.3.1.1. Organoleptic evaluation of enriched PP nutri spreads

Enriched PP nutri spreads were prepared with defatted soya flour and skimmed milk powder and the organoleptic qualities were evaluated and are shown in plate 5. The mean scores obtained for various quality attributes of defatted soya flour enriched PP nutri spreads are presented in Table 27. The different quality attributes were ranked based on their mean score using Kendall's coefficient (W) test.

The highest mean score for different quality attributes was observed in DSF enriched PP nutri spreads. The highest mean score and mean rank score for appearance and colour of DSF enriched PP nutri spreads were 9.00 (5.50) and 9.00 (4.67) for the treatment PT_1 respectively. For flavour and texture, the mean scores and mean rank scores were found to be 8.55 (5.50) and 8.22 (5.33) respectively. The mean score and mean rank score for taste and overall acceptability was 8.11

Table 27. Mean scores for organoleptic evaluation of defatted soya flour (DSF) enriched PP (PP) based nutri spreads

Treatments	Appearance	Colour	Flavour	Texture	Taste	Overall acceptability
PT_0 (65% PP+ 15% HPO+20% OI)	8.88 (5.00)	8.77 (3.83)	8.44 (4.83)	8.11 (5.17)	7.88 (4.83)	7.88 (4.67)
PT_1 (58.5%PP+6.5%DSF)	9.00 (5.50)	9.00 (4.67)	8.55 (5.50)	8.22 (5.33)	8.11 (5.50)	8.11 (5.50)
PT_2 (52%PP+13%DSF)	8.55 (4.17)	9.00 (4.67)	8.22 (4.50)	7.77 (4.50)	7.77 (4.67)	7.77 (4.83)
PT_3 (45.5%PP+19.5%DSF)	8.11 (3.33)	9.00 (4.67)	7.66 (2.83)	7.00 (2.50)	6.77 (3.00)	6.66 (2.83)
PT_4 (39%PP+26%DSF)	7.00 (1.67)	8.22 (2.17)	7.11 (2.17)	6.55 (2.17)	5.77 (1.67)	6.00 (1.83)
PT_5 (32.5%PP+32.5%DSF)	6.44 (1.33)	7.55 (1.00)	6.55 (1.17)	5.88 (1.33)	5.44 (1.33)	5.66 (1.33)
Kendalls W	.896	.917	.868	.859	.927	.912

Value in parentheses are mean rank scores based on Kendall's W

** Significant at 1% level

(5.50) and 8.11 (5.50) for PT_1. PT_1 had better mean score than control for appearance, colour, flavour, texture, taste and overall acceptability. The lowest mean score for different quality was noticed for the treatment PT_5 (50% PP+ 50% DSF). Based on Kendall's (W) value, significant agreement among judges was noted in the evaluation of different quality attributes of defatted soya flour enriched PP based nutri spreads.

The mean scores obtained for various quality attributes of skimmed milk powder enriched PP nutri spreads are presented in Table 28. The different quality attributes were ranked based on their mean score using Kendall's coefficient (W) test.

The mean score for the appearance of SMP enriched PP nutri spreads prepared varied from 7.00 to 8.66 with mean rank scores in the range of 1.17 to 4.17. Among different treatments tried for the preparation of SMP enriched PP nutri spreads, the highest mean scores (8.66) for appearance was noticed in PT_7 and the lowest in PT_{10} (7.00).

The highest mean score for colour (8.88) was noticed in PT_7 (80% PP + 20% Skimmed milk powder). The lowest mean score for colour was observed in PT_{10} (8.11). The mean rank scores for colour ranged between 1.67 and 4.67.

The mean score for flavour of SMP enriched PP nutri spreads were 8.11 to 8.66 with maximum in PT_7 prepared with 80 per cent PP and 20 per cent SMP. The lowest mean score for flavour was noticed in PT_{10}.

The mean score for the texture of skimmed milk powder enriched PP nutri spreads varied from 7.44 to 8.66 with mean rank scores in the range of 1.67 to 4.67. Among different treatments tried for the preparation of SMP enriched PP nutri spreads, the highest mean scores (8.66) for texture was noticed in in PT_7 and the lowest in PT_{10} (7.44).

The mean score for taste of different SMP enriched PP nutri spreads ranged from 7.77 (1.83) to 8.55 (4.33) with highest in PT_7 and the lowest in PT_{10}.

Table 28. Mean scores for organoleptic evaluation of skimmed milk powder (SMP) enriched PP based nutri spreads

Treatments	Appearance	Colour	Flavour	Texture	Taste	Overall acceptability
PT_6 (58.5%PP+6.5%SMP)	8.61 (4.00)	8.61 (3.33)	8.55 (3.50)	8.55 (4.33)	8.38 (3.33)	8.38 (4.30)
PT_7 (52%PP+13%SMP)	8.66 (4.17)	8.88 (4.67)	8.66 (3.83)	8.66 (4.67)	8.66 (3.83)	8.55 (4.33)
PT_8 (45.5%PP+19.5%SMP)	8.22 (3.67)	8.33 (2.67)	8.44 (3.50)	7.77 (2.33)	8.33 (3.33)	7.77 (2.17)
PT_9 (39%PP+26%SMP)	7.55 (2.00)	8.33 (2.67)	8.33 (2.67)	7.55 (2.00)	7.79 (2.67)	7.66 (2.15)
PT_{10} (32.5%PP+32.5%SMP)	7.00 (1.17)	8.11 (1.67)	8.11 (1.50)	7.44 (1.67)	7.77 (1.83)	7.44 (2.00)
Kendalls W	.754	.564	.381	.805	.251	.648

Value in parentheses are mean rank scores based on Kendall's W

** Significant at 1% level

Among the different treatments tried for the preparation of SMP enriched PP nutri spreads, the highest mean score of 8.55 (4.33) for overall acceptability was noticed in PT_7 prepared with 80 per cent PP and 20 per cent SMP. The lowest mean score was noticed for treatment PT_{10}, 7.44 (2.00)

Based on Kendall's (W) value, the agreement among judges in the evaluation of different organoleptic qualities like appearance, colour, texture, flavour, taste and overall acceptability of skimmed milk powder enriched PP based nutri spreads was found to be statistically significant.

4.3.1.2. Organoleptic evaluation of enriched JSF based nutri spreads

Enriched nutri spreads were prepared using JSF as the base adding with two different protein sources like defatted soya flour and skimmed milk powder. Organoleptic evaluation of enriched JSF based nutri spreads were carried out separately and are shown in plate 6.

Enriched JSF nutri spreads were prepared with defatted soya flour (DSF) and skimmed milk powder (SMP) and the organoleptic qualities were evaluated. The mean scores obtained for various quality attributes of defatted soya flour enriched JSF nutri spreads are presented in Table 29. The different quality attributes were ranked based on their mean score using Kendall's coefficient (W) test.

The highest mean score for different quality attributes was observed in defatted soya flour enriched JSF based nutri spreads. The mean score for appearance and colour of defatted soya flour enriched JSF based nutri spreads were 8.66 (5.83) and 8.55 (5.33) for the treatment JT_2 respectively. For flavour and texture the mean scores were found to be 8.22 (6.00) and 8.44 (4.83) for the treatment JT_2 respectively. The mean score for taste was 8.44 (5.33) and for overall acceptability it was 8.43 (5.00) in JT_2. JT_2 had better mean score than control for appearance, colour, flavour, texture, taste and overall acceptability. The lowest mean score for different quality was noticed for the DSF enriched JSF nutri spread for JT_3.

Table 29. Mean scores for organoleptic evaluation of defatted soya flour (DSF) enriched JSF based nutri spreads

Treatments	Appearance	Colour	Flavour	Texture	Taste	Overall acceptability
JT_0 (35% JSF+45%HPO+20% OI)	7.66 (1.83)	8.33 (4.00)	7.56 (2.33)	8.00 (3.17)	8.00 (3.83)	7.88 (2.17)
JT_1 (31.5%JSF +3.5% DSF)	8.44 (5.00)	8.44 (4.50)	7.88 (3.83)	8.44 (4.83)	7.55 (1.83)	8.33 (4.83)
JT_2 (28% JSF+7% DSF)	8.66 (5.83)	8.55 (5.33)	8.22 (6.00)	8.44 (4.83)	8.44 (5.33)	8.43 (5.00)
JT_3 (24.5 JSF+10.5% DSF)	8.00 (3.50)	7.66 (1.17)	7.55 (2.00)	7.44 (1.00)	7.33 (1.17)	7.77 (1.50)
JT_4 (21% JSF+14% DSF)	7.88 (3.00)	8.00 (2.33)	7.77 (3.00)	8.00 (3.17)	8.22 (5.00)	8.11 (3.67)
JT_5 (17.5% JSF+17.5% DSF)	7.55 (1.83)	8.22 (3.67)	7.88 (3.83)	8.11 (4.00)	8.00 (3.83)	8.11 (3.83)
Kendalls W	.862	.827	.721	.822	.927	.656

Value in parentheses are mean rank scores based on Kendall's W

** Significant at 1% level

Based on Kendall's (W) value, significant agreement among judges was noted in the evaluation of different quality attributes of defatted soya flour enriched JSF nutri spreads.

The mean scores obtained for various quality attributes of SMP enriched JSF nutri spreads are presented in Table 30. The different quality attributes were ranked based on their mean score using Kendall's coefficient (w) test.

The mean score for the appearance of SMP enriched JSF nutri spreads prepared varied from 7.44 to 8.88 with mean rank scores in the range of 1.00 to 4.33. Among different treatments tried for the preparation of SMP enriched JSF nutri spreads, the highest mean scores (8.88) for appearance was noticed in JT_8 and JT_7 and the lowest in JT_{10} (7.00).

The highest mean score for colour (8.44) was noticed in JT_8 and JT_7. The lowest mean score for colour was observed in JT_{10} (7.33). The mean rank scores ranged between 1.33 and 4.33.

The mean score for flavour of SMP enriched JSF nutri spreads were 7.77 to 8.22 with maximum in JT_8 prepared with 70 per cent JSF and 30 per cent SMP. The lowest mean score for flavour was noticed in JT_{10}.

The mean score for the texture of SMP enriched JSF nutri spreads varied from 6.88 to 9.00 with mean rank scores in the range of 1.17 to 4.50. Among different treatments tried for the preparation of SMP enriched JSF nutri spreads, the highest mean scores (9.00) for texture was noticed in in JT_8 and JT_7 and the lowest in JT_{10} (6.88).

The mean score for taste of different SMP enriched JSF based nutri spreads ranged from 7.11 (1.17) to 8.66 (4.67) with highest in JT_8 and the lowest in JT_6.

Among the different treatments tried for the preparation of SMP enriched JSF nutri spreads, the highest mean score of 8.66 (4.83) for overall acceptability was noticed in JT_8 prepared with 70 per cent PP and 30 per cent SMP The lowest mean score was noticed for treatment JT_{10}, 7.11 (1.17).

Table 30. Mean scores for organoleptic evaluation of skimmed milk powder (SMP) enriched JSF nutri spreads

Treatments	Appearance	Colour	Flavour	Texture	Taste	Overall acceptability
JT_6 (31.5%JSF +3.5% SMP)	7.55 (2.67)	8.11 (3.33)	8.00 (3.00)	8.00 (3.00)	7.11 (1.17)	7.66 (2.83)
JT_7 (28% JSF+7% SMP)	8.88 (4.50)	8.44 (4.33)	8.20 (3.90)	9.00 (4.50)	8.22 (4.17)	8.55 (4.33)
JT_8 (24.5 JSF+10.5% SMP)	8.88 (4.50)	8.44 (4.33)	8.22 (4.00)	9.00 (4.50)	8.66 (4.83)	8.66 (4.67)
JT_9 (21% JSF+14% SMP)	7.48 (2.33)	7.44 (1.67)	7.87 (2.33)	7.33 (1.83)	7.55 (2.83)	7.11 (1.17)
JT_{10} (17.5% JSF+17.5% SMP)	7.44 (1.00)	7.33 (1.33)	7.77 (2.00)	6.88 (1.17)	7.33 (2.00)	7.44 (2.00)
Kendalls W	.953	.949	.667	.988	.959	.925

Value in parentheses are mean rank scores based on Kendall's W

** Significant at 1% level

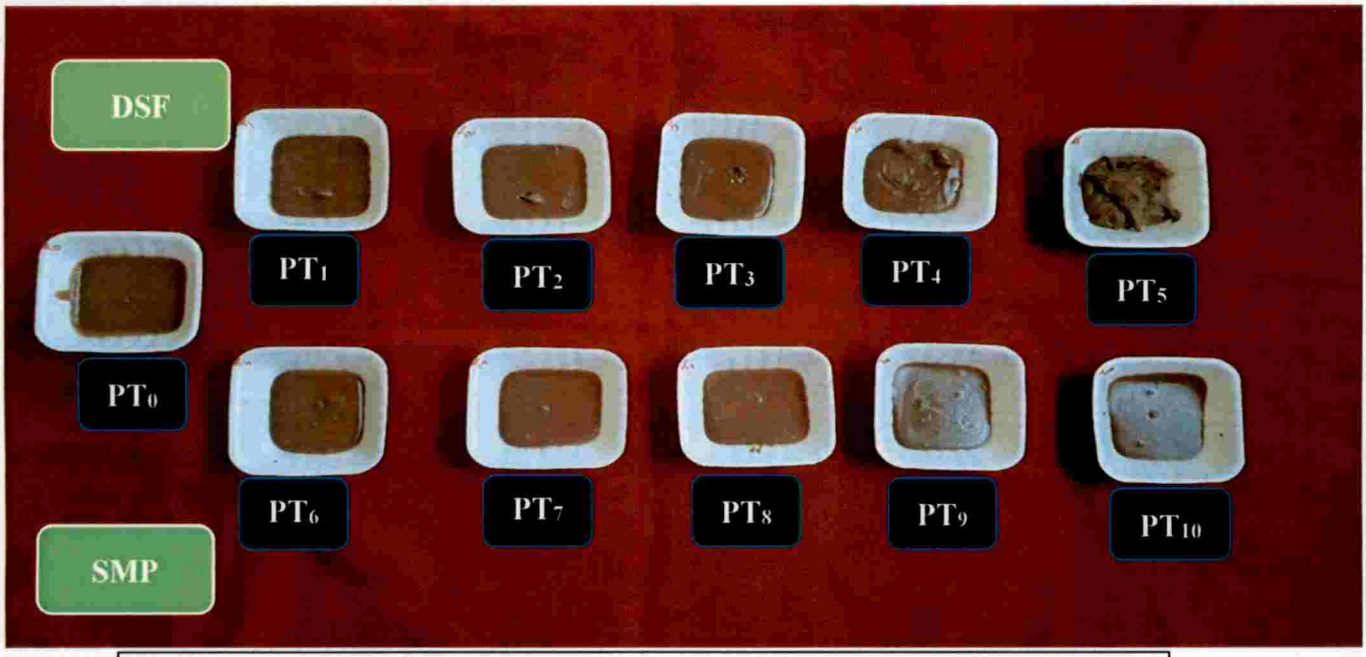


Plate 5. Enriched nutri spreads (Peanut paste) prepared with two protein sources

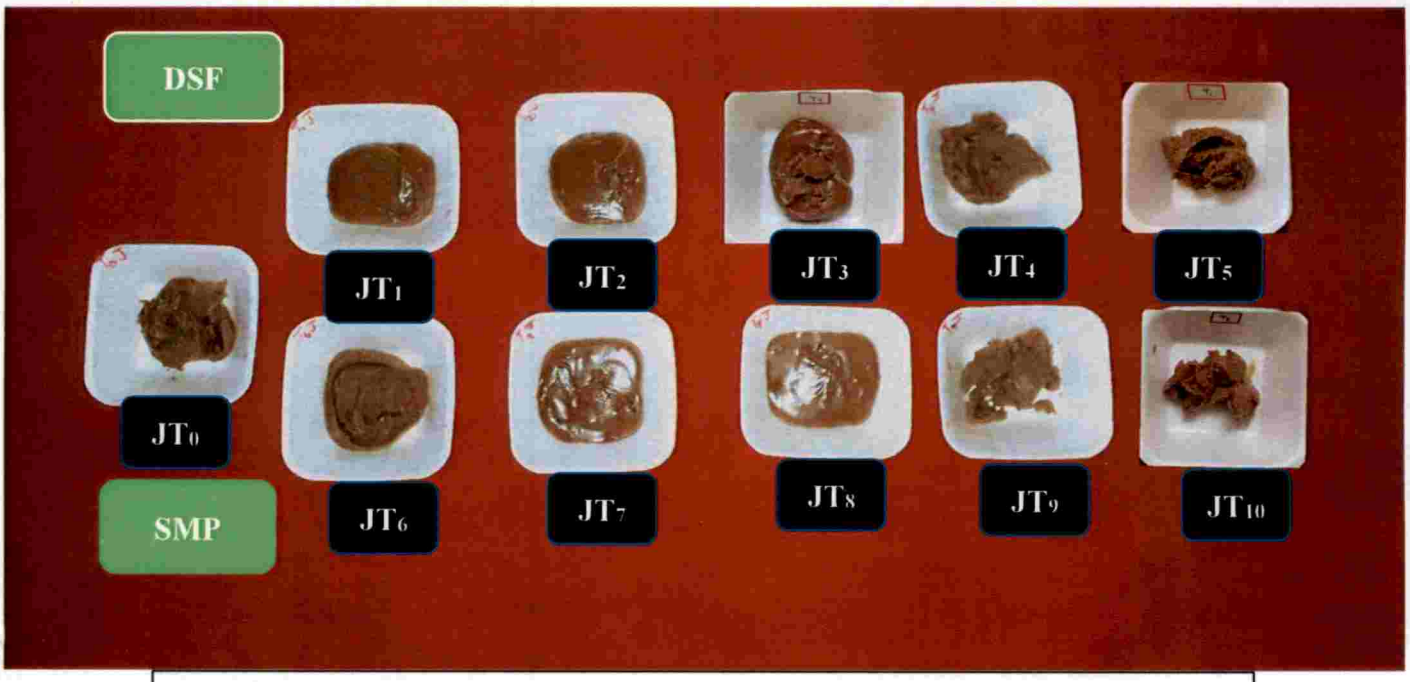


Plate 6. Enriched nutri spreads (Jackfruit seed flour) prepared with two protein sources

DSF- Defatted soya flour, SMP- Skimmed milk powder

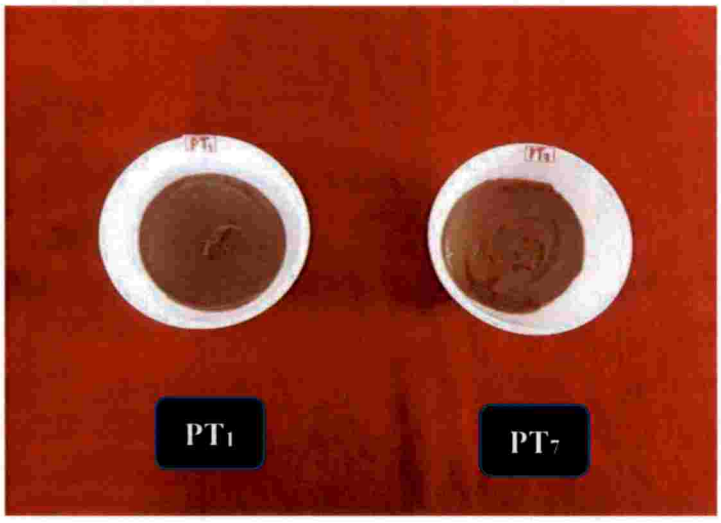


Plate 7. Selected treatments of enriched peanut paste nutri spreads

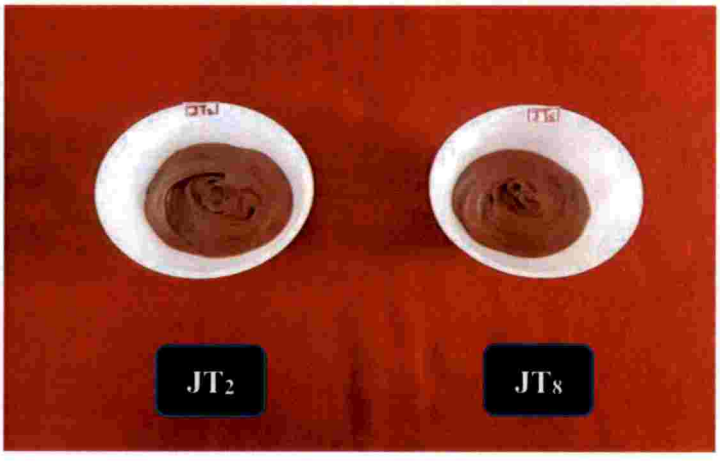


Plate 8. Selected treatments of enriched jackfruit seed flour nutri spreads

Based on Kendall's (W) value, the agreement among judges in the evaluation of different organoleptic qualities like appearance, colour, texture, flavour, taste and overall acceptability of SMP enriched JSF nutri spreads was found to be statistically significant.

4.3.2. Quality evaluation of the selected enriched nutri spreads

The selected two treatments from PP and JSF nutri spreads after storage period and are shown in plate 7 and plate 8. Packed in polyethylene terephthalate containers and kept in ambient and refrigerated conditions for a period of three months. The quality evaluation of the stored nutri spreads were assessed initially, and at end of the storage period.

4.3.2.1. Evaluation of physico- chemical qualities of selected enriched nutri spreads

The physico- chemical qualities of nutri spreads were carried out initially and at monthly intervals for the period of three months. The physico- chemical qualities of nutri spreads such as pH, moisture, reducing sugar, total sugar, fat, protein, energy, total ash, calcium, iron, phosphorus, zinc, sodium and potassium of the selected JSF based nutri spreads were evaluated.

4.3.2.1.1. pH

The pH obtained for selected treatments of enriched nutri spreads are presented in Table 31.

In enriched PP nutri spreads, stored at ambient temperature the pH observed was 4.53 (PT_1) and 4.82 (PT_7) initially. After 3rd month of storage an increase in pH of the PP nutri spreads was observed in both PT_1 (5.35) and in PT_7 (5.67). In enriched JSF nutri spreads, stored at ambient temperature the pH was found to be 4.87 in JT_2 and 4.97 in JT_8 initially. After 3rd month of storage, an increased pH of 5.32 (JT_2) and 5.63 (JT_8) was observed.

Under refrigerant condition, the pH of PP nutri spreads was found to be 4.53 in PT_1 and 4.82 in PT_7 initially. After 3rd month of storage, an increased pH 4.65

Table 31. pH and Moisture content (%)of selected enriched nutri spreads

Treatments	pH			Moisture (%)		
	Initial	3rd month		Initial	3rd month	
		A	R		A	R
PT1 – 90% PP +10% DSF	4.53	5.35	4.65	3.67	4.02	3.84
PT7- 80% PP + 20% SMP	4.82	5.67	4.91	3.24	3.84	3.31
C.D (0.05)	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***
JT2- 80% JSF +20% DSF	4.87	5.32	5.01	3.79	3.98	3.82
JT8- 70% JSF +30% SMP	4.97	5.63	5.12	3.64	3.72	3.69
C.D (0.05)	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***

PP- Peanut paste, DSF- Defatted soya flour, SMP- Skimmed milk powder, JSF- Jackfruit seed flour, A- Ambient, R- Refrigerated

(PT_1) and 4.91 (PT_7) was observed. The JSF nutri spreads the pH was observed as 4.87 (JT_2) and 4.97 (JT_8) initially. After 3rd month of storage an increase in pH of 5.01 (JT_2) and 5.12 (JT_8) was observed. A gradual increase in pH was observed in all treatments on storage. The pH present in enriched nutri spreads have a significant difference between all the treatments during initial and at end of the storage.

4.3.2.1.2. Moisture

The moisture content of the selected enriched nutri spreads packed in PET containers during storage is given in Table 31. Initially, the moisture content of PP nutri spreads are 3.67 per cent (PT_1 – 90% PP +10% DSF) and 3.24 per cent (PT_7 – 80% PP +20% SMP). The moisture content of JSF nutri spreads are 3.79 per cent (JT_2 – 80% JSF +20% DSF) and 3.64 per cent (JT_8 – 70% JSF +30% SMP). After third month of storage, a slight increase in the moisture content noticed in PT_1 (3.24), and also in PT_7 (2.84). The moisture content of selected enriched JSF based nutri spreads are 3.79 per cent (JT_2 – 80% JSF +20% DSF) and 3.64 per cent (JT_8 – 70% JSF +30% SMP). At end of the storage period, the moisture content was noticed in JT_2 (2.98) and in JT_8 (2.72).

At refrigerated condition, by the end of third month of storage the moisture content was found to be 3.84 per cent in PT_1 and 3.31 per cent in PT_7. In JSF nutri spreads the moisture content was found to be 3.82 per cent in JT_2 and 3.69 per cent in JT_8.

On the basis of ANOVA, the variation noticed in the moisture content of the enriched nutri spreads was found to be statistically significant in all the treatments throughout the storage study.

4.3.2.1.3. Reducing sugar

The reducing sugar content of the selected enriched nutri spreads during storage is furnished in Table 32. Based on one way ANOVA, significant variation in the initial and 3rd month of storage values of reducing sugar content was observed. In enriched PP nutri spreads, stored at ambient temperature the reducing sugar content observed was 0.26 per cent (PT_1) and 0.24 per cent (PT_7) initially.

After 3rd month of storage an increase in reducing sugar of the PP nutri spreads was observed which are 0.32 per cent (PT_1) and 0.30 per cent (PT_7). A slight increase in reducing sugar content was observed in JT_2 (0.30%) and JT_8 (0.35%) at the end of storage.

Under refrigerated condition, the reducing sugar content observed After 3rd month of storage, an increase in reducing sugar of the selected enriched PP based nutri spreads was observed which are 0.28 (PT_1) and 0.26 per cent (PT_7). The reducing sugar content was noticed in JT_8 (0.30%) itself after third month of storage. In JT_2, the moisture content after third month of storage was noticed 0.27 per cent. A gradual increase reducing sugar content were observed in selected treatments on storage at refrigerated temperature.

4.3.2.1.4. Total sugar

The total sugar content of enriched nutri spreads stored at ambient and refrigerant condition are furnished in Table 32. Initially, the total sugar content of the PP nutri spreads are 11.57 per cent (PT_1) and 11.89 per cent (PT_7). After 3rd month of storage an increased total sugar of 11.86 per cent (PT_1) and 12.13 per cent (PT_7) were observed in PP nutri spreads. In JSF nutri spreads stored at ambient condition, initially the total sugar content of the selected treatments are 10.12 per cent (JT_2) and 9.98 per cent (JT_8). After 3rd month of storage an increased total sugar of JSF nutri spreads was observed which are 10.98 per cent (JT_2) and 10.64 per cent (JT_8). A gradual increase total sugar content were observed in selected treatments throughout the storage period.

Under refrigerated condition, a slight increase in total sugar content was observed in the PP nutri spreads in storage period. After 3rd month of storage an increase in total sugar of the PP nutri spreads was observed which 11.62 per cent (PT_1) are and 12.01 per cent (PT_7). After 3rd month of storage an increase in total sugar of the JSF nutri spreads was observed as 10.98 per cent (JT_2) and 10.64 per cent (JT_8). A slight increase total sugar content were observed in selected treatments of JSF throughout the storage period.

Table 32. Reducing sugar and Total sugar content (%) of selected enriched nutri spreads

Treatments	Reducing sugar (%)			Total sugar (%)		
	Initial	3rd month		Initial	3rd month	
		A	R		A	R
PT_1 – 90% PP +10% DSF	0.26	0.32	0.28	11.57	11.86	11.62
PT_7- 80% PP + 20% SMP	0.24	0.30	0.26	11.89	12.13	12.01
C.D (0.05)	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***
JT_2- 80% JSF +20% DSF	0.23	0.30	0.27	10.12	10.98	10.17
JT_8- 70% JSF +30% SMP	0.27	0.35	0.30	9.98	10.64	10.72
C.D (0.05)	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***

PP- Peanut paste, DSF- Defatted soya flour, SMP- Skimmed milk powder, JSF- Jackfruit seed flour, A- Ambient, R- Refrigerated

4.3.2.1.5. Fat

The fat content present in selected enriched nutri spreads were estimated and presented in Table 33.

As in Table 34, there was a decrease in fat content for all the treatment during storage. Initially the fat content present in the selected enriched PP based nutri spreads were 35.02 g (PT_1) and 36.31 g (PT_7) per 100 g. At end of the storage period, the fat content were 33.98 g (PT_1) and 35.03 g (PT_7). In JSF nutri spreads, initially the fat content of the selected treatments are 30.54 g (JT_2) and 30.42 g (JT_8). After 3rd month of storage decrease in fat content of the JSF nutri spreads was observed which are 29.23 g (JT_2) and 29.11 g (JT_8) per 100 g.

Under refrigerated condition, at end of the storage period, the fat content were 34.83 g (PT_1) and 36.02 g (PT_7). In JSF nutri spreads, after 3rd month of storage decrease in fat content was observed as 30.09 g (JT_2) and 30.03 g (JT_8). A gradual decrease in fat content were observed in selected treatments throughout the storage period. There was significant variation between enriched nutri spreads initially and during the storage period.

4.3.2.1.6. Protein

The protein content of selected enriched nutri spreads during stored at ambient and refrigerant condition are furnished in Table 33. Decrease in protein content was observed in the selected enriched nutri spreads in storage period at ambient and refrigerated condition. Initially, the protein content of the enriched PP nutri spreads are 20.78 g (PT_1) and 20.76 g (PT_7) per 100g. After 3rd month of storage a decrease in protein content of the PP nutri spreads was observed as 19.35 g (PT_1) and 19.56 g (PT_7). In JSF nutri spreads, initially the protein content of the selected treatments are 14.23 g (JT_2) and 14.34 g (JT_8). After 3rd month of storage, JSF nutri spreads was observed as 13.23 g (JT_2) and 13.12 g (JT_8) per 100 g in ambient condition.

Under refrigerated condition, in PP nutri spreads, after 3rd month of storage a decrease in protein content of the selected enriched PP based nutri spreads was

Table 33. Fat, protein and carbohydrate content (g/100 g) of selected enriched nutri spreads

Treatments	Fat			Protein			Carbohydrate		
	Initial	3rd month		Initial	3rd month		Initial	3rd month	
		A	R		A	R		A	R
PT_1 – 90% PP +10% DSF	35.02	33.98	34.83	20.78	19.35	20.01	21.68	20.73	21.32
PT_7- 80% PP + 20% SMP	36.31	35.03	36.02	20.76	19.56	19.98	20.43	18.96	20.03
C.D (0.05)	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***
JT_2- 80% JSF +20% DSF	30.54	29.23	30.09	14.23	13.23	12.89	19.95	18.53	19.65
JT_8- 70% JSF +30% SMP	30.42	29.11	30.03	14.34	13.12	12.73	22.56	21.02	22.01
C.D (0.05)	**0.013***	**0.047***	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***

PP- Peanut paste, DSF- Defatted soya flour, SMP- Skimmed milk powder, JSF- Jackfruit seed flour, A- Ambient,

R- Refrigerated

found that 20.01 g(PT_1) and 19.98 g (PT_7). In JSF nutri spreads, after 3rd month of storage was observed as 12.89 g (JT_2) and 12.73 g (JT_8).A gradual decrease in protein content were observed in selected treatments throughout the storage period.

4.3.2.1.7. Carbohydrate

The carbohydrate content of selected enriched nutri spreads during stored at ambient and refrigerant condition are furnished in Table 33. Decrease in carbohydrate content was observed in the selected enriched nutri spreads in storage period at ambient and refrigerated condition. Initially, the carbohydrate content of the enriched PP nutri spreads are 21.68 g (PT_1) and 20.43 g (PT_7) per 100 g. After 3rd month of storage a decrease in carbohydrate content of the PP nutri spreads was observed as 20.73 g (PT_1) and 18.96 g (PT_7) per 100 g. In JSF nutri spreads, initially the carbohydrate content of the selected treatments are 19.95 g (JT_2) and 22.56 g (JT_8) per 100 g. After 3rd month of storage, JSF nutri spreads was observed as 18.53 g (JT_2) and 21.02 g (JT_8) per 100 g in ambient condition.

Under refrigerated condition, in PP nutri spreads, after 3rd month of storage a decrease in carbohydrate content of the selected enriched PP based nutri spreads was found that 21.32 g(PT_1) and 20.03 g (PT_7). In JSF nutri spreads, after 3rd month of storage was observed as 19.65 g (JT_2) and 22.01 g (JT_8) per 100 g. A gradual decrease in carbohydrate content were observed in selected treatments throughout the storage period.

4.3.2.1.8. Energy

The calorific value of selected enriched nutri spreads stored at ambient and refrigerated condition are furnished in Table 34. Decrease in calorific value was observed in the selected enriched nutri spreads in storage period at ambient and refrigerated condition. Initially, the calorific value of the enriched PP nutri spreads are 485.37 Kcal (PT_1) and 491.55 Kcal (PT_7). After 3rd month of storage a decrease in calorific value of the PP nutri spreads was observed as 466.14(PT_1) and 469.35 Kcal (PT_7). In JSF nutri spreads, initially the calorific value of the selected treatments are 411.58 Kcal (JT_2) and 421.38 Kcal (JT_8). After 3rd month of storage,

Table 34. Energy (Kcal) and Total ash content (%) of selected enriched nutri spreads

Treatments	Energy (Kcal)			Total ash (%)		
	Initial	3rd month		Initial	3rd month	
		A	R		A	R
PT1 – 90% PP +10% DSF	485.37	466.14	484.79	2.82	2.12	2.46
PT7- 80% PP + 20% SMP	491.55	469.35	484.22	2.12	1.56	1.98
C.D (0.05)	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***
JT2- 80% JSF +20% DSF	411.58	390.11	400.97	1.83	1.12	1.54
JT8- 70% JSF +30% SMP	421.38	397.55	409.23	1.98	1.05	1.49
C.D (0.05)	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***

PP- Peanut paste, DSF- Defatted soya flour, SMP- Skimmed milk powder, JSF- Jackfruit seed flour, A- Ambient,

R- Refrigerated

JSF nutri spreads was observed as 390.11(JT_2) and 397.55 Kcal (JT_8) in ambient condition.

Under refrigerated condition, in PP nutri spreads, after 3rd month of storage a decrease in calorifc value of the selected enriched PP nutri spreads was found that 484.79 (PT_1) and 484.22 Kcal (PT_7). In JSF nutri spreads, after 3rd month of storage was observed as 400.97(JT_2) and 409.23 Kcal (JT_8).A gradual decrease in calorific value were observed in selected treatments throughout the storage period.

4.3.2.1.9. Total ash

The total ash content in enriched nutri spreads is given in Table 34. Initially, the total ash content of PP nutri spreads are 2.82 per cent in PT_1 and 2.12 per cent in PT_7. After third month of storage was noticed 2.12 per cent in PT_1 and 1.56 per cent in PT_7. In JSF nutri spreads, the total ash content found that 1.83 per cent (JT_2) and 1.98 per cent (JT_8). After third month of storage the total ash content was noticed in JT_2 (1.05%) and JT_8 (1.12%) in ambient condition.

At refrigerated condition, after third month of storage, total ash content was noticed in PT1 was 2.46 per cent and PT_7 was 1.98 per cent. The total ash content of JSF nutri spreads were found to be 1.83 per cent (JT_2) and 1.98 per cent (JT_8). The total ash content was noticed in JT_8 (1.54%) itself after third month of storage. In JT2, the total ash content after third month of storage was noticed 1.49 per cent.

4.3.2.1.10. Calcium

The calcium content of selected enriched nutri spreads were estimated and their results were tabulated and given in Table 35.

In PP nutri spreads, the calcium content observed was 4.63 mg 100 g^{-1} in PT_1 and 4.98 mg 100 g^{-1} in PT_7 initially. At end of the storage, the calcium content were 3.96 mg 100 g^{-1} (PT_1) and 4.02 mg 100 g^{-1} (PT_7) respectively. JSF nutri spreads stored at ambient condition, initially the calcium of the selected treatments are 11.02 mg 100 g^{-1} (JT_2) and 11.56 mg 100 g^{-1} (JT_8). After 3rd month of storage, decrease in calcium content of the JSF nutri spreads was observed as 10.64 mg 100 g^{-1}(JT_2) and 10.73 mg 100 g^{-1}(JT_8).

Table 35. Calcium, iron and phosphorus content (mg 100 g^{-1}) of selected enriched nutri spreads

Treatments	Calcium			Iron			Phosphorus		
	Initial	3rd month		Initial	3rd month		Initial	3rd month	
		A	R		A	R		A	R
PT_1 – 90% PP +10% DSF	4.63	3.96	4.59	1.02	0.57	0.99	3	2.54	2.97
PT_7- 80% PP + 20% SMP	149.80	148.92	149.72	0.98	0.38	0.92	130.10	128.91	129.88
C.D (0.05)	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***
JT_2- 80% JSF +20% DSF	11.02	10.64	10.99	1.13	0.84	1.09	1.4	1.12	1.34
JT_8- 70% JSF +30% SMP	136.08	134.85	135.98	0.97	0.39	0.91	110.70	109.71	110.62
C.D (0.05)	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***

PP- Peanut paste, DSF- Defatted soya flour, SMP- Skimmed milk powder, JSF- Jackfruit seed flour, A- Ambient,

R- Refrigerated

Under refrigerated condition, at end of the storage, the calcium content were found in PP nutri spreads are 4.59 mg 100 g^{-1} in PT_1 and 4.91 mg 100 g^{-1} in PT_7 respectively. There was a reduction in calcium content for all the selected enriched PP nutri spreads on storage at refrigerated condition. In JSF nutri spreads, after 3rd month of storage, the calcium content of the JSF nutri spreads was observed as 10.99 mg 100 g^{-1}(JT_2) and 11.49 mg 100 g^{-1}(JT_8). A gradual decrease in calcium content were observed in selected treatments throughout the storage period. There was significant variation between enriched nutri spreads initially and during the storage period.

4.3.2.1.11. Iron

The iron content of enriched nutri spreads were estimated and their results were tabulated and given in Table 35.

In PP nutri spreads, the iron content observed in PT_1 was 1.02 mg 100 g^{-1} and in PT_7, it was 0.98 mg 100 g^{-1} initially. At end of the storage, the iron content were 0.57 mg 100 g^{-1} (PT_1) and 0.38 mg 100 g^{-1} (PT_7) respectively. In JSF nutri spreads stored at ambient condition, initially the iron content of the selected two treatments are 1.13 mg 100 g^{-1} (JT_2) and 0.97 mg 100 g^{-1} (JT_8). After 3rd month of storage, decrease in iron content of the JSF nutri spreads was observed as 0.84 mg 100 g^{-1}(JT_2) and 0.39 mg 100 g^{-1}(JT_8).

Under refrigerated condition, in PP nutri spreads, after third months of storage, the iron content were 0.99 mg 100 g^{-1} (PT_1) and 0.92 mg 100 g^{-1} (PT_7) respectively. After 3rd month of storage decrease in iron content of the JSF nutri spreads was observed as 1.09 mg 100 g^{-1}(JT_2) and 0.91 mg 100 g^{-1}(JT_8). A gradual decrease in iron content were observed in selected treatments throughout the storage period.

4.3.2.1.12. Phosphorus

The phosphorus content of the selected enriched nutri spreads were estimated and their results were tabulated and given in Table 35.

Initially, the phosphorus content of PP nutri spreads are 3.00 mg $100g^{-1}$ (PT_1 – 90% PP +10% DSF) and 3.1 mg 100 g^{-1} (PT_7 – 80% PP +20% SMP). The phosphorus content was noticed in PT_1 was 2.54 mg $100g^{-1}$ itself after third month of storage. In PT_7, phosphorus content after third month of storage was noticed 2.67 mg 100 g^{-1}. In JSF nutri spreads, the phosphorus content was recorded as 1.4 mg 100 g^{-1} (JT_2 – 80% JSF +20% DSF) and 1.7 mg 100 g^{-1} (JT_8 – 70% JSF +30% SMP). The phosphorus content was noticed in JT_8 (1.12 mg 100 g^{-1}) itself after third month of storage. In JT_2, the phosphorus content after third month of storage was 1.21mg 100 g^{-1}.

At refrigerated condition, the phosphorus content was noticed in PT_1 (2.97mg $100g^{-1}$) by the end of storage. In PT_7, phosphorus content after third month of storage was noticed as 2.98 mg 100 g^{-1}. The phosphorus content was noticed in JT_8 (1.34 mg 100 g^{-1}) by the end of storage. In JT_2, the phosphorus content after third month of storage noticed was 1.65 mg 100 g^{-1}.

4.3.2.1.13. Zinc

The zinc content of the selected enriched nutri spreads were estimated and their results were tabulated and given in Table 36.

In PP nutri spreads, the zinc content observed in PT_1 was 0.017 mg 100 g^{-1} and in PT_7, it was 0.023 mg 100 g^{-1} initially. At end of the storage, the zinc content were 0.009 mg 100 g^{-1} (PT_1) and 0.014 mg 100 g^{-1} (PT_7) respectively. In JSF nutri spreads, initially the zinc content of the selected two treatments are 0.046 mg 100 g^{-1} (JT_2) and 0.081 mg 100 g^{-1} (JT_8). After 3rd month of storage decrease in zinc content of the selected enriched JSF based nutri spreads was observed which are 0.023 mg 100 g^{-1}(JT_2) and 0.072 mg 100 g^{-1}(JT_8). There was a reduction in zinc content for all the selected enriched nutri spreads on storage at ambient condition.

Under refrigerated condition, in PP nutri spreads, At end of the storage, the zinc content were 0.013 mg 100 g^{-1} (PT_1) and 0.019 mg 100 g^{-1} (PT_7) respectively. In JSF nutri spreads, after 3rd month of storage decrease in zinc content of the JSF nutri spreads was observed as 0.041 mg 100 g^{-1}(JT_2) and 0.077 mg 100 g^{-1}(JT_8). A

Table 36. Zinc, sodium and potassium content (mg 100 g^{-1}) of selected enriched nutri spreads

Treatments	Zinc			Sodium			Potassium		
	Initial	3rd month		Initial	3rd month		Initial	3rd month	
		A	R		A	R		A	R
PT_1 – 90% PP +10% DSF	0.017	0.009	0.013	4.54	3.97	4.49	39.64	38.93	39.58
PT_7- 80% PP + 20% SMP	0.023	0.014	0.019	4.63	4.02	4.56	38.83	38.01	38.72
C.D (0.05)	**0.001***	**0.001***	**0.001***	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***
JT_2- 80% JSF +20% DSF	0.046	0.023	0.041	6.46	5.87	6.40	27.54	27.12	27.46
JT_8- 70% JSF +30% SMP	0.081	0.072	0.077	5.97	5.65	5.92	27.45	26.89	27.38
C.D (0.05)	**0.001***	**0.001***	**0.001***	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***	**0.013***

PP- Peanut paste, DSF- Defatted soya flour, SMP- Skimmed milk powder, JSF- Jackfruit seed flour

gradual decrease in zinc content were observed in selected treatments throughout the storage period. There was significant variation between selected enriched JSF nutri spreads initially and during the storage period.

4.3.2.1.14. Sodium

The sodium content of the enriched nutri spreads were estimated and their results were tabulated and given in Table 36.

Initially, the sodium content of PP nutri spreads are 4.54 mg $100g^{-1}$ (PT_1 – 90% PP +10% DSF) and 4.63 mg 100 g^{-1} (PT_7 – 80% PP +20% SMP). The sodium content was noticed in PT_1 (3.97 mg $100g^{-1}$) itself after third month of storage. In PT_7, sodium content after third month of storage was noticed 4.02 mg 100 g^{-1}. The sodium content of JSF nutri spreads are 6.46 mg 100 g^{-1} (JT_2 – 80% JSF +20% DSF) and 6.02 mg 100 g^{-1} (JT_8 – 70% JSF +30% SMP). The sodium content was noticed in JT_8 (5.87 mg 100 g^{-1}) itself after third month of storage. In JT_2, the sodium content after third month of storage was 5.65 mg 100 g^{-1}.

Under refrigerated condition, the sodium content was noticed in PT_1 (4.49 mg $100g^{-1}$) by the end of storage. In PT_7, sodium content after third month of storage was noticed 4.56 mg 100 g^{-1}. In JSF nutri spreads, the sodium content was noticed in JT_8 (6.40 mg 100 g^{-1}) by the end of storage. In JT_2, the sodium content after third month of storage was noticed 5.97 mg 100 g^{-1}.

4.3.2.1.15. Potassium

The potassium content of the enriched nutri spreads were estimated and their results were tabulated and given in Table 36.

In PP nutri spreads, initial values among the two treatments, the potassium content was observed in PT_1 (39.64 mg 100 g^{-1}) and in PT_7 (38.83 mg 100 g^{-1}). At end of the storage, the potassium content were 38.93 mg 100 g^{-1} (PT_1) and 38.01 mg 100 g^{-1} (PT_7) respectively. In JSF nutri spreads, initially the potassium content of the selected two treatments are 27.94 mg 100 g^{-1} (JT_2) and 27.45 mg 100 g^{-1} (JT_8). After 3rd month of storage decrease in potassium content of the JSF nutri spreads was observed as 27.12 mg 100 g^{-1}(JT_2) and 26.89 mg 100 g^{-1}(JT_8). There

was a reduction in potassium content for all the selected enriched PP based nutri spreads on storage at ambient condition.

Under refrigerated condition, in PP nutri spreads, At end of the storage, the potassium content were observed as 39.58 mg 100 g^{-1} (PT_1) and 38.72 mg 100 g^{-1} (PT_7) respectively. There was a reduction in potassium content for all the selected enriched PP nutri spreads on storage at refrigerated condition. After 3rd month of storage decrease in potassium content of the JSF nutri spreads was observed which are 27.88 mg 100 g^{-1}(JT_2) and 27.40 mg 100 g^{-1}(JT_8). A gradual decrease in potassium content were observed in selected treatments throughout the storage period.

4.3.2.1.17. Peroxide value

The peroxide value of selected enriched nutri spreads were not detected throughout the storage period.

4.3.3. Organoleptic evaluation of enriched selected spreads

The organoleptic qualities of the selected enriched nutri spreads during storage were tabulated and given in Table 37 and 38.

At ambient condition, the mean scores for the appearance of PP nutri spreads initially observed 8.89(PT_1) and 8.58 (PT_7) which gradually decreased throughout the storage period was 8.11(PT_1) and 7.84 (PT_7) respectively. In JSF nutri spreads, the mean score for appearance noticed as 8.66 (JT_2) and 8.88 (JT_8) initially. At end of the storage period, the appearance were noticed in JT_2 was 8.01 and in JT_8 was 8.14.

The colour of the PP nutri spreads noticed 9.00 (PT_1) and 8.61 (PT_7) initially. During first, second and third month of storage treatment PT_1 was found to have mean scores of 8.83, 8.37 and 8.03 whereas mean scores was seen in PT_7 (8.45, 8.14 and 7.96). The mean scores for the colour of JSF nutri spreads initially observed 8.55 (JT_2) and 8.44 (JT_8). Which gradually decreased in the first, second and third month of storage, 8.22 (JT_2) and 8.14 (JT_8), 7.98 (JT_2) and 7.84 (JT_8) and 7.51(JT_2) and 7.43 (JT_8) respectively.

Table 37. Mean scores for organoleptic evaluation of selected enriched nutri spreads during storage at ambient condition

Treatments	Appearance				Colour				Flavour			
	Initial	1st month	2nd month	3rd month	Initial	1st month	2nd month	3rd month	Initial	1st month	2nd month	3rd month
PT_1	8.89	8.61	8.38	8.11	9.00	8.83	8.37	8.03	8.55	8.28	8.08	7.87
PT_7	8.58	8.23	8.01	7.84	8.61	8.45	8.14	7.96	8.55	8.38	8.15	7.93
JT_2	8.66	8.42	8.21	8.01	8.55	8.22	7.98	7.51	8.22	7.91	7.62	7.38
JT_8	8.88	8.57	8.34	8.14	8.44	8.14	7.84	7.43	8.22	7.94	7.71	7.49

Treatments	Texture				Taste				Overall acceptability			
	Initial	1st month	2nd month	3rd month	Initial	1st month	2nd month	3rd month	Initial	1st month	2nd month	3rd month
PT_1	8.22	8.03	7.82	7.51	8.11	7.93	7.61	7.38	8.11	7.93	7.71	7.53
PT_7	8.55	8.13	7.92	7.72	8.66	8.27	8.04	7.86	8.66	8.31	7.97	7.68
JT_2	8.44	8.12	7.84	7.42	8.44	8.15	7.94	7.65	8.43	8.19	7.95	7.69
JT_8	9.00	8.71	8.46	8.11	8.66	8.24	8.01	7.83	8.66	8.25	8.01	7.82

The flavour of the PP nutri spreads noticed 8.55 (PT_1) and 8.55 (PT_7) initially. During first, second and third month of storage treatment PT_1 was found to have mean scores of 8.28, 8.08 and 7.87 whereas mean scores was seen in PT_7 (8.38, 8.15 and 7.93). In JSF nutri spreads initially observed 8.22(JT_2) and 8.22 (JT_8). Which gradually decreased in the first, second and third month of storage, 7.91 (JT_2) and 7.94 (JT8), 7.62 (JT_2) and 7.71 (JT8) and 7.38(JT_2) and 7.49 (JT8) respectively.

The texture and taste of PP nutri spreads were 8.22 and 8.11 (PT_1) and 8.55 and 8.66 (PT_7) (initially). After third month of storage, the texture and taste were observed as 7.42 and 7.65(JT_2) and 8.11 and 7.83 (JT_8) respectively. In JSF nutri spreads were 8.44 and 8.44 (JT_2) and 9.00 and 8.66 (JT_8) (initially) and at end of the storage, it observed as 7.42 and 7.94 (JT_2) and 7.72 and 7.86 (JT_8) (3^{rd} month) respectively.

The overall acceptability of the PP nutri spreads noticed as 8.11 (PT_1) and 8.55(PT_7) initially. During first, second and third month of storage treatment PT_1 was found to have mean scores of 7.93, 7.71 and 7.53 whereas mean scores was seen in PT_7 (8.21, 7.97 and 7.68). In JSF nutri spreads initially observed 8.43 (JT_2) and 8.66 (JT_8). Which gradually decreased in the first, second and third month of storage, 8.19 (JT_2) and 8.25 (JT_8), 7.95 (JT_2) and 8.01 (JT_8) and 7.69(JT_2) and 7.82 (JT_8) respectively.

At refrigerated condition, the mean scores for the appearance of PP nutri spreads initially observed 8.89(PT_1) and 8.58 (PT_7) which gradually decreased in the first, second and third month of storage, 8.78 (PT_1) and 8.46 (PT_7), 8.61 (PT_1) and 8.32 (PT_7) and 8.43 (PT_1) and 8.21 (PT_7) respectively. In JSF nutri spreads initially noticed 8.66 (JT_2) and 8.88 (JT_8). During storage period, the mean scores were observed 8.58 (JT_2) and 8.71 (JT_8) after first month, after second month of storage, the mean scores were observed in JT_2 is 8.45 and JT_8 is 8.63. At end of the storage period, the appearance were noticed in JT_2 is 8.33 and in JT_8 is 8.51.

The colour of the PP nutri spreads noticed 9.00 (PT_1) and 8.61 (PT_7) initially. During first, second and third month of storage treatment PT_1 was found to have mean scores of 8.94, 8.81 and 8.69 whereas mean scores was seen in PT_7

Table 38. Mean scores for organoleptic evaluation of selected enriched nutri spreads during storage at refrigerated condition

Treatments	Appearance				Colour				Flavour			
	Initial	1st month	2nd month	3rd month	Initial	1st month	2nd month	3rd month	Initial	1st month	2nd month	3rd month
PT_1	8.89	8.78	8.61	8.43	9.00	8.94	8.81	8.69	8.55	8.46	8.21	8.01
PT_7	8.58	8.46	8.32	8.21	8.61	8.54	8.43	8.35	8.55	8.47	8.26	8.12
JT_2	8.66	8.58	8.45	8.33	8.55	8.46	8.31	8.22	8.22	8.10	7.97	7.82
JT_8	8.88	8.71	8.63	8.51	8.44	8.35	8.23	8.15	8.22	8.09	7.99	7.83

Treatments	Texture				Taste				Overall acceptability			
	Initial	1st month	2nd month	3rd month	Initial	1st month	2nd month	3rd month	Initial	1st month	2nd month	3rd month
PT_1	8.22	8.01	7.95	7.86	8.11	8.00	7.92	7.81	8.11	8.02	7.96	7.88
PT_7	8.55	8.39	8.14	8.03	8.66	8.51	8.44	8.35	8.66	8.41	8.32	8.19
JT_2	8.44	8.34	8.09	7.98	8.44	8.31	8.18	8.12	8.43	8.35	7.89	7.52
JT_8	9.00	8.91	8.84	8.71	8.66	8.58	8.42	8.36	8.66	8.58	8.09	7.86

(8.54, 8.43 and 8.35). In JSF nutri spreads initially observed 8.55 (JT_2) and 8.44 (JT_8). Which gradually decreased at end of the storage8.22 (JT_2) and 8.15 (JT_8) respectively.

The flavour of the selected PP nutri spreads noticed 8.55 (PT_1) and 8.55 (PT_7) initially. After third months of storage treatment PT_1 was found to have mean score of 8.01 whereas mean scores was seen in PT_7 was 8.12. In JSF nutri spreads initially observed 8.22(JT_2) and 8.22 (JT_8). Which gradually decreased in the first, second and third month of storage, 8.10 (JT_2) and 8.09 (JT_8), 7.97 (JT_2) and 7.99 (JT_8) and 7.82(JT_2) and 7.83 (JT_8) respectively.

The texture and taste of PP nutri spreads were 8.22 and 8.11 (PT_1) and 8.55 and 8.66 (PT_7) (initially), 8.01 and 8.00 (PT_1) and 8.39 and 8.51 (PT_7) (first month), 7.95 and 7. 92(PT_1) and 8.14 and 8.44 (PT_7) (second month) and 7.86 and 7.81(PT_1) and 8.03 and 8.35 (PT_7) (3^{rd} month) respectively. In JSF nutri spreads were 8.44 and 8.44 (JT_2) and 9.00 and 8.66 (JT_8) (initially) and after third months of storage texture and taste observed as 7.98 and 8.12 (JT_2) and 8.71 and 8.36 (JT_8) respectively.

The overall acceptability of the PP nutri spreads noticed in PT_1 was 8.11 and in PT_7 was 8.66 initially. After third months of storage treatment PT_1 was found to have mean score of 7.88 whereas mean score was seen in PT_7 was 8.19. The mean scores for the overall acceptability of JSF nutri spreads initially observed 8.43 (JT_2) and 8.66 (JT_8). Which gradually decreased in the first, second and third month of storage, 8.35 (JT_2) and 8.58 (JT_8), 7.89 (JT_2) and 8.09 (JT_8) and 7.52 (JT_2) and 7.86 (JT_8) respectively.

4.3.4. Enumeration of total microflora

The microbial population of the selected enriched nutri spreads were assessed initially and also at monthly intervals for a period of three months and the results are presented in Table 39 and Table 40.

As revealed in Table 39, initially the bacterial count was not detected in PP nutri spreads. The bacterial count was found to be increased gradually to 0.48×10^6 cfu/g (PT_1) and 0.41x 10^6 cfu/g (PT_7) after third month of storage. In JSF nutri spreads, initially the bacterial counts were not detected in enriched PP based nutri

spreads. At end of the storage, bacterial count was found to be 0.39 x 10^6 cfu/g (JT_2) and 0.43x 10^6 cfu/g (JT_8).

In PP nutri spreads, fungal growth was not detected during initial and first month of storage. During the end of second month, the fungal growth of 0.04×10^3 cfu/g (PT_1) and 0.02x 10^3 cfu/g (PT_7) were detected and it was increased after third month of storage. In JSF nutri spreads, initially and after first month of storage fungal counts were not detected in enriched JSF based nutri spreads. At end of the storage, fungal count was found to be 0.11 x 10^3 cfu/g (JT_2) and 0.12x 10^3 cfu/g (JT_8).

Yeast growth was not detected in selected enriched nutri spreads throughout the storage period.

At refrigerated condition, as revealed in Table 40, initially and after first month of storage bacterial counts were not detected. The bacterial count was found to be after second month of storage, 0.05×10^6 cfu/g (PT_1) and 0.02x 10^6 cfu/g (PT_7) , which increased to 0.06×10^6 cfu/g (PT_1) and 0.03x 10^6 cfu/g (PT_7) after third month of storage. In JSF nutri spreads, initially and after first month of storage, bacterial counts were not detected. At end of the storage, bacterial count was found to be 0.04 x 10^6 cfu/g (JT_2) and 0.09x 10^6 cfu/g (JT_8).

Fungal and yeast growth were not detected in selected enriched nutri spreads throughout the storage period at refrigerated condition.

4.4. Cost of production for selected nutri spreads

The cost of production of selected nutri spreads were estimated per 100g of finished product and the details are furnished in Table 41.

The cost for selected PP based nutri spread was Rs. 66.18 and for JSF based nutri spread was Rs. 45.13. The cost varied from Rs. 55.25 to Rs. 80.35 / 100 g for selected enriched nutri spreads. The cost incurred for the production of defatted soya flour added PP based nutri spread was Rs. 78.73/ 100 g and the cost for the skimmed milk powder added PP based nutri spread was found to be Rs. 80.34 /100g. The cost incurred for the production of defatted soya flour added JSF based

Table 39. Total microbial count of the selected enriched nutri spreads during storage during storage at ambient condition

Treatments	Microbial population (cfu/g)							
	Bacteria (10^6cfu/g)				Fungi (10^3cfu/g)			
	Initial	1st month	2nd month	3rd month	Initial	1st month	2nd month	3rd month
PT_1 – 90% PP +10% DSF	ND	0.28	0.32	0.48	ND	ND	0.04	0.09
PT_7- 80% PP + 20% SMP	ND	0.21	0.30	0.41	ND	ND	0.02	0.07
JT_2- 80% JSF +20% DSF	ND	0.18	0.26	0.39	ND	ND	0.06	0.11
JT_8- 70% JSF +30% SMP	ND	0.06	0.21	0.43	ND	ND	0.05	0.12

PP- Peanut paste, DSF- Defatted soya flour, SMP- Skimmed milk powder, JSF- Jackfruit seed flour

Table 40. Total microbial count of the selected enriched nutri spreads during storage during storage at refrigerated condition

Treatments	Microbial population (cfu/g)			
	Bacteria (10^6cfu/g)			
	Initial	1st month	2nd month	3rd month
PT_1 – 90% PP +10% DSF	ND	ND	0.05	0.06
PT_7- 80% PP + 20% SMP	ND	ND	0.02	0.03
JT_2- 80% JSF +20% DSF	ND	ND	0.01	0.04
JT_8- 70% JSF +30% SMP	ND	ND	0.07	0.09

PP- Peanut paste, DSF- Defatted soya flour, SMP- Skimmed milk powder, JSF- Jackfruit seed flour

nutri spread was Rs. 47.51 /100 g and the cost for the skimmed milk powder added JSF based nutri spread was found to be Rs. 55.23 /100g.

Table 41. Cost of production for selected nutri spreads

Treatments	Cost (Rs./ 100 g)
PP + Hydrogenated palm oil	66.18
JSF + Hydrogenated palm oil	45.13
Enriched PP+ Defatted soya flour nutri spread	78.73
Enriched PP+ Skimmed milk powder	80.34
Enriched JSF+ Defatted soya flour nutri spread	47.51
Enriched JSF+ Skimmed milk powder	55.25


Discussion

5. DISCUSSION

Results of the study entitled 'standardisation and quality evaluation of nutri spreads' are discussed under the following headings

5.1. Standardisation of nutri spreads

5.1.1. Organoleptic evaluation of nutri spreads

5.1.2. Physico-chemical qualities of developed nutri spreads

5.2. Quality evaluation of the selected nutri spreads during storage

5.2.1. Changes in physico- chemical qualities

5.2.2. Changes in organoleptic qualities

5.2.3. Changes in microbial qualities

5.3. Enrichment of the developed spreads with protein sources

5.3.1. Organoleptic evaluation of enriched nutri spreads

5.3.2. Changes in physico-chemical qualities of enriched nutri spreads

5.3.3. Changes in organoleptic qualities of enriched selected spreads

5.3.4. Changes in microbial qualities of the enriched spreads

5.4. Cost of production for the selected nutri spreads

5.1. Standardisation of nutri spreads

Peanut paste (PP) and jackfruit seed flour (JSF) based nutri spreads were prepared using various fat sources like cocoa butter (CB), unsalted butter (UB) and hydrogenated palm oil (HPO) in different combinations. Peanut paste were used upto 50 per cent to 75 per cent in all the treatments. Jackfruit seed flour (JSF) were used upto 25 per cent to 50 per cent in all the treatments. With a view to select the most appropriate combination for the preparation of nutri spreads, 36 treatments were evaluated for various organoleptic qualities like appearance, colour, flavor, texture, taste and overall acceptability using score card having nine point hedonic scale.

5.1.1. Organoleptic evaluation of nutri spreads

Cocoa butter is a natural and highly valued fat that contributes to the desirable textural and sensory properties of chocolate and confectionery products. Cocoa butter has been reported to have several health benefits too. Morrissey *et al.* (1986) studied the graded levels of cocoa butter (10 and 30%) and showed the cholesterol lowering effect. Kiitchevsky *et al.* (1988) showed that 10% cocoa butter in diet lowered the liver cholesterol and triglyceride levels. The suitability of cocoa butter for the development of nutri spreads in combination with PP and JSF for the development of nutri spreads was assessed in this study.

Among peanut paste based nutri spreads prepared with cocoa butter (CB), the treatment PT_4 (60 % PP + 20% CB) secured a maximum mean score of 7.00 and above for all quality attributes like appearance, colour, flavor, texture, taste and overall acceptability. Incorporation of 20 per cent cocoa butter was found to be providing good sensory qualities for the PP based nutri spreads. Among jackfruit seed flour (JSF) based nutri spreads prepared with cocoa butter (CB), the mean scores and mean rank scores for sensory parameters of JSF nutri spreads prepared with cocoa butter was the highest for treatment JT_6 (25% JSF+ 55% CB) than the other treatments. The mean score for taste and overall acceptability was 6.40 and 6.35 respectively. The organoleptic scores of nutri spreads prepared with jackfruit seed- cocoa butter combination were comparatively lower than that of peanut paste-cocoa butter combination.

In JSF nutri spreads prepared with cocoa butter, the organoleptic qualities were inferior, as the texture was slightly hard due to the solidifying nature of cocoa butter. This can be overcome by high speed blending with advance technologies. Talbot (1999) stated that chocolate is a food product preferred by many people due to its desirable qualities such as a shiny gloss on the surface, a snap when broken, a smooth texture and melt-in-mouth characteristics. These qualities are closely related to the uniqueness of cocoa butter, the fat component present in chocolates that is hard and brittle at room temperature whereas melting completely at body temperature.

When suitability of unsalted butter for the development of PP based nutri spreads was assessed, PT_9 (65% PP+ 15% UB) had the highest mean score in all the sensory attributes like appearance (8.13), colour (8.40), flavour (7.37), texture (7.44), taste (6.86) and overall acceptability (7.37). Inclusion of 15 per cent unsalted butter was found to be good in obtaining desirable texture, but imparted a ghee flavour to the product when combined with peanut paste.

The organoleptic qualities revealed that nutri spread prepared with 25 per cent JSF and 55 per cent unsalted butter (JT_{12}) was highly acceptable. The results of sensory evaluation reported that mean score obtained for JT_{12} was 6.97 for appearance, 7.15 for colour, 7.80 for flavour, 7.28 for texture, 7.42 for taste and 7.26 for overall acceptability. Unsalted butter was found to be providing excellent organoleptic qualities when blended with jackfruit seed flour.

Organoleptic evaluation of peanut paste (PP) nutri spreads prepared with hydrogenated palm oil (HPO) revealed that treatment PT_{15} (65% PP+ 15% HPO) was highly acceptable. The mean score obtained for treatment T_{15} was 8.08 for appearance, 8.22 for colour, 7.71 for flavour, 8.08 for texture, 8.04 for taste and 8.08 for overall acceptability. In this combination, the added fat content could be reduced to 15 per cent. This may be due to the desirable textural qualities imparted by hydrogenated palm oil.

Organoleptic evaluation of jackfruit seed flour (JSF) nutri spreads prepared with hydrogenated palm oil (HPO) showed that treatment JT_{16} (35% JSF + 45% HPO) was highly acceptable. The mean score obtained for treatment JT_{16} was 8.88 for appearance, 9.00 for colour, 8.11 for flavour, 7.97 for texture, 8.73 for taste and 8.66 for overall acceptability.

When the overall acceptability of JSF nutri spreads using CB, UB and HPO were compared, it was found that the highest overall acceptability of above 8 was demonstrated by HPO added treatments. Caglar *et al.* (2013) observed that a gradual rise in overall acceptability scores in carob flour functional spread with the increasing of hydrogenated palm oil content. It can therefore be assumed that the

use of hydrogenated palm oil improved the acceptability of the products. Swanson and Perry (2007) suggested that the reduction of fat in the modified oatmeal and chocolate chip cookies influenced the acceptance adversely.

Aydjn and Ozdemir (2017) formulated carob flour based functional spread with 38 g of carob flour and 42 g of hydrogenated palm oil was more acceptable and has high overall acceptability.

Jackfruit seed flour has been proven to be an excellent filling agent in various products. Incorporation of 35 per cent jackfruit seed flour along with 45 per cent hydrogenated palm oil resulted in nutri spread with high sensory qualities. Faridha and Aziah (2012) developed a highly acceptable low calorie cake incorporated with JSF (18%) and wheat flour. The prepared product was highly acceptable for sensory qualities. Incorporation of 25 per cent of jackfruit seed flour bread showed good sensory qualities with a score of 7.15 for overall acceptability. Cake prepared using 25 per cent of JSF (20 to 25 % replacement of wheat flour) had highest overall acceptability. Aziah (2012) observed that increase in the substitution of seed flour resulted in decrease in colour, flavour, texture, taste and overall acceptability of the prepared product. Similar to this, the above 35 per cent inclusion of JSF considerably reduced the organoleptic qualities of JSF nutri spreads.

The most acceptable three treatments of peanut paste based nutri spreads added with three different fat sources selected were PT_4, PT_9 and PT_{15}. In nutri spreads prepared based on JSF, inferior textural qualities were obtained for those prepared by adding cocoa butter as a fat source. Cocoa butter (CB) and jackfruit seed flour (JSF) solidified and hard texture was obtained for all treatments. Hence, only two treatments (JT_{12} and JT_{16}) were selected for further studies.

5.1.2. Physico-chemical qualities of developed nutri spreads

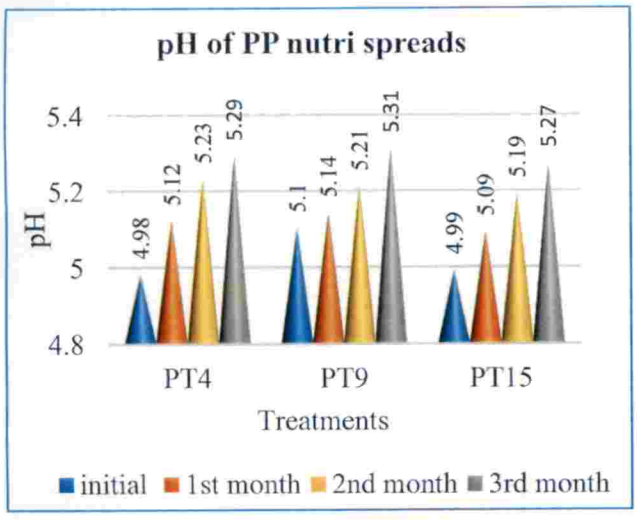
The textural properties such as gel strength, adhesiveness, brittleness and rupture strength of nutri spreads were analyzed. The gel strength value in the selected nutri spreads varied from 1.057 N (PT_4) to 4.975 (JT_{16}) N. Genovese *et al.* (2010) reported that gel strength is a point in the initial stage of penetration where

little deformation has occurred. The Rupture strength value in the selected nutri spreads varied from 5.438 N (JT_{16}) to 12.844 N (PT_4 & PT_{15}). Genovese *et al.* (2010) reported that rupture strength is the rupture point of the product. The brittleness and adhesiveness in the selected nutri spreads varied from 18.705 mm (PT_9) to 25.808 mm (PT_{15}) and 2.789 N (JT_{12}) to 144.131 N (PT_4). Genovese *et al.* (2010) reported that brittleness is the distance that the probe penetrates the product. Adhesiveness is an important parameter for food products. It enables the degree of adhesion of food on the teeth to be predicted (Besbes *et al.*, 2009).

Initially the pH value in the selected PP nutri spreads were 4.98 (PT_4), 5.10 (PT_9) and 4.99 (PT_{15}) per cent. The moisture content in the selected PP nutri spreads were 2.05 (PT_4), 2.97 (PT_9) and 1.81 (PT_{15}) per cent. The reducing sugar and total sugar content in the selected PP nutri spreads were 0.25 and 12.95 (PT_4), 0.30 and 11.96 (PT_9) and 0.26 and 11.67 (PT_{15}) per cent. The fat content in the selected PP nutri spreads were 31.08 (PT_4), 28.32 (PT_9) and 40.49 (PT_{15}) g/100 g. Woodroof (1983) observed a fat content of 46.5 per cent in peanut butter. The major ingredient raw peanut contain around 49 per cent fat (ARS, 2001). Gopalan *et al.* (1989) also reported a fat content of 39.8 g in raw peanuts. The protein content in the selected PP nutri spreads were 18.22 (PT_4), 19.03 (PT_9) and 15.08 g/100 g (PT_{15}). Woodroof (1983) observed a protein content of 29.3 per cent in peanut butter. In the major ingredient peanut is rich in protein and contain 26 g as observed by ARS (2001) in raw peanuts. Gopalan *et al.* (1989) reported a protein content of 26.2 g in raw peanuts. The carbohydrate content in the selected PP nutri spreads were 21.95 (PT_4), 22.75 (PT_9) and 23.62 g/100 g (PT_{15}). Woodroof (1983) observed a carbohydrate content of 17.1 per cent in peanut butter. In the major ingredient peanut is rich in carbohydrate and contain 17.00 g as observed by ARS (2001) in raw peanuts. Gopalan *et al.* (1989) reported a carbohydrate content of 26.7 g in raw peanuts. The calorific value in the selected PP nutri spreads were 440.40 (PT_4), 422.00 (PT_9) and 519.21 Kcal/100 g (PT_{15}). Woodroof (1983) observed a calorific value of 575 Kcal in peanut butter. Calorific value of 567 Kcal was observed by ARS (2001) in raw peanuts. Gopalan *et al.* (1989) reported a calorific value of 570 Kcal in 100 g of raw peanuts. The total ash content in the selected PP nutri spreads

were 1.86 (PT_4), 2.38 (PT_9) and 2.19 (PT_{15}) per cent. The calcium, iron, phosphorus, zinc, sodium and potassium content in the selected PP nutri spreads were 5.09, 1.67, 2.67, 0.24, 5.55 and 41.41 mg 100 g^{-1} in PT_4, 13.09, 2.36, 2.03, 0.21, 4.99 and 37.62 mg 100 g^{-1} in PT_9 and 5.13, 2.59, 3.05, 0.35, 5.27 and 40.70 mg 100 g^{-1} in PT_{15}. Peanuts are good sources of minerals. Gopalan *et al.* (1989) observed that the nutrient content of 100 g of roasted peanut were 2.50 g (total ash), 77 mg (calcium), 370 mg (phosphorus) and 3.10 mg (iron). High calcium of 13.09 mg 100 g^{-1} was observed in PT_9. Unsalted butter contains 24 mg 100 g^{-1} amount of calcium.

Initially the pH value in JSF nutri spreads were 5.33 (JT_{12}) and 5.10 (JT_{16}). The moisture content in selected JSF nutri spreads were 3.35 (JT_{12}) and 1.71 (JT_{16}) per cent. Patange *et al.* (2013) observed that the pH in ghee based low fat spread was 5.3 initially. Ocloo *et al.* (2010) found that the pH and titratable acidity values is 5.78. The total content in selected JSF nutri spreads were 9.54 (JT_{12}) and 8.97 (JT_{16}) per cent. The fat content in selected JSF nutri spreads were 31.09 (JT_{12}) and 46.02 g/100 g (JT_{16}). The protein content in selected JSF nutri spreads were 5.93 (JT_{12}) and 6.60 g/100 g (JT_{16}). The carbohydrate content in selected JSF nutri spreads were 36.72 (JT_{12}) and 19.86 g/100 g (JT_{16}).The calorific value in selected JSF nutri spreads were 450.65 (JT_{12}) and 520.02 Kcal/100 g (JT_{16}). The total ash content in selected JSF nutri spreads were 1.21 (JT_{12}) and 0.90 (JT_{16}) per cent. The calcium, iron, phosphorus, zinc, sodium and potassium content in the selected JSF nutri spreads were 12.10, 2.01, 2.55, 0.41, 12.59 and 33.59 mg/100 g (JT_{12}) and 16.5, 1.86, 3.15, 0.67, 8.29 and 27.60 mg/100 g (JT_{16}). Ocloo *et al.* (2010) found that the protein, and carbohydrate contents of jackfruit seed flour was 13.50 g and 79.34 g/100 g respectively. The jackfruit seed contains very high amount of calcium that is 3087 mg/kg, iron 130.74 mg/kg, potassium content 14781 mg/ kg, sodium contain 60.66 mg/kg, copper 10.45 mg/kg and manganese 1.12 mg/kg. The protein content is very different, because the seeds were collected from different region because different region sample have slightly different nutrition content (Swami *et al.*, 2012).



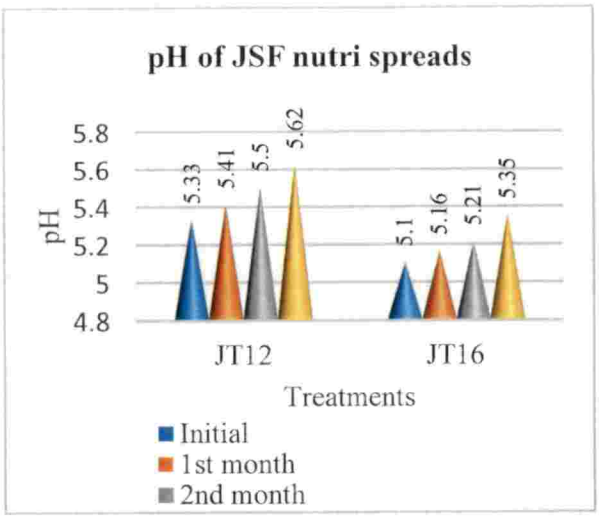
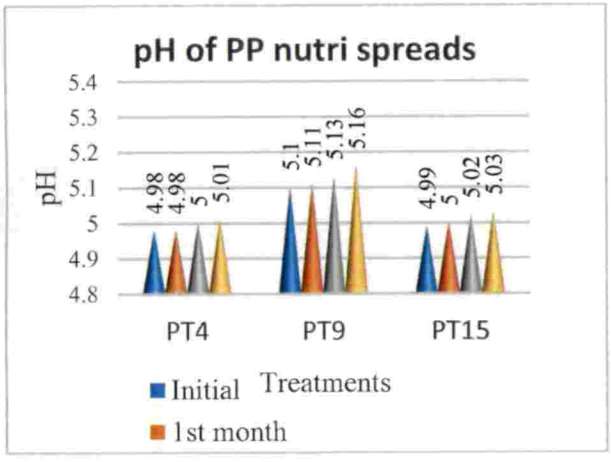


Fig.1a. pH of nutri spreads stored under ambient condition



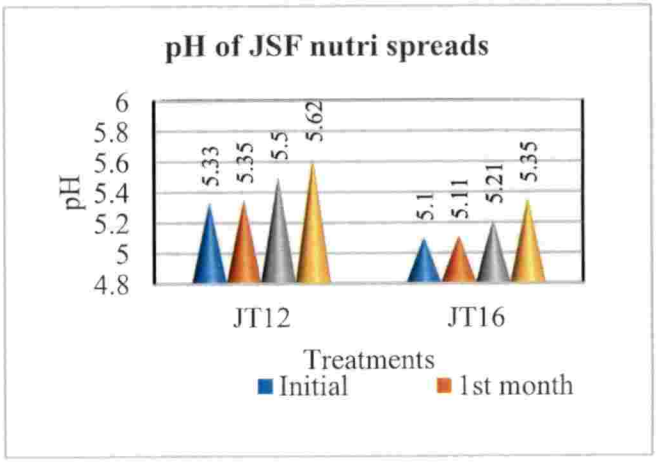


Fig.1b. pH of nutri spreads stored under refrigerated condition

PP- Peanut paste, JSF- Jackfruit seed flour

PT_4 (60% PP + 20% CB)

PT_9 (65% PP + 15% UB)

PT_{15} (65% PP + 15% HPO)

JT_{12} (25% JSF + 55% UB)

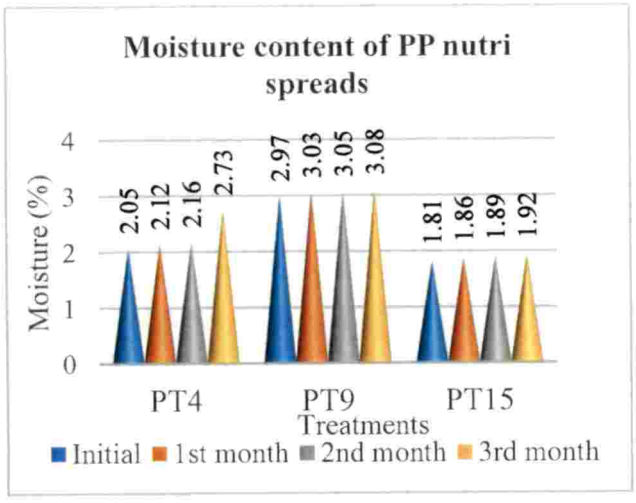
JT_{16} (35% JSF + 45% HPO)

5.2. Quality evaluation of the selected nutri spreads during storage

5.2.1. Changes in physico- chemical qualities during storage

The major changes in physico-chemical qualities during storage of the developed nutri spreads were assessed separately in both PP and JSF based nutri spreads. The changes in stored nutri spreads under ambient and refrigerated conditioned were also assessed. The pH of the selected nutri spreads varied from 4.98 to 5.33 with the minimum in treatment PT_4 and maximum in JT_{12}. At the end of storage, under ambient condition, pH increased in the range of 5.27 to 5.62 per cent with the maximum in JT_{12} and minimum in PT_{15} and is presented in Figure 1a. Under refrigerated condition, the pH varied from 5.01 to 5.40 by the end of the storage period. The increase in pH of the sample stored at refrigeration temperature was slightly lesser than the sample stored at room temperature and is presented in Figure 1b. Patange *et al.* (2013) studied that, at the end of 5 weeks of storage, the pH increased slightly however significantly to 5.6. These finding are in similar with Dalaly *et al.* (1968), Spurgeon *et al.* (1970) and Balasubramanyam and Kulkarni (1999) who found an increased pH in stored spreads. This could be attributed to various hydrolytic reactions throughout storage.

Among all the treatments, the moisture content of the nutri spreads initially varied between 1.71 to 3.35 per cent with the minimum in JT_{16} and maximum in JT_{12}. A slight increase in moisture content in the range of 1.83 (JT_{16}) to 3.82 (JT_{12}) per cent was observed at the end of storage and is presented in Figure 2a and Figure 2b. Jeyarani *et al.* (2015) reported moisture content of 5.00 to 6.19 per cent in omega-3 fatty acids enriched chocolate spreads using soybean and coconut oils. Amevor *et al.* (2018) stated that the moisture content in cashew nut chocolate spreads varied from 0.90 to 1.40 per cent. The moisture content of the products increased because of the moisture uptake and high relative humidity of the storage conditions. The moisture intake was influenced by temperature and time of storage. He and Hoseney (1990) stated that temperature, humidity and permeableness of the material is a very important parameter to extend the moisture absorption capacity of the product.



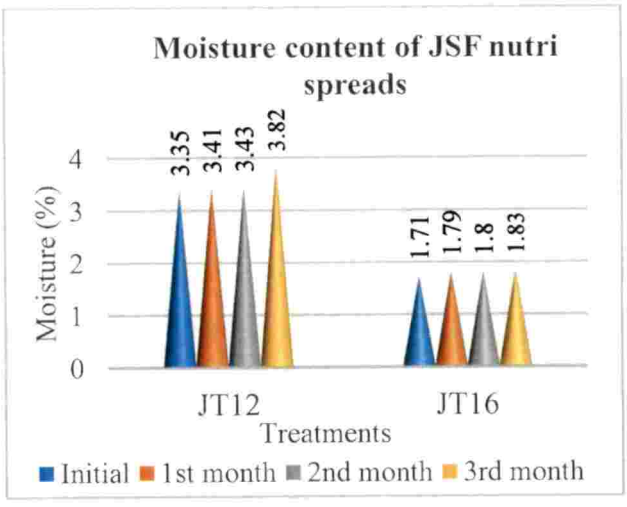
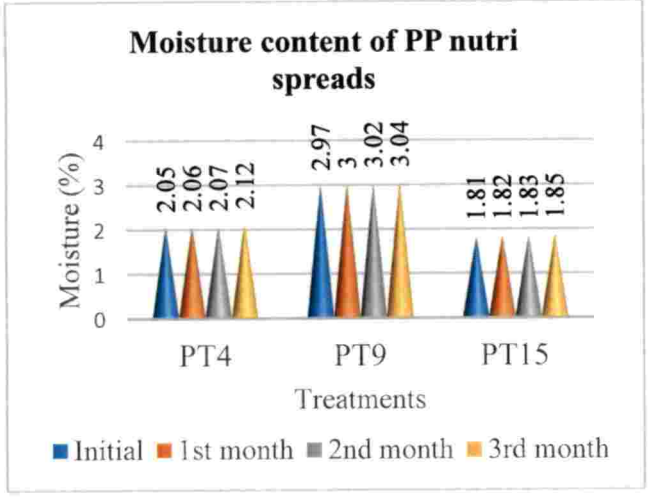


Fig.2a. Moisture content (%) of nutri spreads stored under ambient condition



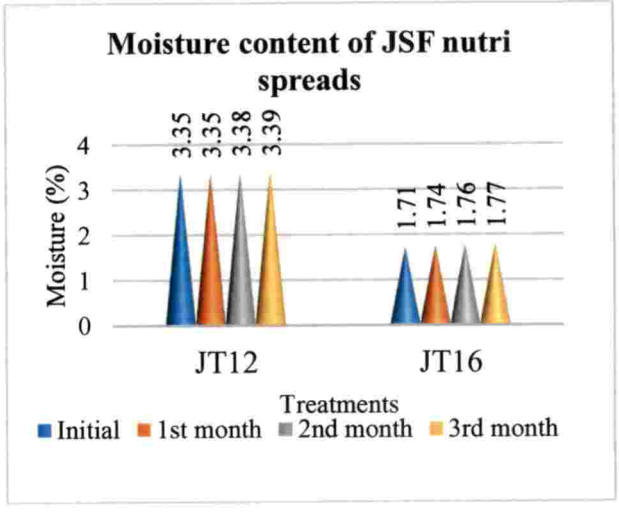


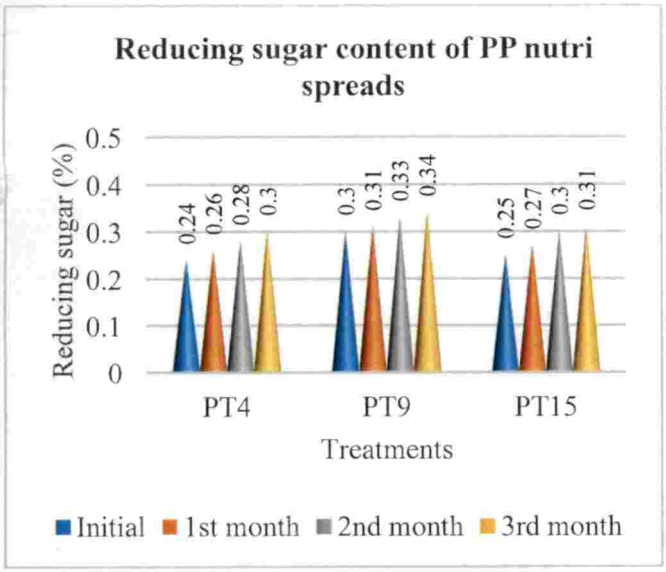
Fig.2b. Moisture content (%) of nutri spreads stored under refrigerated condition

PP- Peanut paste, JSF- Jackfruit seed flour
PT_4 (60% PP+ 20% CB)
PT_9 (65% PP+ 15%UB)
PT_{15} (65% PP+ 15% HPO)
JT_{12} (25% JSF+ 55% UB)
JT_{16} (35% JSF+ 45% HPO)

The total sugar content initially varied from 8.97 (JT_{16}) to 12.95 (PT_4) per cent. At end of storage, total sugar content varied from 10.54 to 13.96 per cent. Total sugar of selected nutri spreads were increased gradually during storage and is presented in Figure 4a and Figure 4b. Sindumathi and Amutha (2014) reported that reducing and total sugars were gradually increased on storage for coconut based jam. Shahanas *et al.* (2015) showed that spreads using fruit extracts and tender coconut pulp had a total sugars of 68.67 per cent. Thilagavathi *et al.* (2015) stated that increased level of air and moisture content in formulated products hasten the breakdown of total sugars to reducing sugars. They observed increase in total sugars content on storage period due to the formation of simpler sugar like sucrose, glucose and fructose on starch degradation.

The initial fat content of the selected nutri spreads varied from 28.32 to 46.02 g/100g and is presented in Figure 5a. A significantly higher initial fat content was recorded in the JT_{16} (35% JSF + 45% HPO) and the lowest was in PT_4 (60% PP + 20% CB). The fat content reduced slightly during storage. At end of storage, fat content of selected nutri spreads varied from 27.98 g /100 g to 45.95 g /100 g. The decrease in fat content of the sample stored at refrigeration temperature was slightly lesser than the sample stored at room temperature and is presented in Figure 5b. Rao *et al.* (1984) observed that decrease in fat content on storage may be due to of the enzymatic activity of lipase and lipoxidase that was produced by microorganism. An identical finding of Sugasini (2003) proved that fat content observed to be decreased throughout storage period. Shazad *et al.* (2005) reported that fat content reduced throughout storage which can be due to the development of oxidative rancidity.

In the present study, initial protein content of selected nutri spreads varied from 5.93 to 19.03 g/100 g, the maximum protein content was observed in treatment PT_9 and minimum protein content in JT_{12} and is presented in Figure 6a. At the end of storage, protein content of the selected nutri spreads varied from 5.25 g /100 g to 18.92 g /100 g. The decrease in protein content of the sample stored at refrigeration temperature was slightly lesser than the sample stored at room temperature and is



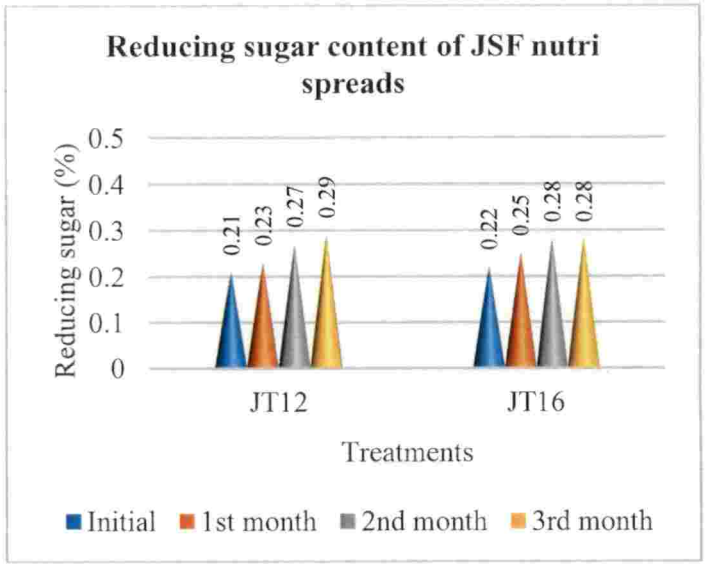
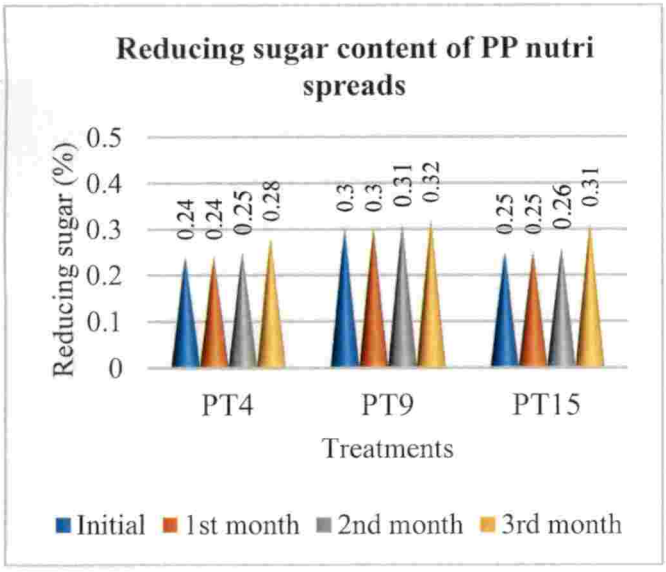


Fig.3a. Reducing sugar content (%) of nutri spreads stored under ambient condition



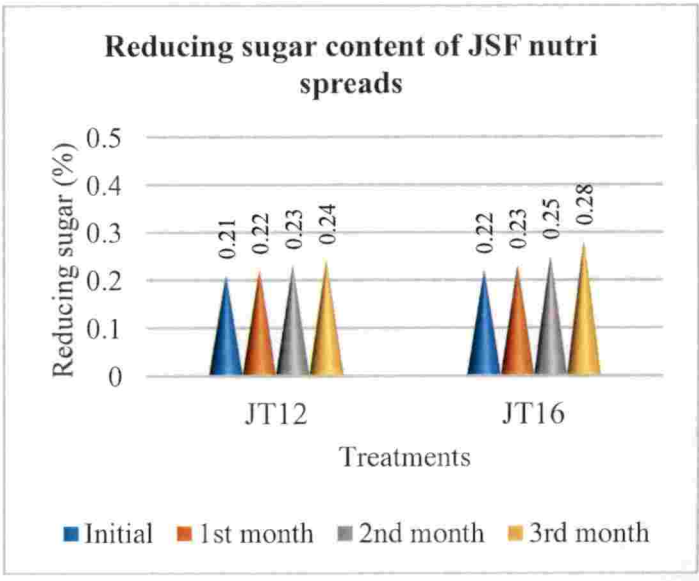
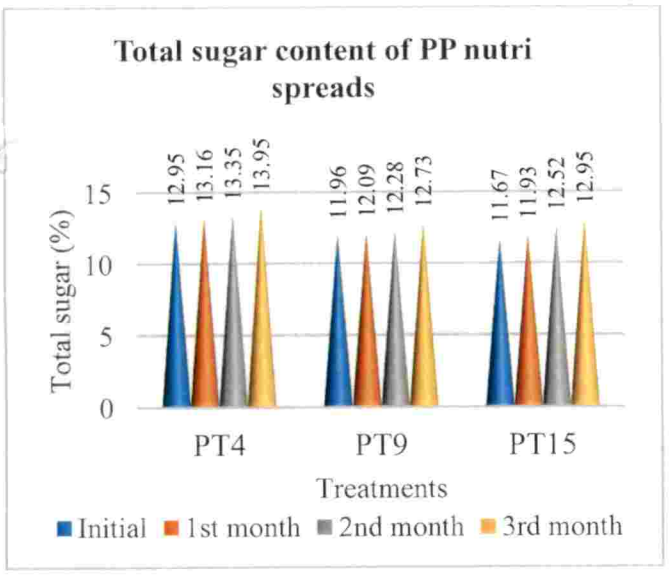


Fig.3b. Reducing sugar (%) of nutri spreads stored under refrigerated condition

PP- Peanut paste, JSF- Jackfruit seed flour
PT_4 (60% PP+ 20% CB)
PT_9 (65% PP+ 15%UB)
PT_{15} (65% PP+ 15% HPO)
JT_{12} (25% JSF+ 55% UB)
JT_{16} (35% JSF+ 45% HPO)



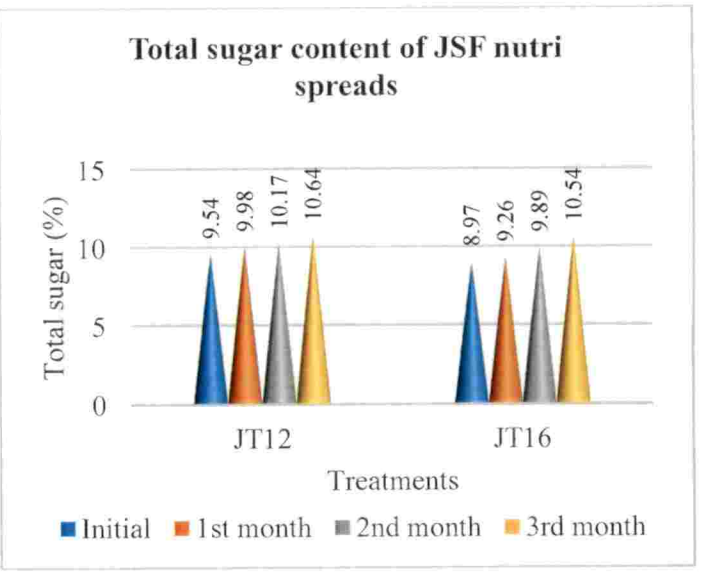
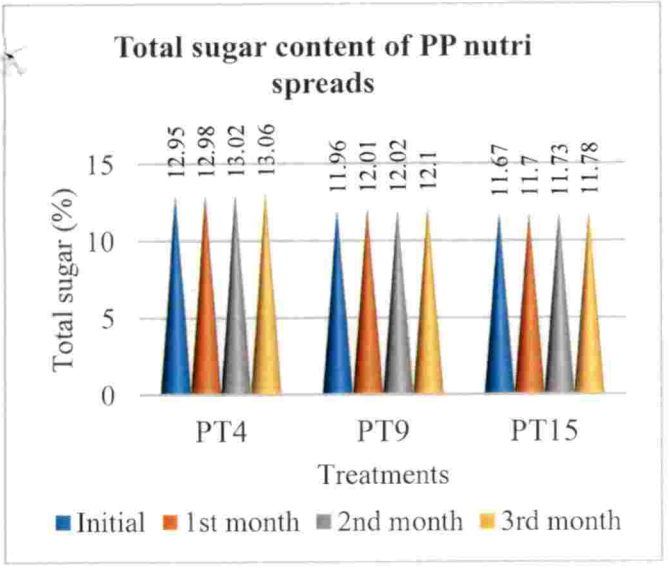


Fig.4a. Total sugar content (%) of nutri spreads stored under ambient condition



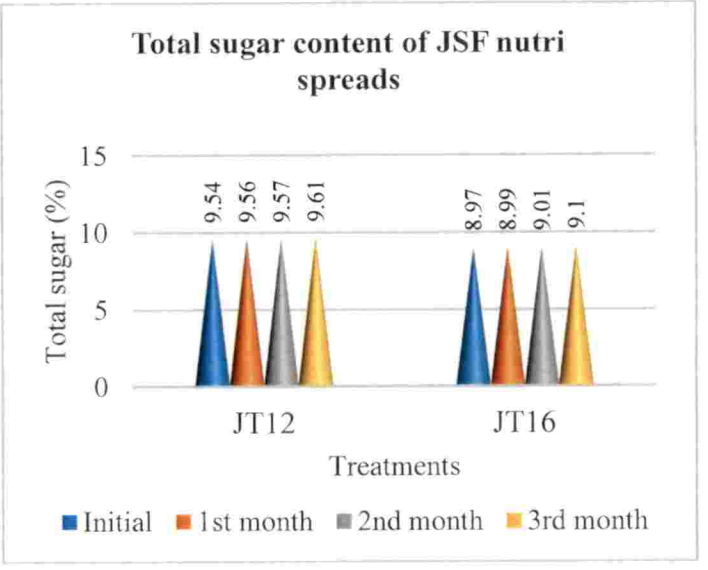


Fig.4b. Total sugar content (%) of nutri spreads stored under refrigerated condition

PP- Peanut paste, JSF- Jackfruit seed flour
PT_4 (60% PP+ 20% CB)
PT_9 (65% PP+ 15%UB)
PT_{15} (65% PP+ 15% HPO)
JT_{12} (25% JSF+ 55% UB)
JT_{16} (35% JSF+ 45% HPO)

presented in Figure 6b. Kumar (2015) formulated chocolate spread incorporating whey protein concentrate, cocoa powder, olive oil and butter fat which had a protein content of 6.54 per cent. Amevor *et al.* (2018) reported that cashew nut chocolate spread had a protein content ranged from 10.13 to 12.47 per cent. Goldin (1998) observed that, crude protein content decreased on storage which might be because of raise in the moisture absorption and production of free amino acids. Shazad *et al.* (2005) stated that there was a reduction in protein content on storage due to the moisture uptake from atmosphere and protein degradation of the stored product.

In the present study, initial carbohydrate content of selected nutri spreads varied from 19.86 to 36.78 g/100 g, the maximum carbohydrate content was observed in treatment JT_{12} and minimum protein content in JT_{16}. At the end of storage, carbohydrate content of the selected nutri spreads varied from 19.76 g /100 g to 36.70 g /100 g. The decrease in carbohydrate content of the sample stored at refrigeration temperature was slightly lesser than the sample stored at room temperature.

In the present study, calorific value of the selected nutri spreads varied from 422.00 to 520.02 Kcal /100 g initially which decreased to 418.26 to 518.65 Kcal/ 100 g after third month of storage and is presented in Figure 7a and 7b. The calorific value decreased on storage due to the direct influence of protein, carbohydrate and fat. Owusu (2012) reported that the calorific value of avocado fruit spread was 176.76 Kcal.

The total ash content of the selected nutri spreads initially varied between 0.90 (JT_{16}) to 2.38 (PT_9) per cent and is presented in Figure 8a. At end of storage, total ash content decreased with a range of 0.83 (JT_{16}) to 2.31 (PT_9) per cent and is presented in Figure 8b. Jeyarani *et al.* (2015) reported that total ash content present in omega-3 fatty acids enriched chocolate spreads using soybean and coconut oils varied from 0.90 to 2.89 per cent. Amevor *et al.* (2018) stated that the total ash content in cashew nut chocolate spreads varied from 1.31 to 1.85 per cent.

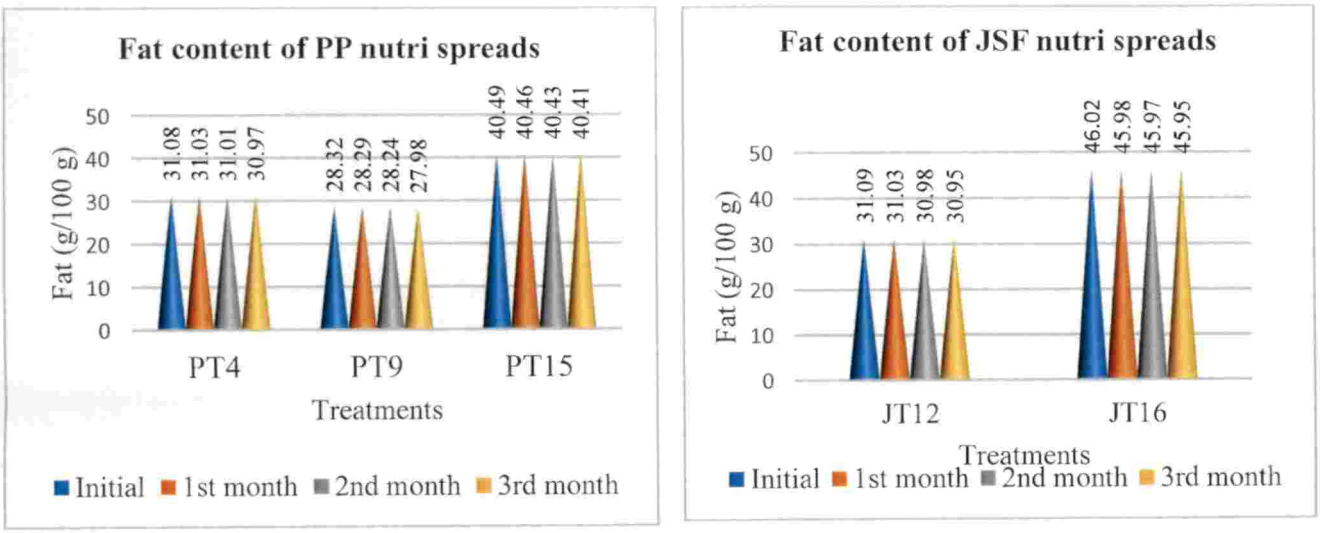


Fig. 5a. Fat content (g/100 g) of nutri spreads stored under ambient condition

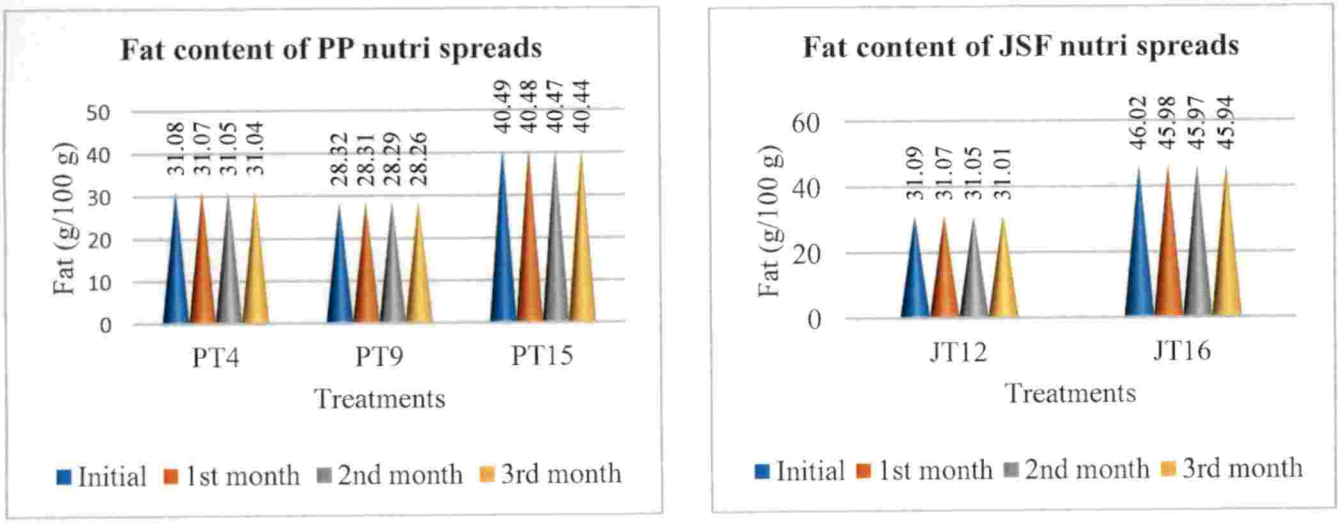
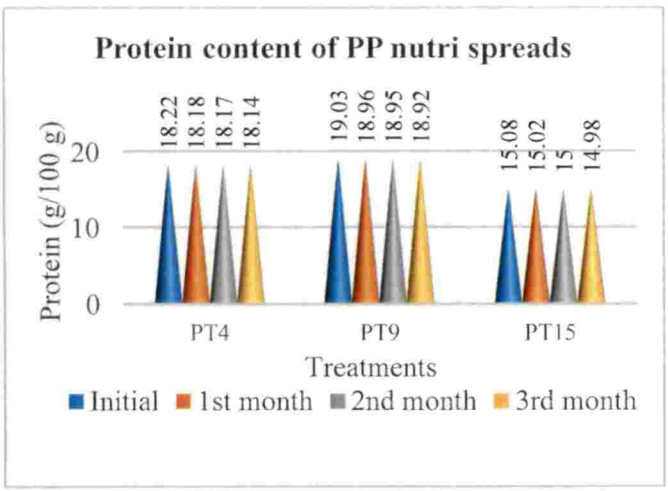


Fig.5b. Fat content (g/100 g) of nutri spreads stored under refrigerated condition

PP- Peanut paste, JSF- Jackfruit seed flour
PT_4 (60% PP+ 20% CB)
PT_9 (65% PP+ 15%UB)
PT_{15} (65% PP+ 15% HPO)
JT_{12} (25% JSF+ 55% UB)
JT_{16} (35% JSF+ 45% HPO)



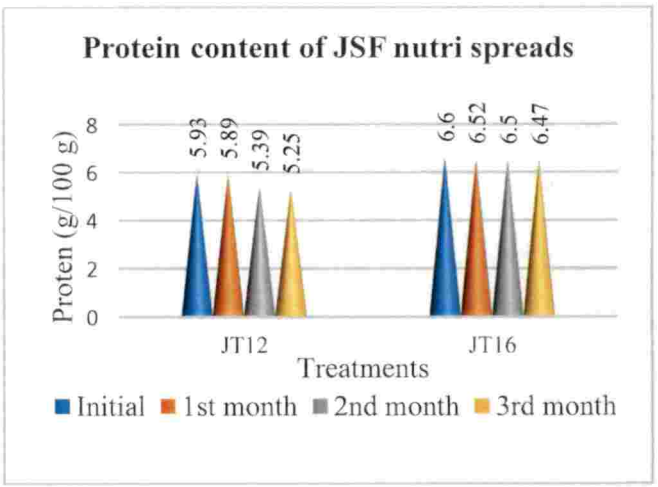
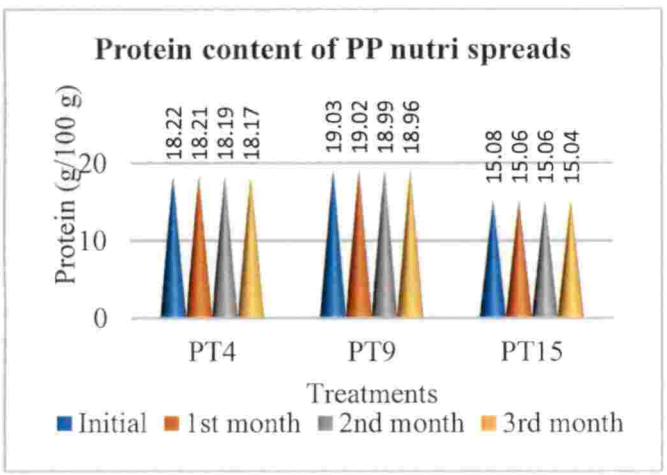


Fig. 6a. Protein content (g/100 g) of nutri spreads stored under ambient condition



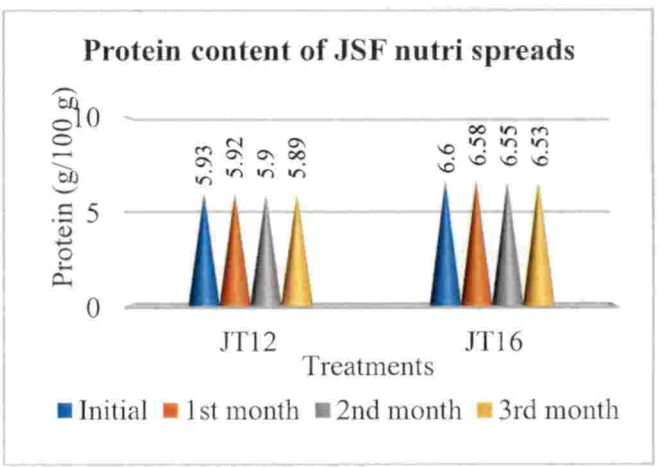


Fig.6b. Protein content (g/100 g) of nutri spreads stored under refrigerated condition

PP- Peanut paste, JSF- Jackfruit seed flour
PT_4 (60% PP+ 20% CB)
PT_9 (65% PP+ 15%UB)
PT_{15} (65% PP+ 15% HPO)
JT_{12} (25% JSF+ 55% UB)
JT_{16} (35% JSF+ 45% HPO)

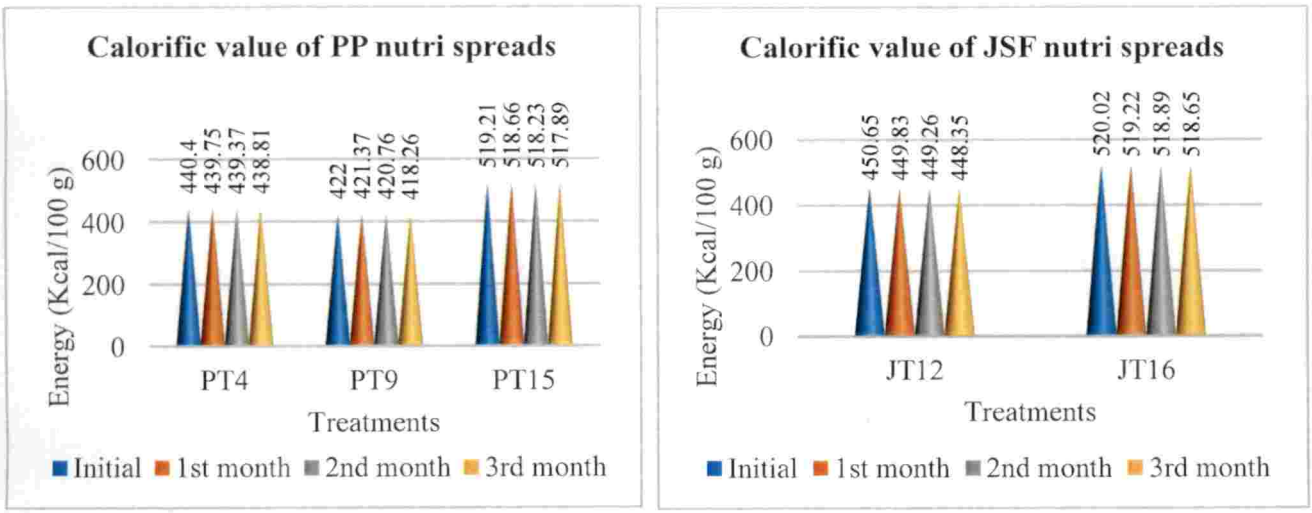


Fig.7a. Calorific value (Kcal/100 g) of nutri spreads stored under ambient condition

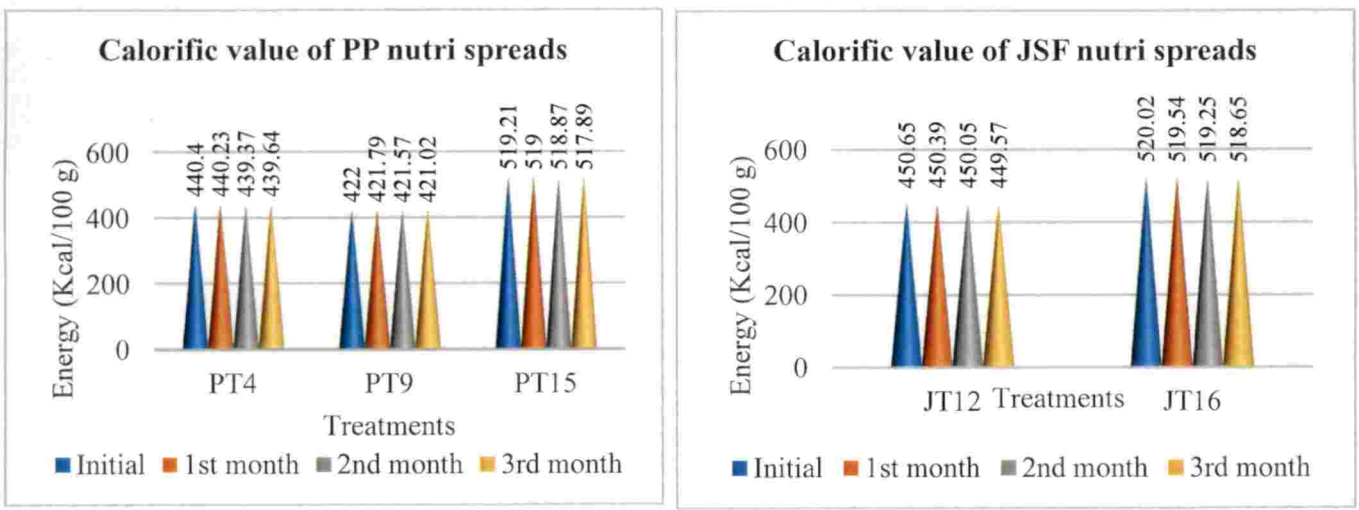


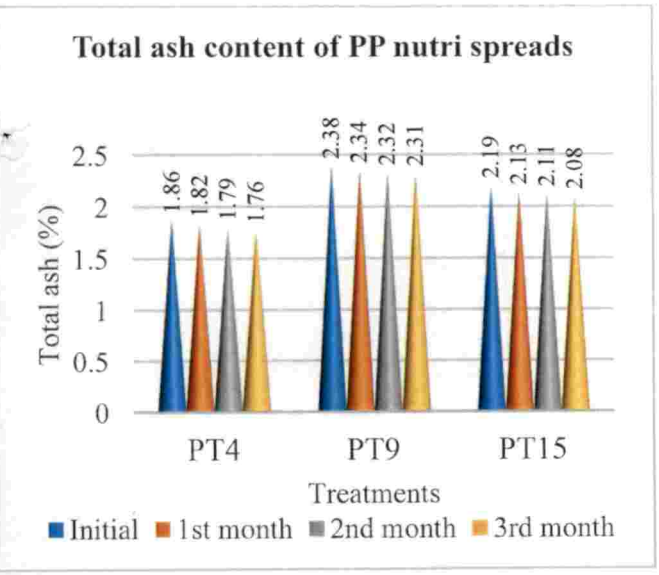
Fig.7b. Calorific value (Kcal/100 g) of nutri spreads stored under refrigerated condition

PP- Peanut paste, JSF- Jackfruit seed flour
PT_4 (60% PP+ 20% CB)
PT_9 (65% PP+ 15%UB)
PT_{15} (65% PP+ 15% HPO)
JT_{12} (25% JSF+ 55% UB)
JT_{16} (35% JSF+ 45% HPO)

Among the selected nutri spreads calcium, phosphorus and zinc content was observed to be the highest in JT_{16} of 16.5 mg 100 g^{-1}, 3.15 mg 100 g^{-1}, 0.67 mg 100 g^{-1}. Iron content was observed to be the highest in PT_{15} of 2.59 mg 100 g^{-1}. Sodium and potassium content varied from 4.99 to 12.59 mg 100 g^{-1} and 27.60 to 41.41 mg 100 g^{-1} initially and are presented in Figure 9a, 10a, 11a, 12a, 13a and 14a. The mineral content decreased on storage in the developed nutri spreads. The decrease in mineral content of the sample stored at refrigeration temperature was slightly lesser than the sample stored at room temperature and are presented in Figure 9b, 10b, 11b, 12b, 13b and 14b. Rangaswami and Bagyaraj (2000) stated that the mineral content of the product reduced on storage because of the use of available nutrients by the microbes present within the products. A similar result was observed by Sharon (2010), Lakshmy (2011), Mohan (2014), Anaveri (2016), Chandraprabha (2017), Ajisha (2017) and Reshma (2017). They observed that mineral content of the products decreased on storage.

5.2.2. Changes in organoleptic qualities

The selected nutri spreads were evaluated for the organoleptic qualities. The evaluation was done initially and at monthly intervals, for a period of three months of storage under ambient and refrigerated conditions. The mean score for overall acceptability obtained for selected PP based nutri spreads, initially varied from 7.37 to 8.28 and are presented in Figure 15a. The mean score obtained for overall acceptability of selected JSF based nutri spreads, initially varied from 7.26 to 8.88 and presented in Figure 16a. During storage, under both ambient and refrigerated condition, sensory qualities of all the nutri spreads decreased. Among PP based nutri spread, stored under ambient condition, mean score for overall acceptability was found to be the highest in PT_{15} (7.46) by the end of the storage. This indicate that PT_{15} (65% PP+15% HPO) was acceptable by the end of storage period. Among JSF based nutri spreads, mean score for overall acceptability was found to be the highest in JT_{16} (35% JSF+ 45% HPO) throughout the storage period at ambient condition. Under refrigerated condition, by the end of third month of storage, a slight decrease in the mean scores of overall acceptability was observed and are



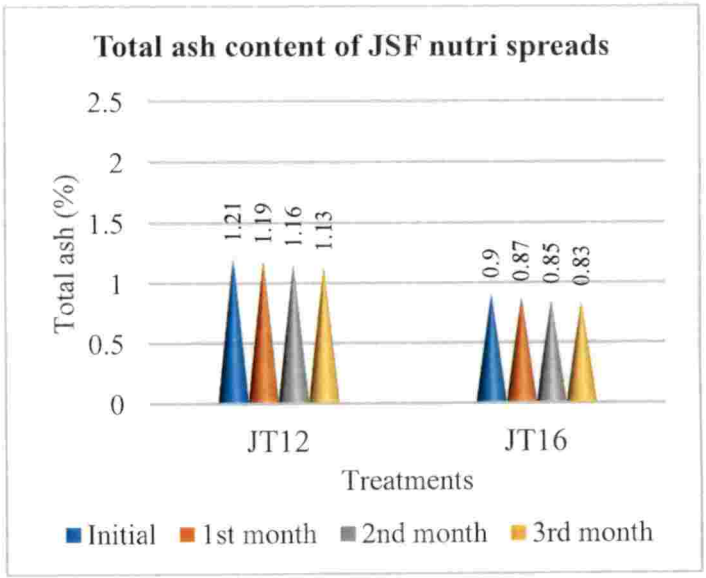
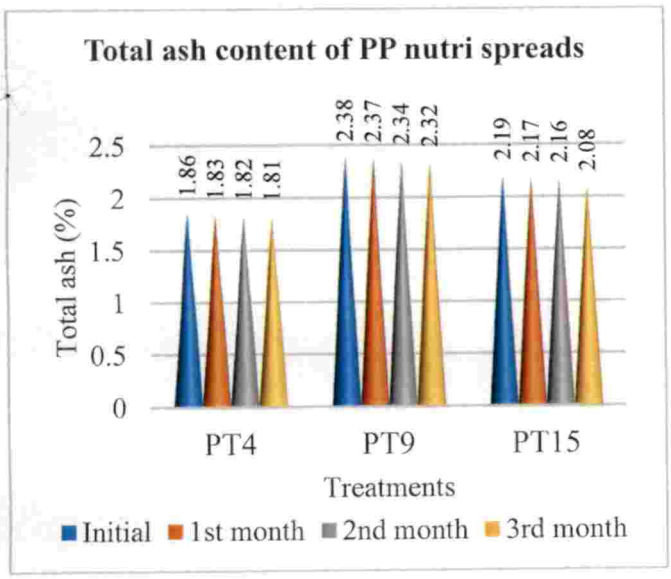


Fig.8a. Total ash content (%) of nutri spreads stored under ambient condition



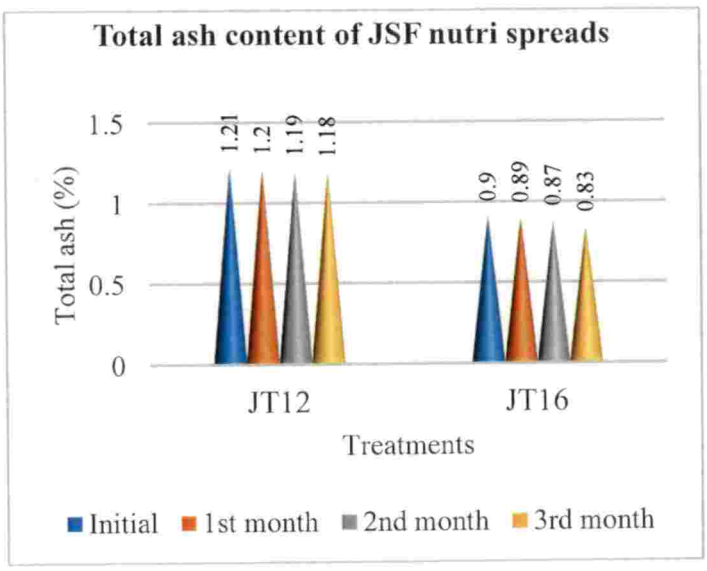
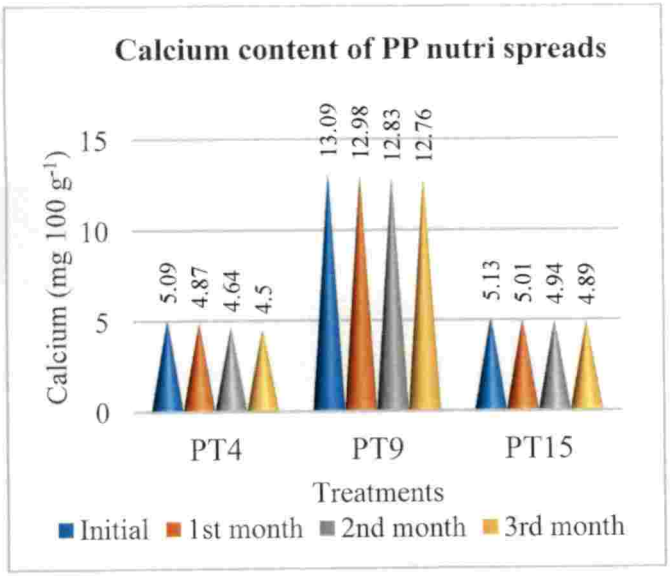


Fig. 8b. Total ash content (%) of nutri spreads stored under refrigerated condition

PP- Peanut paste, JSF- Jackfruit seed flour
PT_4 (60% PP+ 20% CB)
PT_9 (65% PP+ 15%UB)
PT_{15} (65% PP+ 15% HPO)
JT_{12} (25% JSF+ 55% UB)
JT_{16} (35% JSF+ 45% HPO)



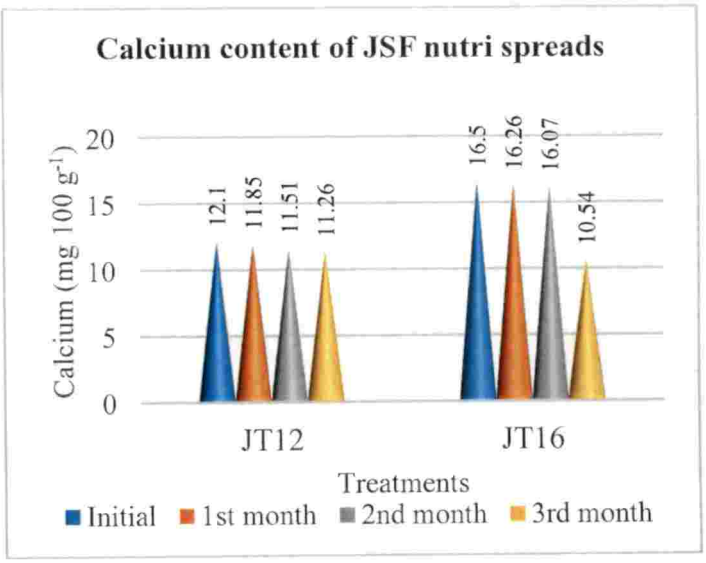
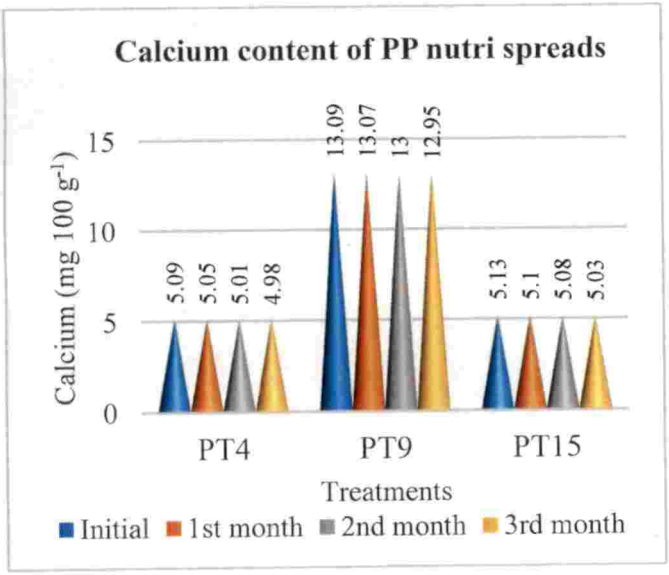


Fig.9a. Calcium content (mg 100 g^{-1}) of nutri spreads stored under ambient condition



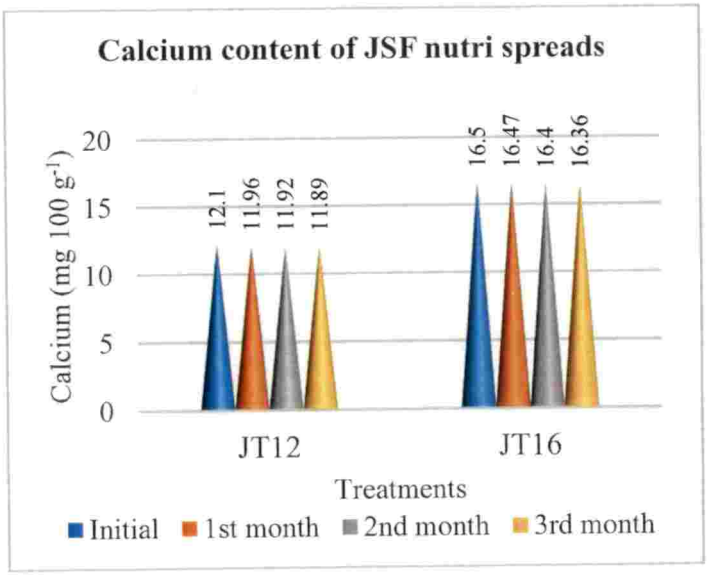
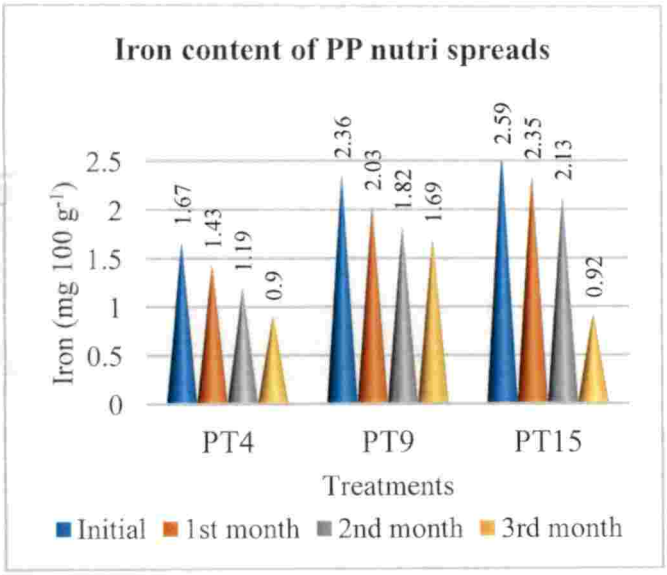


Fig. 9b. Calcium content (mg 100 g^{-1}) of nutri spreads stored under refrigerated condition

PP- Peanut paste, JSF- Jackfruit seed flour
PT_4 (60% PP+ 20% CB)
PT_9 (65% PP+ 15%UB)
PT_{15} (65% PP+ 15% HPO)
JT_{12} (25% JSF+ 55% UB)
JT_{16} (35% JSF+ 45% HPO)



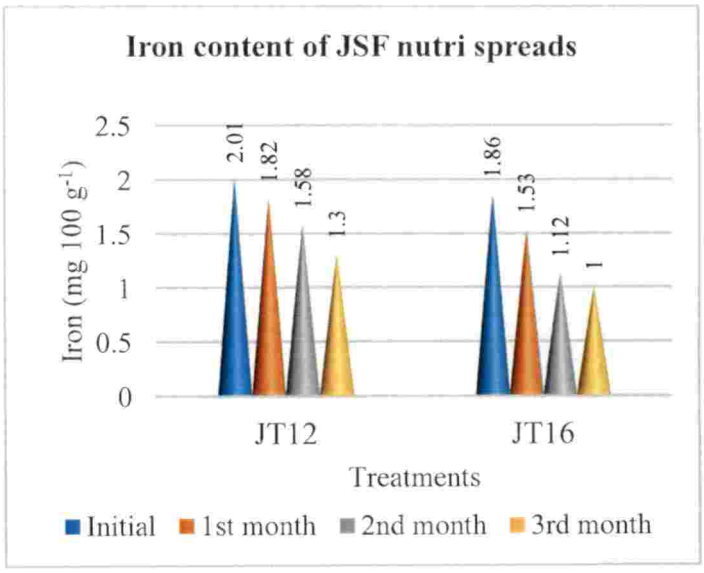
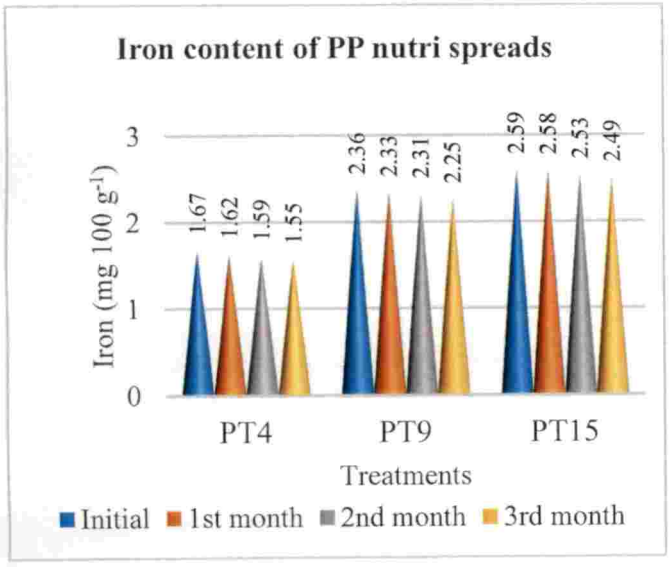


Fig.10a. Iron content (mg 100 g^{-1}) of nutri spreads stored under ambient condition



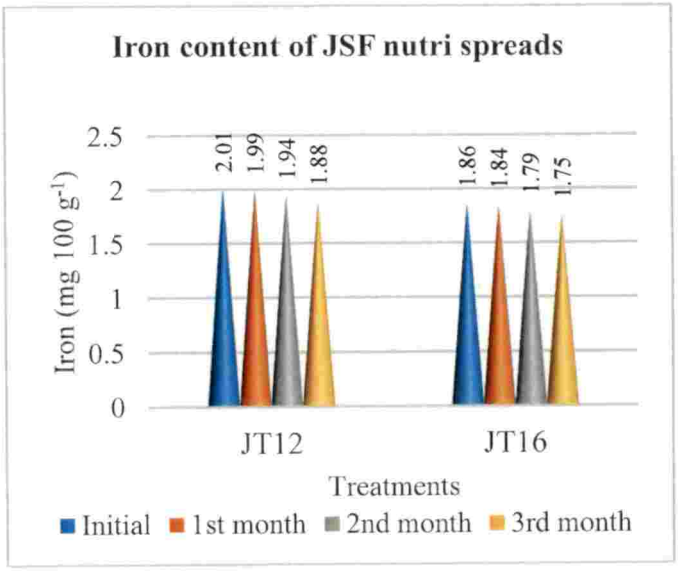


Fig.10b. Iron content (mg 100 g^{-1}) of nutri spreads stored under refrigerated condition

PP- Peanut paste, JSF- Jackfruit seed flour
PT_4 (60% PP+ 20% CB)
PT_9 (65% PP+ 15%UB)
PT_{15} (65% PP+ 15% HPO)
JT_{12} (25% JSF+ 55% UB)
JT_{16} (35% JSF+ 45% HPO)

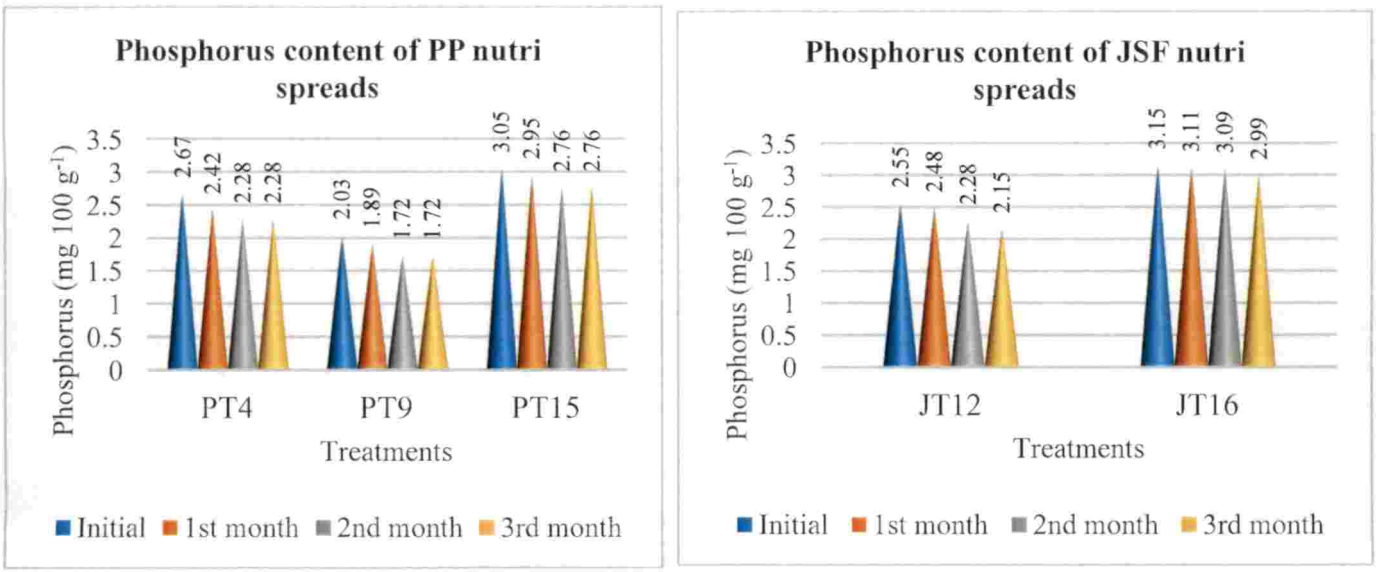


Fig.11a. Phosphorus content (mg 100 g^{-1}) of nutri spreads stored under ambient condition

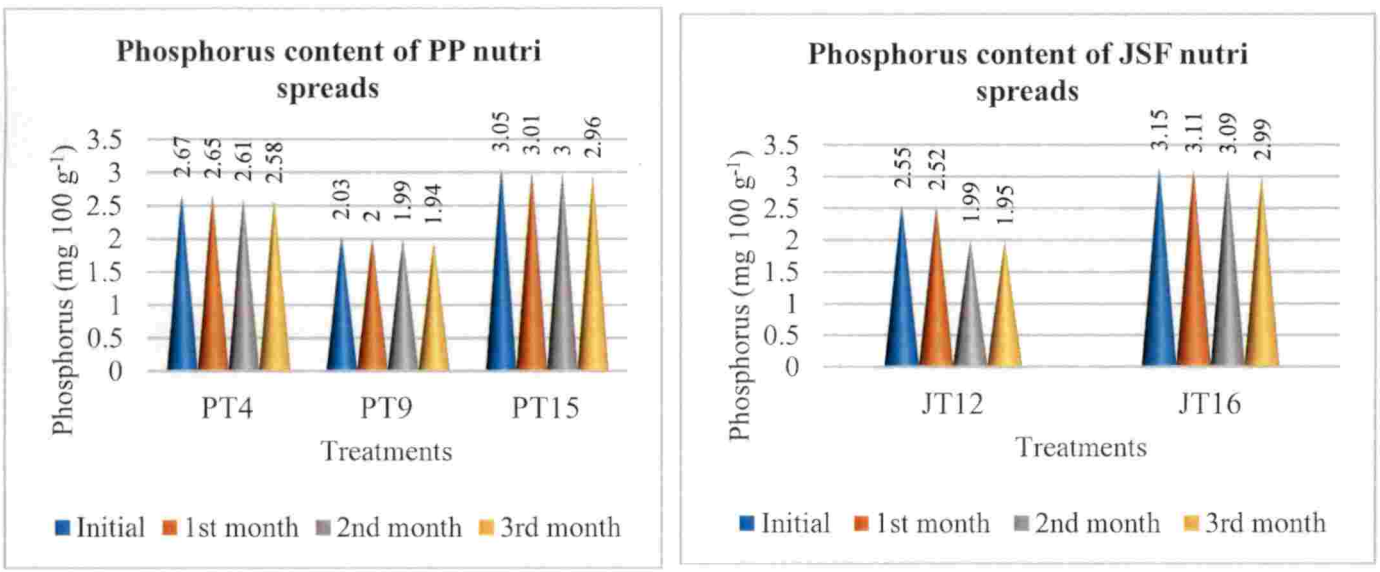


Fig.11b. Phosphorus content (mg 100 g^{-1}) of nutri spreads stored under refrigerated condition

PP- Peanut paste, JSF- Jackfruit seed flour
PT_4 (60% PP+ 20% CB)
PT_9 (65% PP+ 15%UB)
PT_{15} (65% PP+ 15% HPO)
JT_{12} (25% JSF+ 55% UB)
JT_{16} (35% JSF+ 45% HPO)

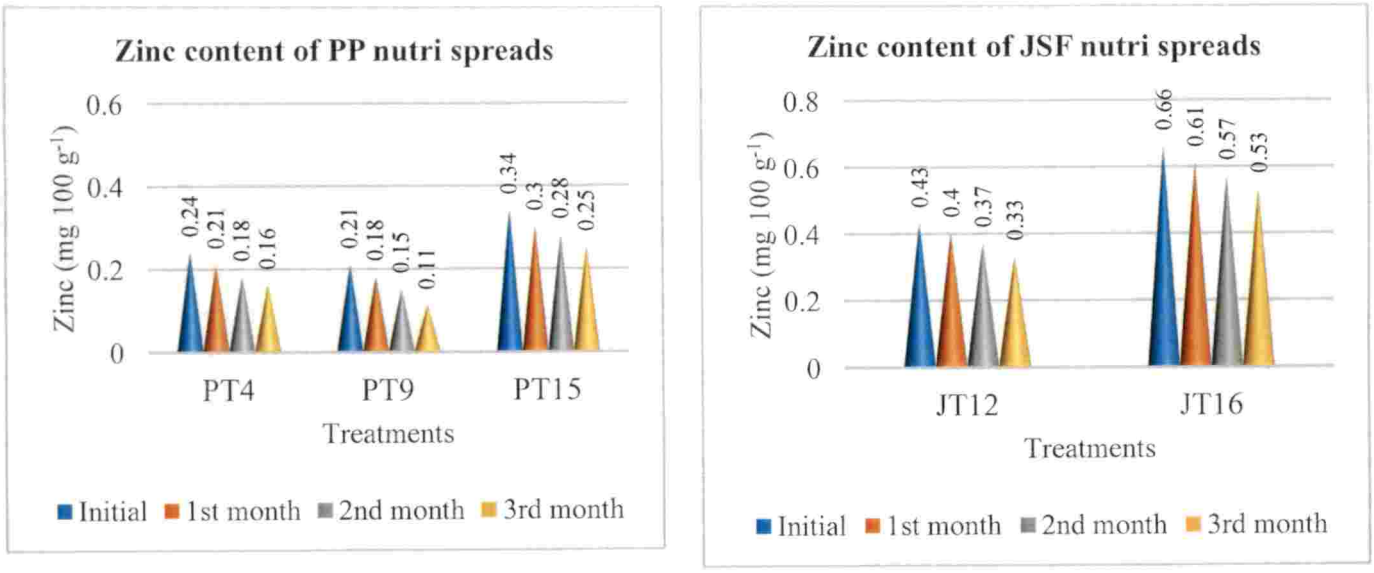


Fig.12a. Zinc content (mg 100 g^{-1}) of nutri spreads stored under ambient condition

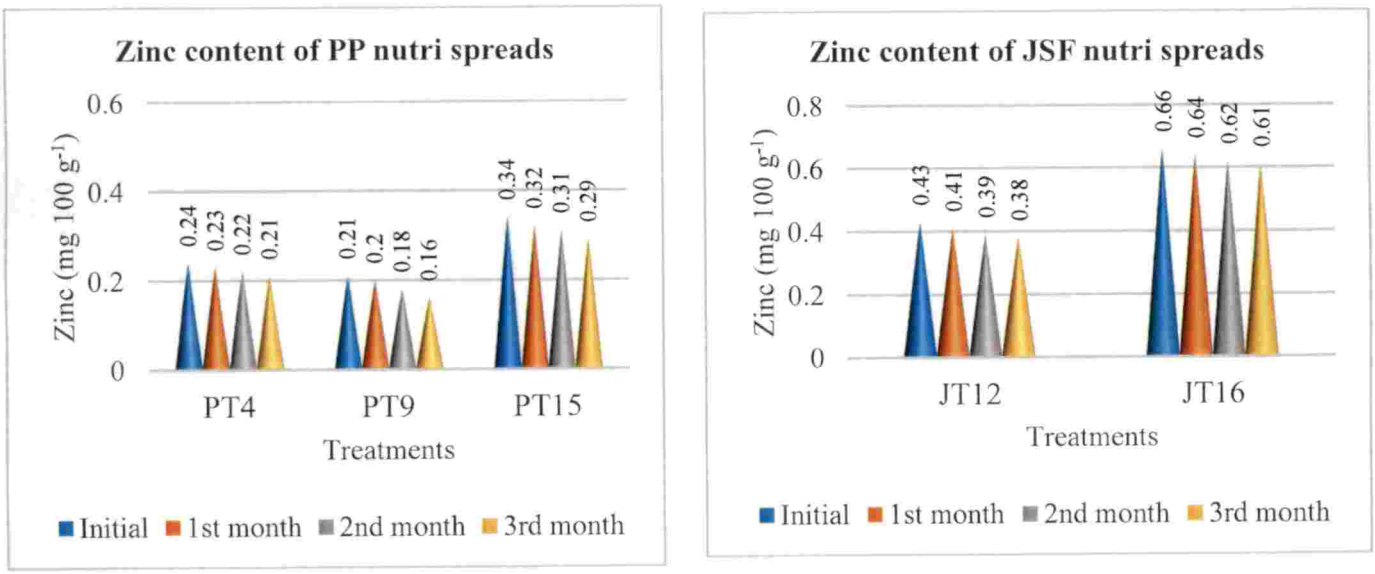
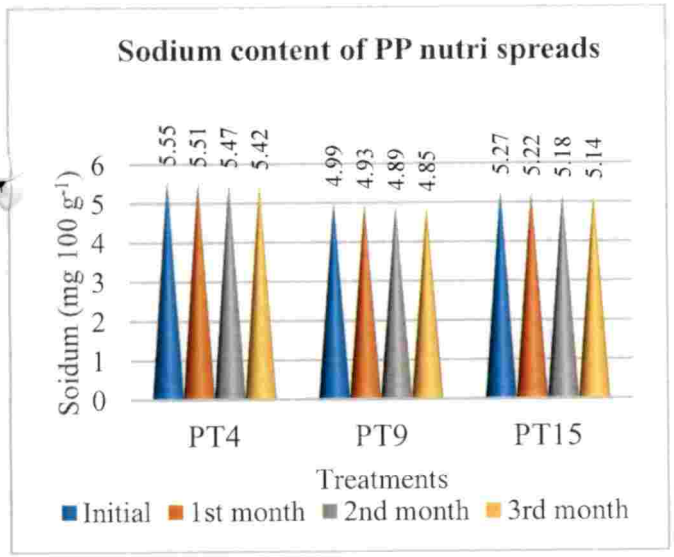


Fig.12b. Zinc content (mg 100 g^{-1}) of nutri spreads stored under refrigerated condition

PP- Peanut paste, JSF- Jackfruit seed flour
PT_4 (60% PP+ 20% CB)
PT_9 (65% PP+ 15%UB)
PT_{15} (65% PP+ 15% HPO)
JT_{12} (25% JSF+ 55% UB)
JT_{16} (35% JSF+ 45% HPO)



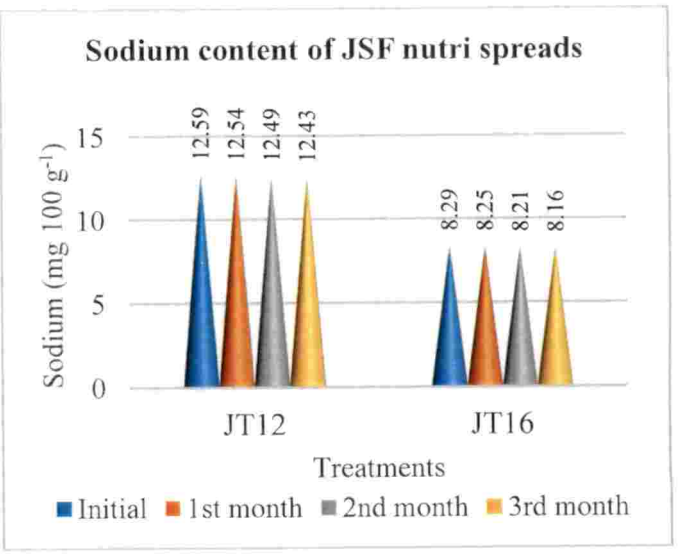
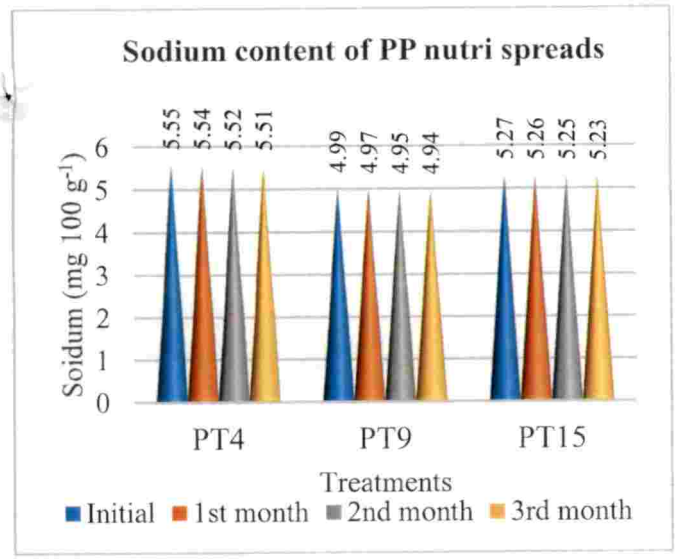


Fig.13a. Sodium content (mg 100 g^{-1}) of nutri spreads stored under ambient condition



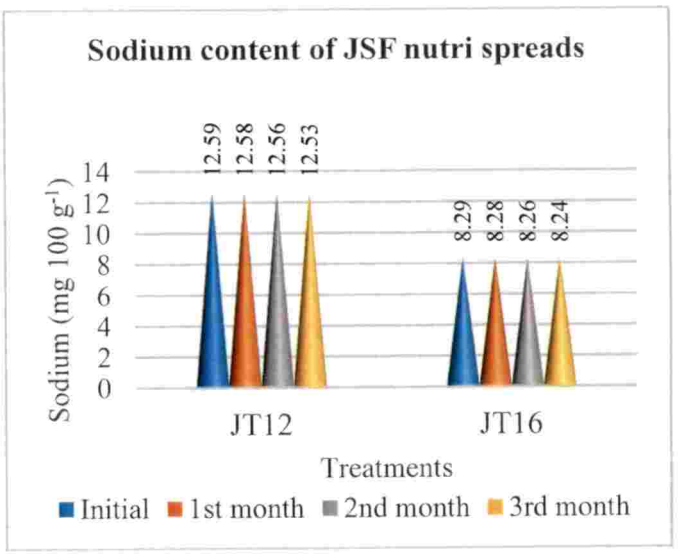
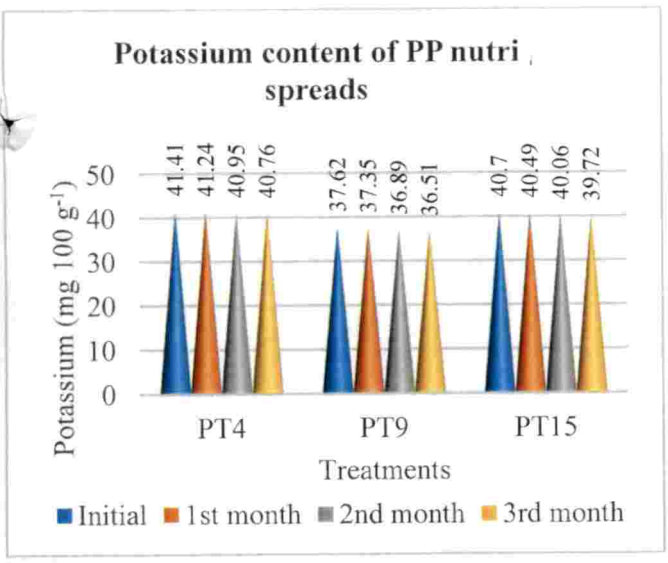


Fig.13b. Sodium content (mg 100 g^{-1}) of nutri spreads stored under refrigerated condition

PP- Peanut paste, JSF- Jackfruit seed flour
PT_4 (60% PP+ 20% CB)
PT_9 (65% PP+ 15%UB)
PT_{15} (65% PP+ 15% HPO)
JT_{12} (25% JSF+ 55% UB)
JT_{16} (35% JSF+ 45% HPO)



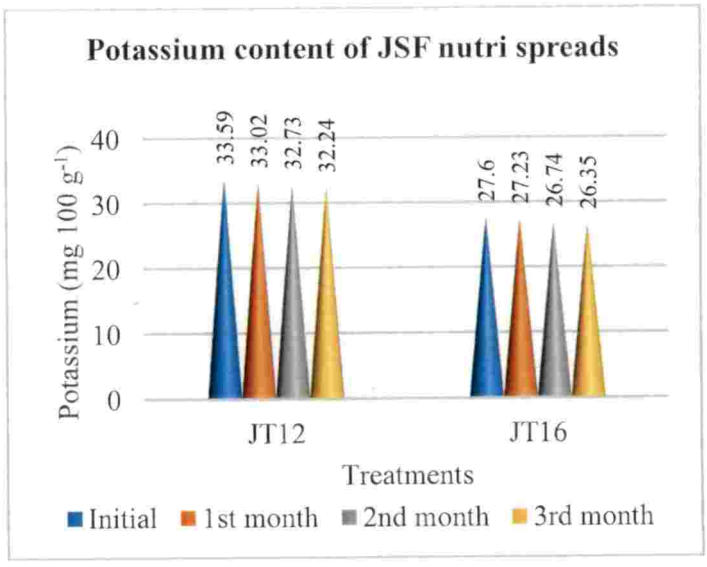
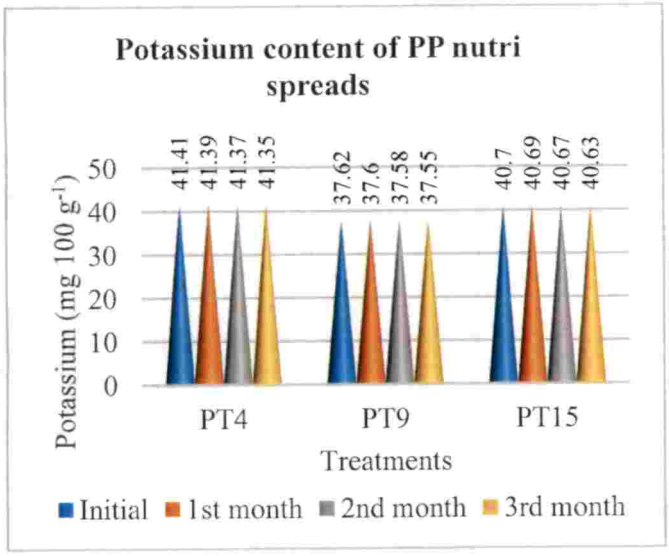


Fig.14a. Potassium content (mg 100 g^{-1}) of nutri spreads stored under ambient condition



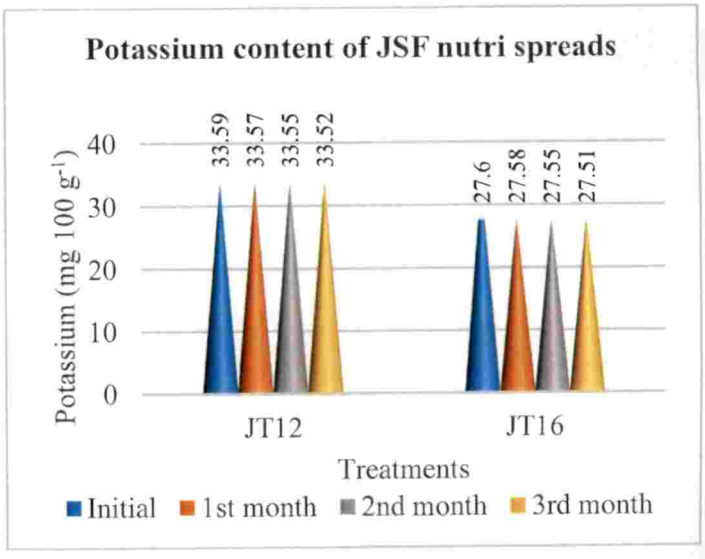


Fig.14b. Potassium content (mg 100 g^{-1}) of nutri spreads stored under refrigerated condition

PP- Peanut paste, JSF- Jackfruit seed flour
PT_4 (60% PP+ 20% CB)
PT_9 (65% PP+ 15%UB)
PT_{15} (65% PP+ 15% HPO)
JT_{12} (25% JSF+ 55% UB)
JT_{16} (35% JSF+ 45% HPO)

presented in Figure 15b and 16b. In JSF nutri spreads, the mean score for overall acceptability was observed in JT_{12} (6.71) and JT_{16} (8.37) respectively.

Samsudin (2006) found that the use of hydrogenated palm oil in spreads were more stable against oil separation at room temperature (30°C). It increase the spreadability and mouthfeel of products.

Chauhan *et al.* (2012) observed that the jam prepared from tender coconut pulp and pineapple pulp showed good sensory acceptability after 6 months of storage at room and refrigerated conditions. Shahanas (2014) formulated fruit based spreads which were found to be highly acceptable in sensory properties upto 6 months of storage. Sindumathi and Amutha (2014) observed that the mean score for all the quality attributes was initially 9.00 for jam based on coconut packed in glass bottles and PET containers and was shelf stable upto 180 days.

5.2.3. Changes in microbial qualities

In the present study, the selected nutri spreads were evaluated for bacteria, fungi and yeast. The presence of bacteria, yeast or mould was not detected initially. After first month of the storage, the bacterial load present in selected nutri spreads varied from 0.02 x 10^6 cfu/g to 0.43 x 10^6 cfu/g. The bacterial load increased during storage. The fungal colony for the selected nutri spreads were not observed in initial and first month of storage. After second month of storage, the fungal colony was observed with a variation of 0.01 x 10^3 cfu/g (PT_{15}) to 0.83 (JT_{12}) x 10^3 cfu/g. At end of the storage, the fungal colonies were increased and varied from 0.03 x 10^3 cfu/g (PT_{15}) to 1.02 (JT_{12}) x 10^3 cfu/g. There was no yeast in any of the selected nutri spreads throughout the storage period at ambient condition.

The presence of bacteria was not detected initially and after first month of storage under refrigerated condition. After second month of the storage, the bacterial load present in selected nutri spreads varied from 0.01 x 10^6 cfu/g to 0.03 x 10^6 cfu/g. The bacterial load increased slightly during storage. The fungal colonies and yeast colonies were not detected throughout the storage. The low moisture content and water activity showed higher storability of the period. Within the

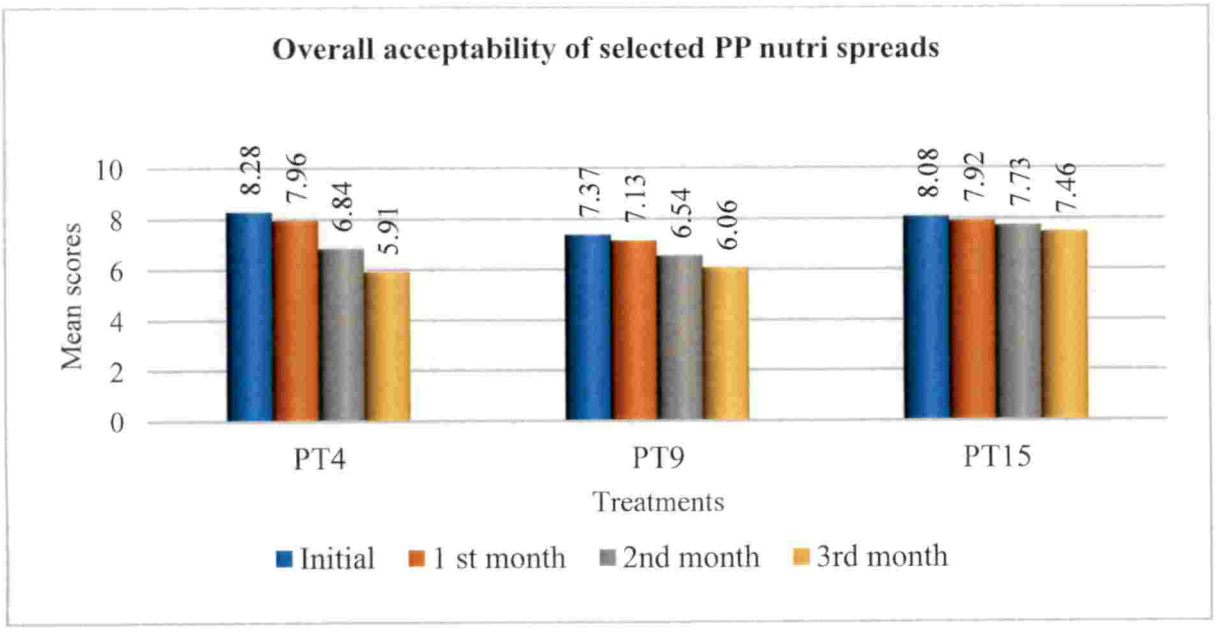


Fig. 15a. Mean scores for overall acceptability of selected PP nutri spreads during storage at ambient condition

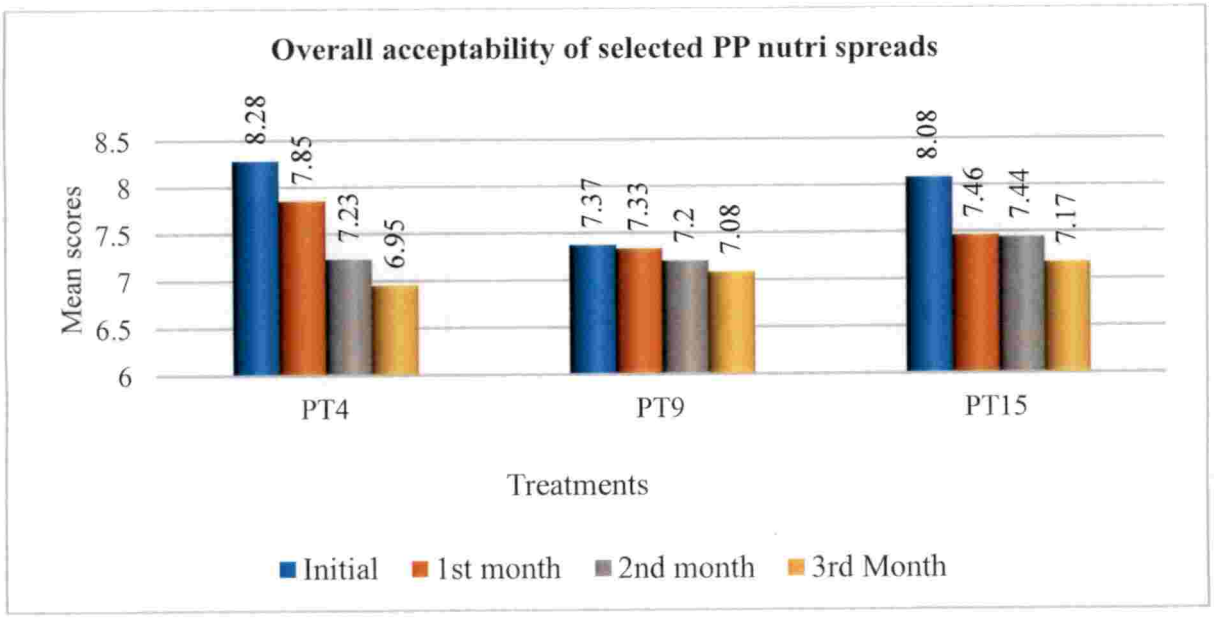


Fig. 15b. Mean scores for overall acceptability of selected PP nutri spreads during storage at refrigerated condition

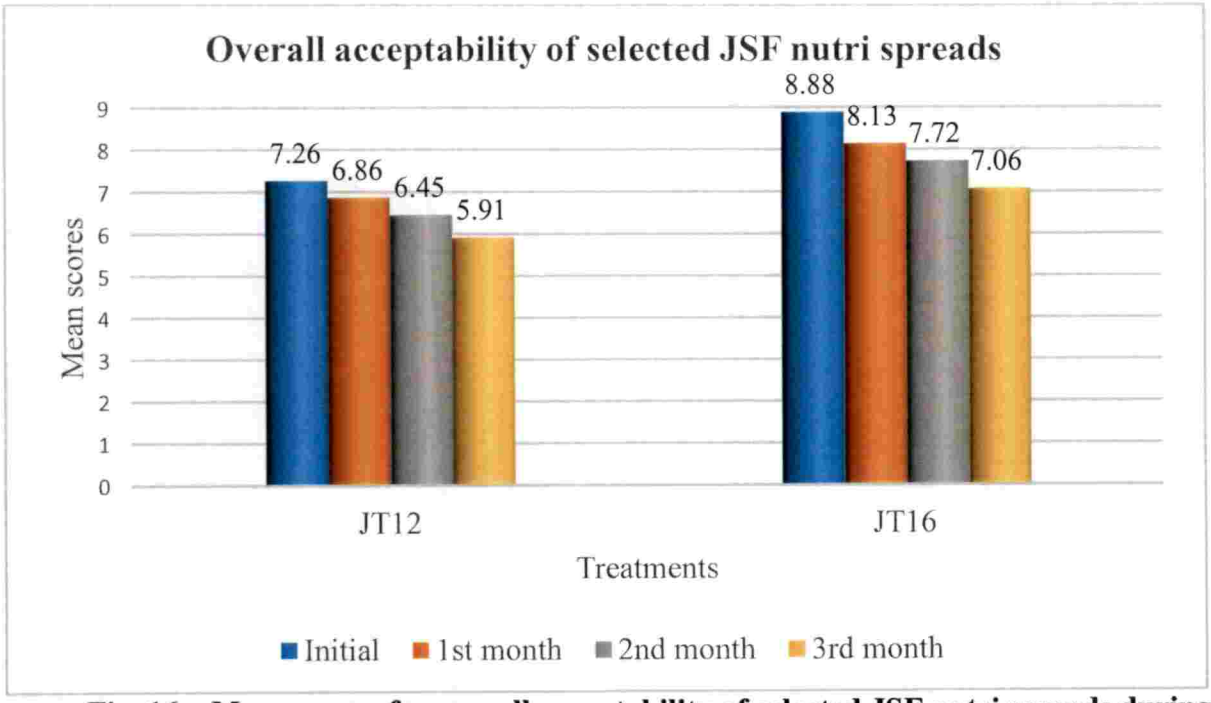


Fig. 16a. Mean scores for overall acceptability of selected JSF nutri spreads during storage at ambient condition

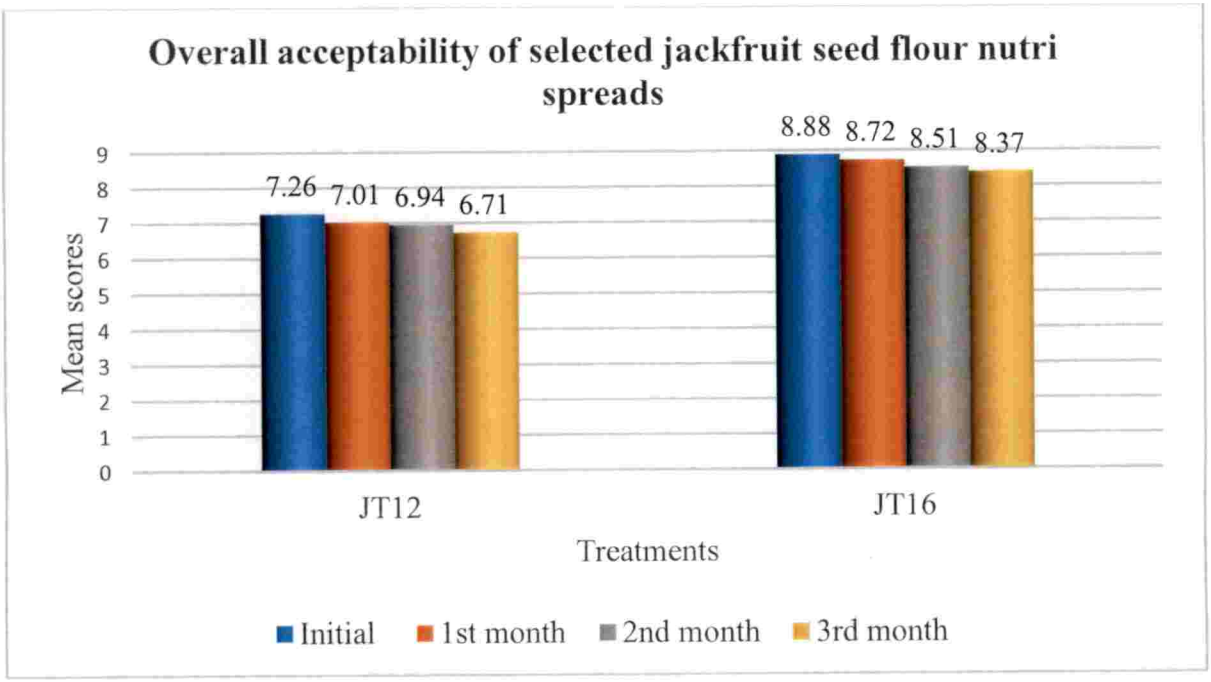


Fig. 16b. Mean scores for overall acceptability of selected JSF nutri spreads during storage at refrigerated condition

present study microbial growth raised on storage which may be related to moisture uptake of the product. Bera *et al.* (2001) stated that moisture content, relative humidity, storage temperature are the parameters that directly influence the microbic load.

Rozail *et al.* (2016) observed that the peanut butter and other nut butter products are microbiologically stable and safe for consumption because of the low water activity between 0.22–0.30 as it cannot support the growth and proliferation of microbes. The presence of microbes was not detected in peanut butter samples during the 16 weeks of storage at ambient and refrigerated conditions.

5.3. Enrichment of the developed spreads with protein sources

The selected two combinations that is PT_{15} (65% PP+ 15% HPO) and JT_{16} (35% JSF+ 45% HPO) were enriched using two protein sources *viz.* defatted soya flour (DSF) and skimmed milk powder (SMP). These protein sources were incorporated to the base material in both selected spreads in varying percentage levels (10%, 20%, 30%, 40% and 50%).

5.3.1. Organoleptic evaluation of enriched nutri spreads

Organoleptic evaluation of enriched nutri spreads were carried out separately.

Among peanut paste nutri spreads enriched with defatted soya flour (DSF), the treatment PT_1 (90 % PP + 10% DSF) secured the highest mean score of 8.00 and above for all quality attributes like appearance, colour, flavour, texture, taste and overall acceptability. The organoleptic qualities decreased as the content of DSF increased in the combination with peanut paste. Addition of 10 per cent DSF resulted in a highly acceptable product and hence 10 per cent enrichment was found to be desirable in spreads prepared with peanut paste.

In the present study, peanut paste (PP) nutri spread enriched with skimmed milk powder (SMP), the treatment PT_7 (80% PP+ 20% SMP) had the highest mean score for all the sensory attributes like appearance (8.66), colour (8.33), flavour (8.66), texture (8.66), taste (8.66) and overall acceptability (8.55). In enriched nutri

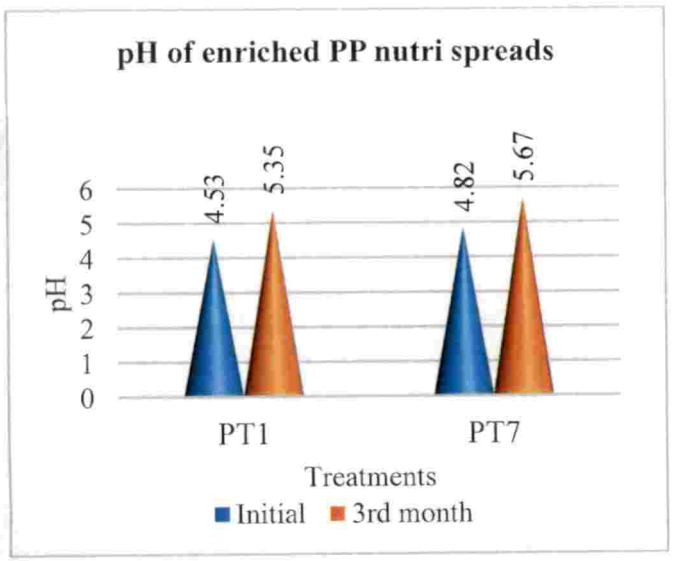
spreads added with skimmed milk powder, 20 per cent incorporation of skimmed milk powder resulted in highest sensory scores. When the proportion of SMP increased beyond 20 per cent, the textural qualities reduced considerably.

Among JSF nutri spreads enriched with defatted soya flour (DSF), the treatment JT_2 (80% JSF + 20% DSF) secured highest mean score of 8.00 and above for all quality attributes like appearance, colour, flavor, texture, taste and overall acceptability. For enrichment of JSF spreads, 20 per cent incorporation of defatted soya flour was found to be desirable.

In the present study, jackfruit seed flour (JSF) nutri spread enriched with skimmed milk powder (SMP), treatment JT_8 (70% JSF + 30% SMP) had a highest mean score in all the sensory attributes like appearance (8.88), colour (8.44), flavour (8.22), texture (9.00), taste (8.66) and overall acceptability (8.66). In enriched JSF, 30 per cent incorporation of skimmed milk powder was found to be the most acceptable. When the percentage of skimmed milk powder increased, the appearance, colour, flavour and texture decreased significantly.

Patel and Gupta (1988) suggested that adding of 5 per cent and 10 per cent skim milk powder (SMP) enhanced flavour and texture characteristics of spread. Deshpande and Thompkinson (2000) observed that proteins were added to the spread, which imparted a creamy appearance and taste, thereby raising the consumer acceptability. Wilson and David (2017) observed that 9 percent soya protein along with 0.6 percent lecithin and 4 per cent dietary fibre has the high scores for texture and overall acceptability in soy spread.

Four best protein enriched combinations of spreads, two each from peanut paste, that is PT_1 (90% PP+ 10% DSF) and PT_7 (80% PP+ 20% SMP) and two each from jackfruit seed flour that is JT_2 (80% JSF+ 20% DSF) and JT_8 (70% JSF+ 30% SMP) were selected based on the organoleptic qualities



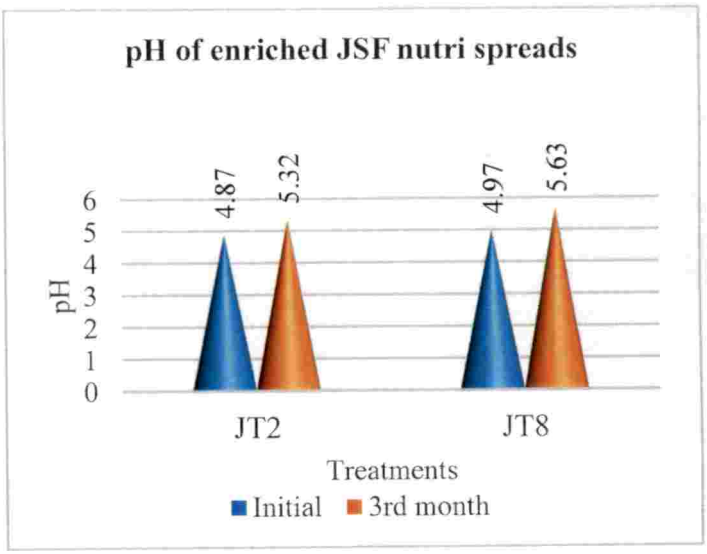
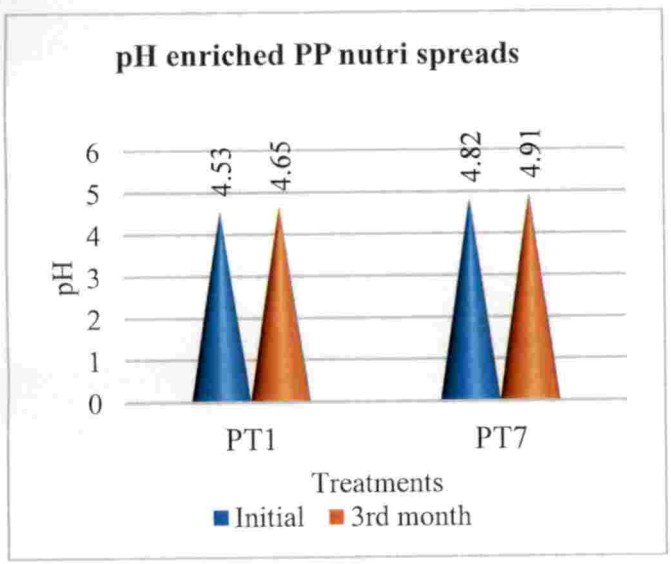


Fig.17a. pH of enriched nutri spreads stored under ambient condition



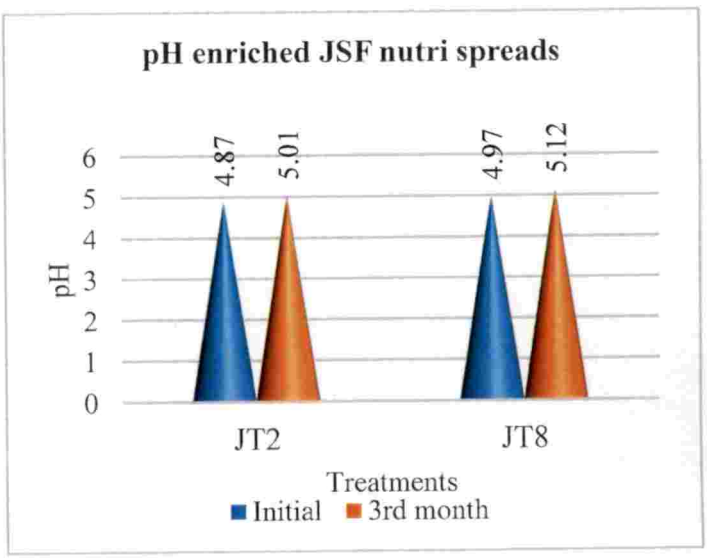


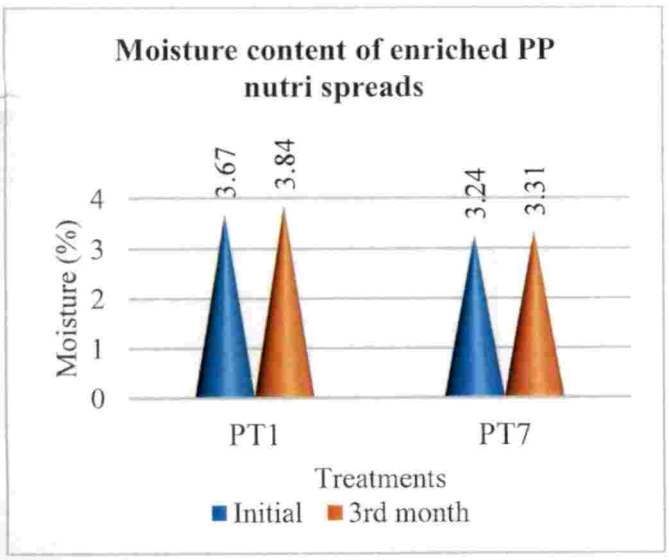
Fig.17b. pH of enriched nutri spreads stored under refrigerated condition

PP- Peanut paste, JSF- Jackfruit seed flour
PT_1 (90% PP+ 10% DSF)
PT_7 (80% PP+ 20% SMP)
JT_2 (80% PP+ 20% DSF)
JT_8 (70% PP + 30% SMP)

5.3.2. Changes in physico-chemical qualities of the enriched nutri spreads

The pH of the enriched nutri spreads initially varied from 4.53 to 4.97 with minimum in treatment PT_1 prepared using 58.5 per cent of PP and 6.5 per cent of DSF and maximum in JT_8 prepared using 24.5 per cent of JSF and 10.5 per cent of SMP and are presented in Figure 17a. At end of storage, pH increased with a range of 5.32 to 5.67 per cent with the maximum in JT_8 and minimum in JT_2. Under refrigerated condition, the pH varied from 4.65 to 5.12 at end of the storage period. The increase in pH of the sample stored at refrigeration temperature was slightly lesser than the sample stored at room temperature and are presented in Figure 17b. These finding are in accordance with Rahman *et al.* (2015), who observed that, there was a rise in pH value from 7.6 to 8.6 in soymilk fat spread. A slight increase in pH was observed in soymilk fat spread stored at different temperatures during 10 days of storage.

The moisture content of the enriched nutri spreads initially varied from 3.24 to 3.79 per cent with the minimum in treatment PT_7 (80% PP+ 20% SMP) and maximum in JT_2 (80% JSF+ 20% DSF) under ambient condition. At end of storage, moisture content increased and it was the maximum in PT_1 (3.72%) and minimum in JT_8 (4.02%) and are presented in Figure 18a and 18b. The same trend was observed in nutri spreads stored under refrigerated condition also. The increase in moisture content of the sample stored at refrigeration temperature was slightly lesser than the sample stored at room temperature. The moisture intake was influenced by temperature and time of storage. He and Hoseney (1990) stated that temperature, humidity and permeablity of the material is a very important parameter to extend the moisture absorption capacity of the product. Naran (2005) observed that the moisture in defatted soya flour added ground nut spreads were 1.34 per cent and also observed that the moisture content in whey protein concentrate added ground nut spreads was 1.07 per cent. Honfo *et al.* (2011) stated that the moisture content in shea butter was increased during storage. Initially the moisture content present in shea butter was 4.9 per cent. After 2 months of storage, the moisture



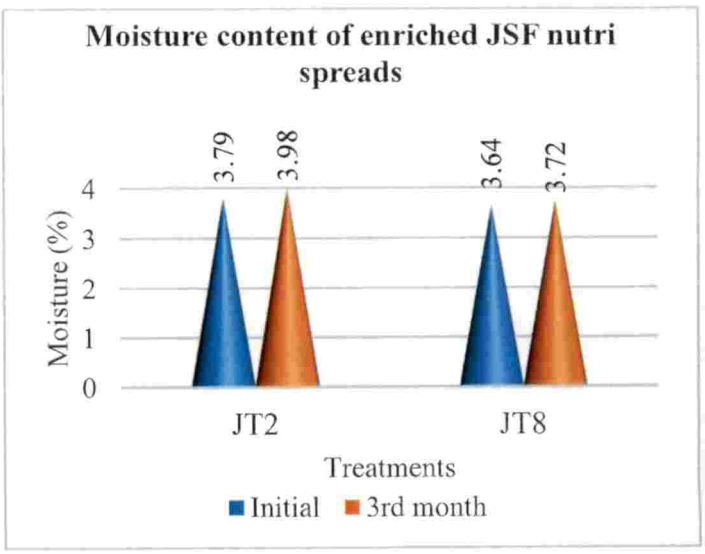
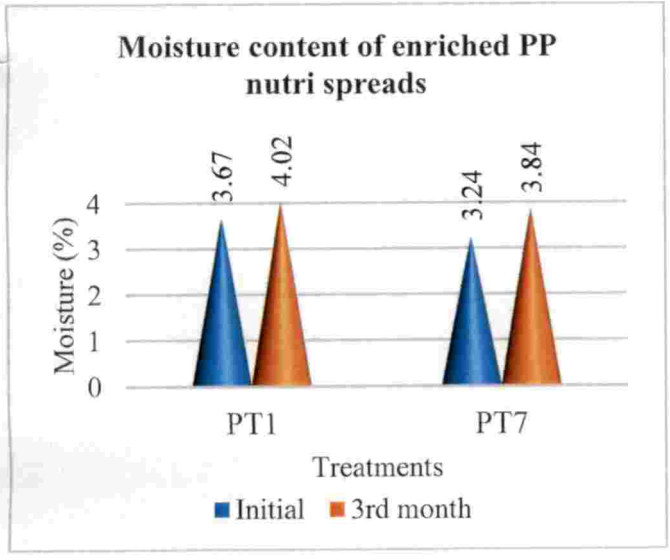


Fig. 18a. Moisture content (%) of enriched nutri spreads stored under ambient condition



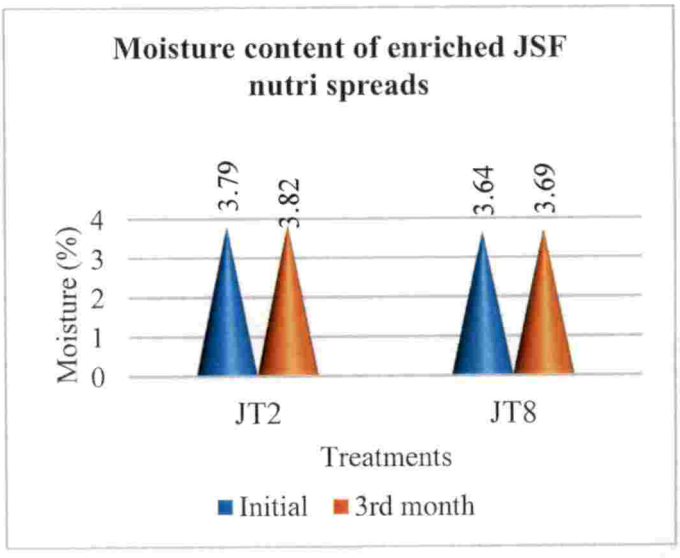
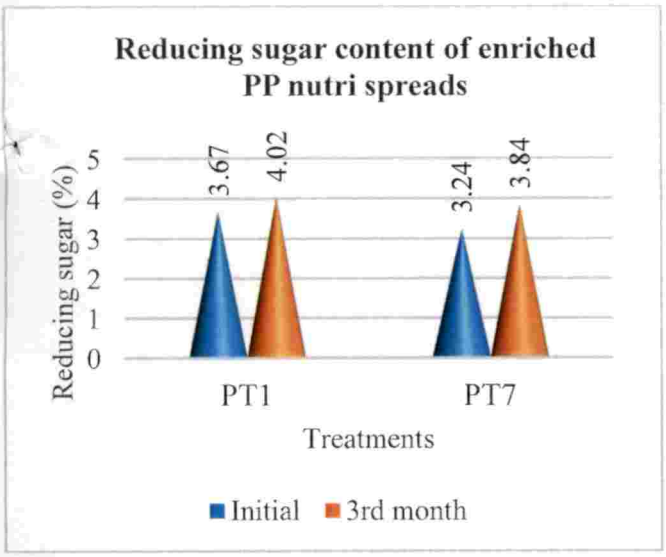


Fig.18b. Moisture content (%) of enriched nutri spreads stored under refrigerated condition

PP- Peanut paste, JSF- Jackfruit seed flour
PT_1 (90% PP+ 10% DSF)
PT_7 (80% PP+ 20% SMP)
JT_2 (80% PP+ 20% DSF)
JT_8 (70% PP + 30% SMP)



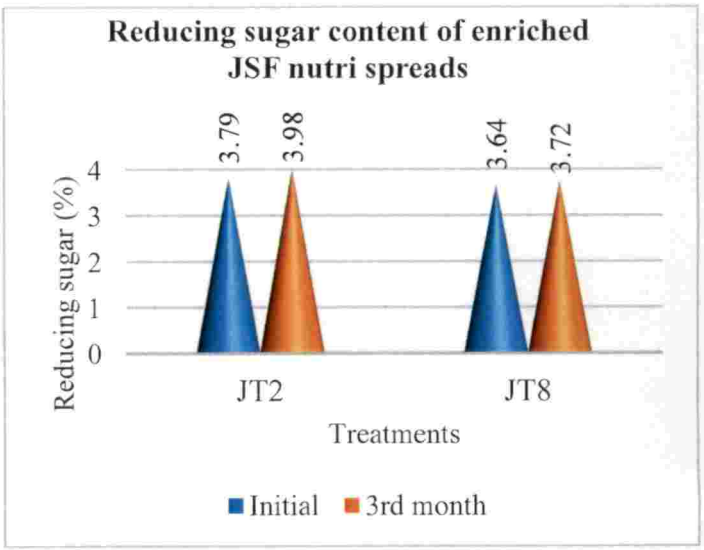
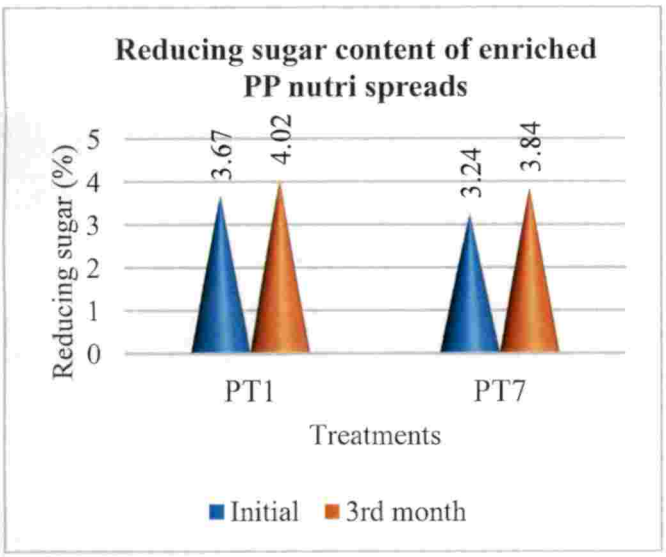


Fig.19a. Reducing sugar content (%) of enriched nutri spreads stored under ambient condition



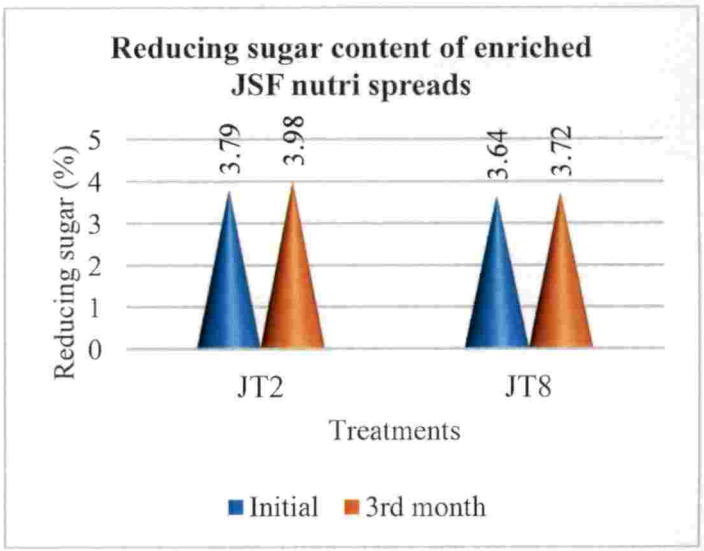
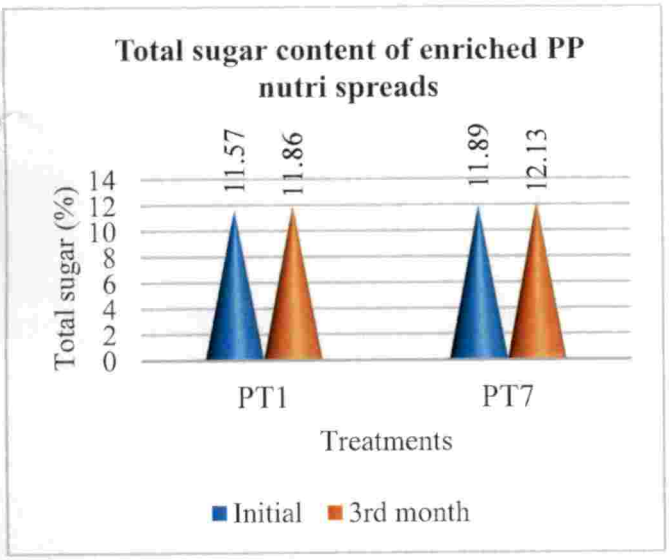


Fig.19b. Reducing sugar (%) of enriched nutri spreads stored under refrigerated condition

PP- Peanut paste, JSF- Jackfruit seed flour
PT_1 (90% PP+ 10% DSF)
PT_7 (80% PP+ 20% SMP)
JT_2 (80% PP+ 20% DSF)
JT_8 (70% PP + 30% SMP)



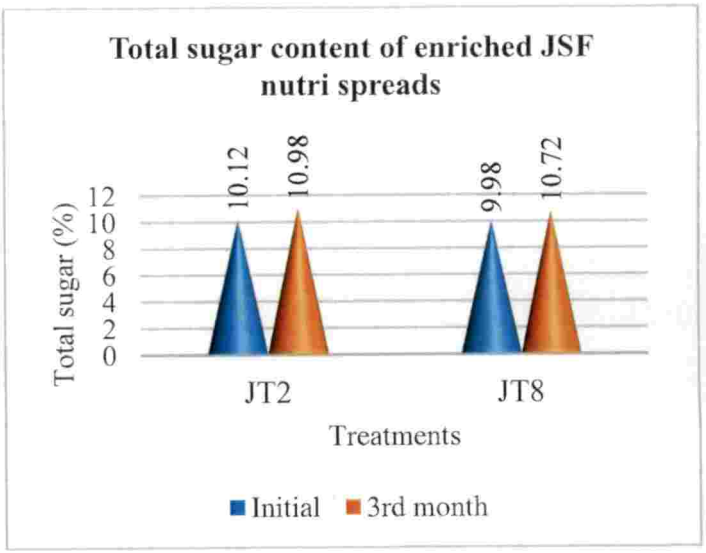
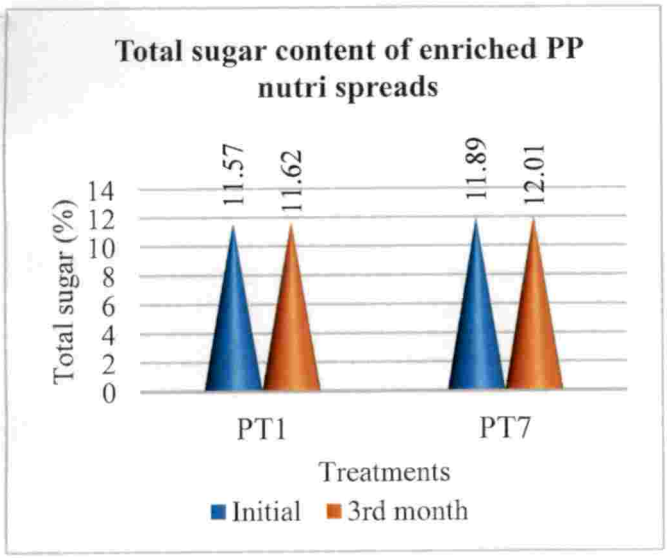


Fig. 20a. Total sugar content (%) of enriched nutri spreads stored under ambient condition



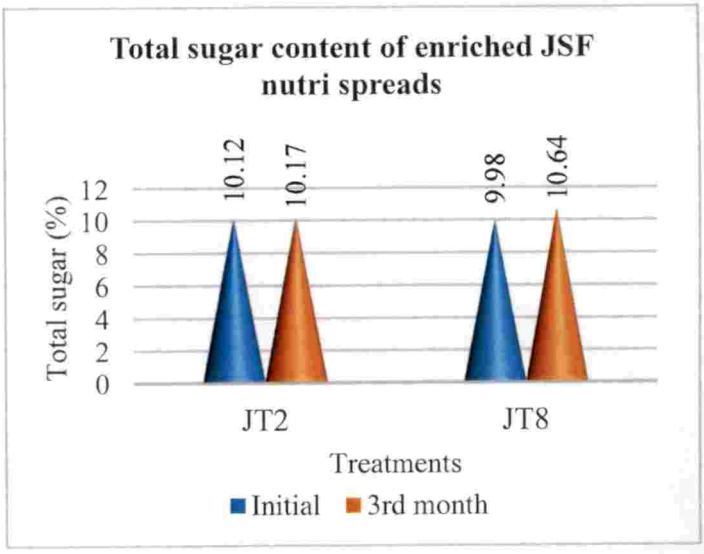


Fig.20b. Total sugar (%) of enriched nutri spreads stored under refrigerated condition

PP- Peanut paste, JSF- Jackfruit seed flour
PT_1 (90% PP+ 10% DSF)
PT_7 (80% PP+ 20% SMP)
JT_2 (80% PP+ 20% DSF)
JT_8 (70% PP + 30% SMP)

content increased to 5.10 per cent. Rozail *et al.* (2016) observed that the initial moisture content of stabilizer free natural peanut butter was 1.6 ± 0.05 per cent.

The reducing and total sugar content initially varied from 0.23 to 0.27 per cent and 9.98 to 11.89 per cent which was found to be the highest in PT_7 (80% JSF+20% SMP). At end of storage, total and reducing sugar content varied from 10.17 to 12.01 per cent and 0.26 to 0.30 per cent and are presented in Figure 19a and 20a. Reducing sugar and total sugar of selected nutri spreads were increased gradually during storage. At refrigerated condition, after third month of storage, total and reducing sugar content varied from 10.64 to 12.13 per cent and 0.30 to 0.35 per cent and are presented in Figure 19b and 20b. The increase in reducing sugar and total sugar content of the sample stored at refrigeration temperature was slightly lesser than the sample stored at room temperature. There was an increase in reducing and total sugars content on storage period due to the formation of simpler sugar like sucrose, glucose and fructose on starch degradation. The increase in reducing sugar might be because of the inversion of sucrose to glucose and fructose (Lotha, 1992 and Pruthi *et al.*, 1994). An identical results were found by Vidya and Narain (2011) in wood apple jam and Shakir *et al.* (2009) in pear apple mixed jam. Shahanas *et al.* (2015) reported that reducing sugars were gradually increased on storage for tender coconut based jam. Thilagavathi *et al.* (2015) stated that increased level of air and moisture content in formulated products hasten the breakdown of total sugars to reducing sugars.

The initial fat content of the selected enriched PP nutri spreads were 35.02 (PT_1- 90% PP+ 10% DSF) and 36.31 g/100 g (PT_7- 80% PP+ 20% SMP). The initial fat content of enriched JSF nutri spreads were 30.54 (JT_2- 80% JSF+ 20% SMP) and 30.42 g/100 g (JT_8- 70% JSF+30% SMP) and are presented in Figure 21a. The fat content reduced slightly during storage. At end of storage, fat content of the selected nutri spreads varied from 29.11 g/100 g to 35.03 g/100 g. Under refrigerated conditions also slight regulation in fat content was also observed and are presented in Figure 21b. The decrease in fat content of the sample stored at refrigeration temperature was slightly lesser than the sample stored at room

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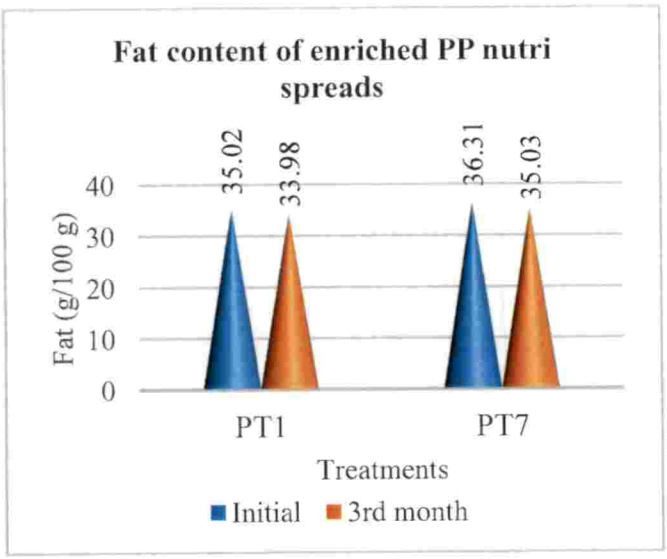


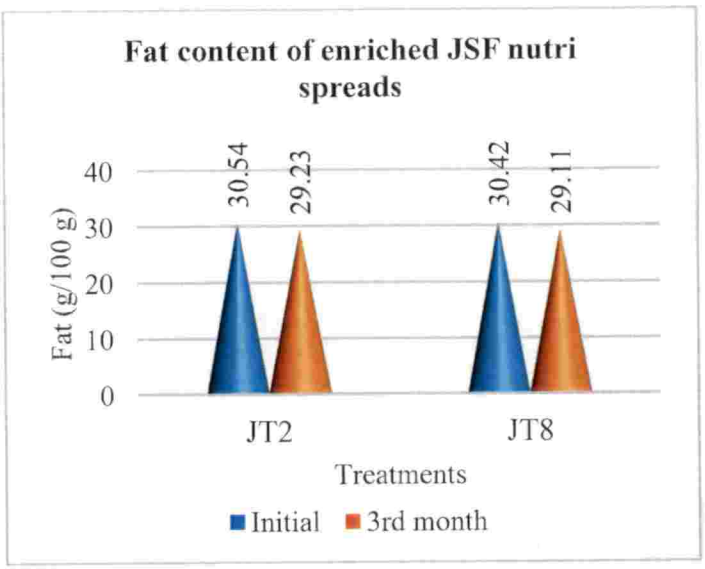
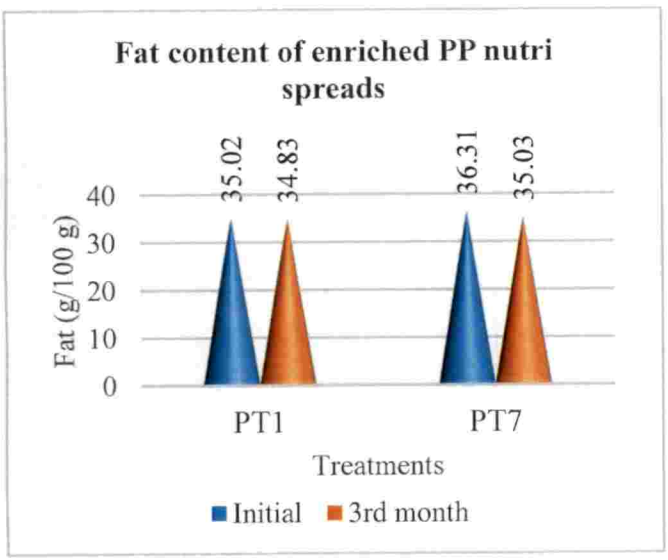


Fig.21a. Fat content (g/100 g) of enriched nutri spreads stored under ambient condition



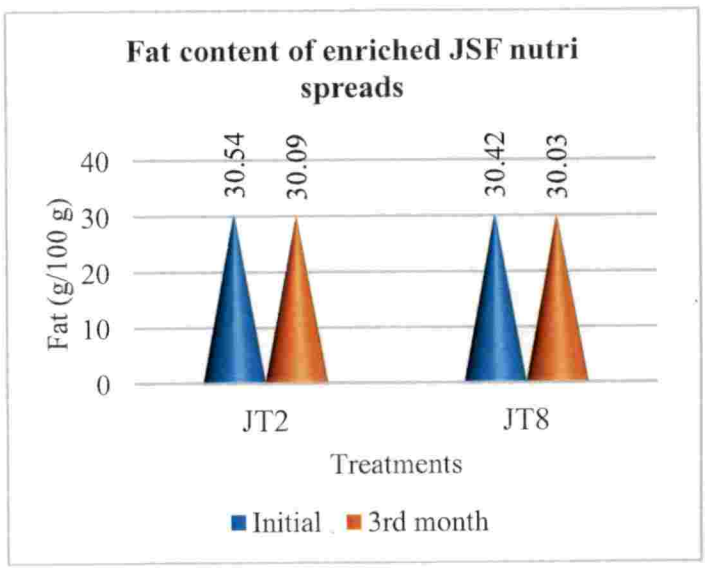


Fig.21b. Fat content (g/100 g) of enriched nutri spreads stored under refrigerated condition

PP- Peanut paste, JSF- Jackfruit seed flour
PT_1 (90% PP+ 10% DSF)
PT_7 (80% PP+ 20% SMP)
JT_2 (80% PP+ 20% DSF)
JT_8 (70% PP + 30% SMP)

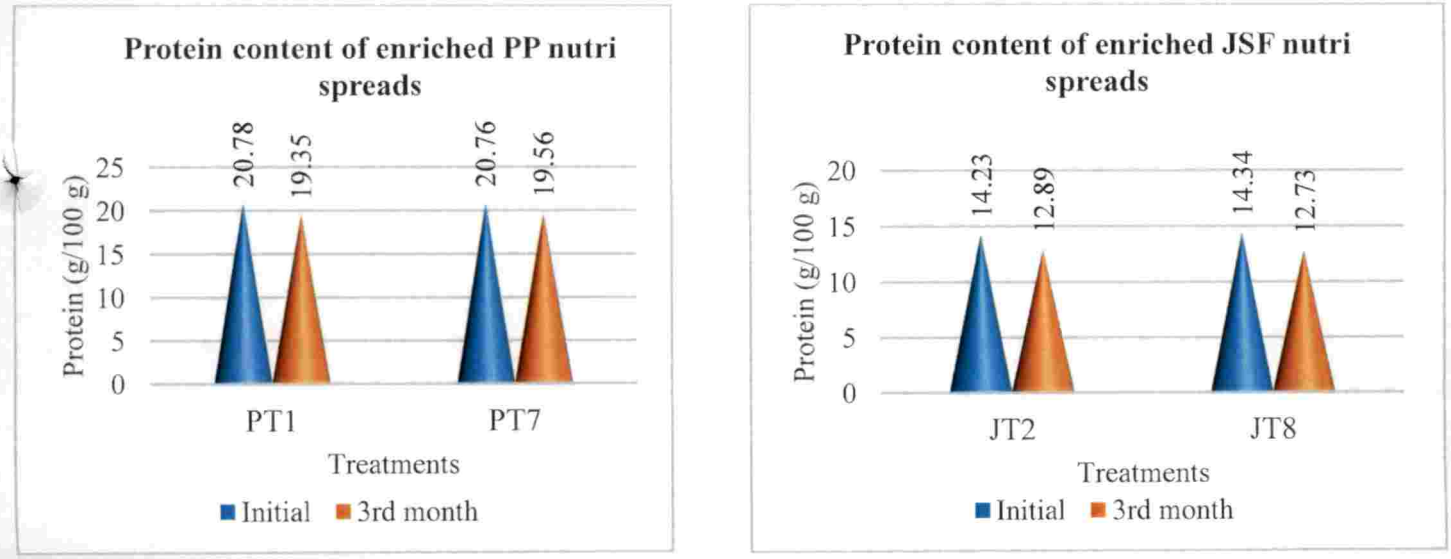


Fig.22a. Protein content (g/100 g) of enriched nutri spreads stored under ambient condition

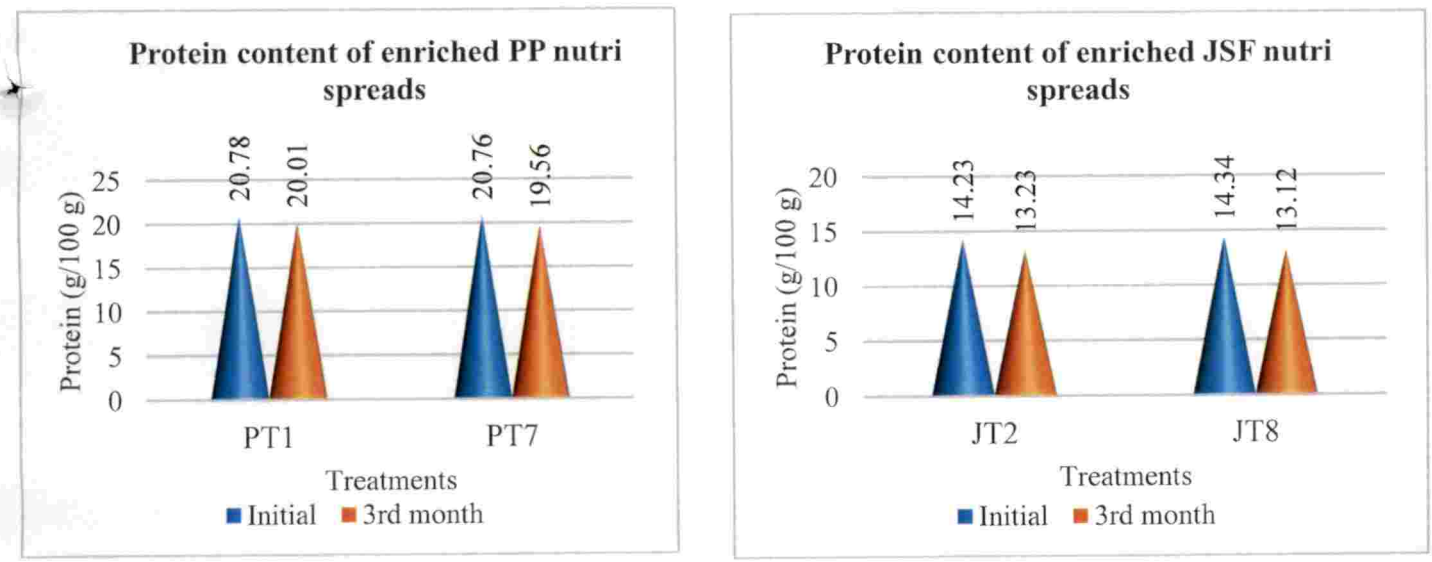


Fig.22b. Protein content (g/100 g) of enriched nutri spreads stored under refrigerated condition

PP- Peanut paste, JSF- Jackfruit seed flour
PT_1 (90% PP+ 10% DSF)
PT_7 (80% PP+ 20% SMP)
JT_2 (80% PP+ 20% DSF)
JT_8 (70% PP + 30% SMP)

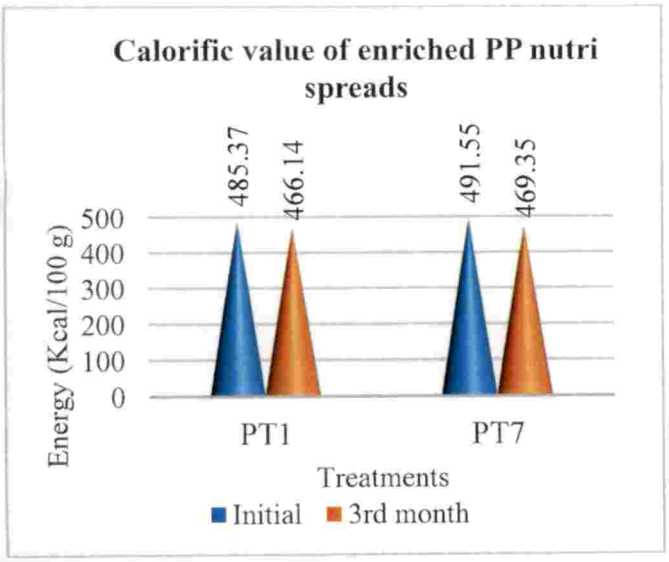
temperature. Naran (2005) observed that the fat in defatted soya flour added ground nut spreads was 39.57 g/100 g, it also observed that the fat content in whey protein concentrate added ground nut spreads was 36.50 g/100 g. Murugkar and Jha (2011) observed that decrease in fat content on storage could also be because of the enzymatic activity of lipase and lipoxidase that was produced by microorganism. A similar study of Shahanas (2014) proved that fat content observed to be decreased throughout the storage period.

The initial protein content of enriched PP nutri spreads were 15.08 (PT_1- 90% PP+ 10% DSF) and 20.78 g/100 g (PT_7- 80% PP+ 20% SMP). The initial protein content of enriched JSF nutri spreads were 14.23 (JT_2- 80% JSF+20% DSF) and 14.34 g/100 g (JT_8- 70% JSF+ 30% SMP). The protein content reduced slightly during storage. At end of storage, protein content of enriched nutri spreads varied from 13.12 g /100 g to 19.35 g /100 g and are presented in Figure 22a. The same decreasing trend in quality was observed in products stored under refrigerated condition also. The decrease in protein content of the sample stored at refrigeration temperature was slightly lesser than the sample stored at room temperature and are presented in Figure 22b. After enrichment protein content was increased by 14 per cent in PP nutri spreads and in JSF nutri spreads increased by 60 per cent. Naran (2005) observed that the protein content in defatted soya flour added ground nut spreads was 34.85 g/100 g. The author also observed that the protein content in whey protein concentrate added ground nut spreads was 34.88 g/100 g. Murugkar and Jha (2011) observed that, the total protein content decreased on storage which might be because of the raise in the moisture absorption and production of free amino acids. Kumar (2015) formulated chocolate spread incorporating whey protein concentrate, cocoa powder, olive oil and butter fat which had a protein content of 6.54 per cent. Rahman *et al.* (2015) stated that the protein content in soymilk fat spread was 25.1 g/100 g initially, which decreased to 24.9 g/100 g of the spread after 20 days of storage. Wilson and David (2017) reported that soya spread incorporated with soy protein isolate had a protein content in the range of 11.66 to 14.04 per cent.

The initial carbohydrate content of enriched PP nutri spreads were 21.68 (PT_1- 90% PP+ 10% DSF) and 20.43 g/100 g (PT_7- 80% PP+ 20% SMP). The initial carbohydrate content of enriched JSF nutri spreads were 19.95 (JT_2- 80% JSF+20% DSF) and 22.56 g/100 g (JT_8- 70% JSF+ 30% SMP). The carbohydrate content reduced slightly during storage. At end of storage, carbohydrate content of enriched nutri spreads varied from 18.53 g /100 g to 21.02 g /100 g. The same decreasing trend in quality was observed in products stored under refrigerated condition also. The decrease in carbohydrate content of the sample stored at refrigeration temperature was slightly lesser than the sample stored at room temperature. Naran (2005) observed that the carbohydrate content in defatted soya flour added ground nut spreads was 22.35 g. The author also observed that the carbohydrate content in whey protein concentrate added ground nut spreads was 24.19 g

The initial calorific value of enriched PP nutri spreads were 485.37 (PT_1- 90% PP+ 10% DSF) and 491.55 Kcal/100 g (PT_7- 80% PP+ 20% SMP). The initial fat content of enriched JSF nutri spreads were 411.58 (JT_2- 80% JSF+ 20% DSF) and 421.38 Kcal/100 g (JT_8- 70% JSF+ 30% SMP) (Fig. 23a). The calorific value reduced slightly during storage. Under refrigerated condition, the same trend was observed. At end of storage, calorific value of the enriched nutri spreads varied from 390.11 Kcal /100 g to 466.14 Kcal /100 g and are presented in Figure 23b. The calorific value decreased on storage due to the direct influence of protein, carbohydrate and fat. Kirse and and Karklina (2014) reported that the calorific value of pulse spreads varied from 101.9 Kcal to 335.0 Kcal/100 g.

The initial total ash content of enriched PP nutri spreads were 2.82 (PT_1- 90% PP+ 10% DSF) and 2.12 g/100 g (PT_7- 80% PP+ 20% SMP). The initial total ash content of the enriched JSF nutri spreads were 1.83 (JT_2- 80% JSF+ 20% DSF) and 1.98 g/100 g (JT_8- 70% JSF+ 30% SMP) (Fig. 24a). The total ash content reduced slightly during storage. At end of storage total ash content of enriched nutri spreads varied from 1.05 g /100 g to 2.12 g /100 g. Similar trend was observed in enriched nutri spreads stored at refrigerated condition also and are presented in Figure 24b. Owusu (2012) stated that the ash content of avocado fruit spread was



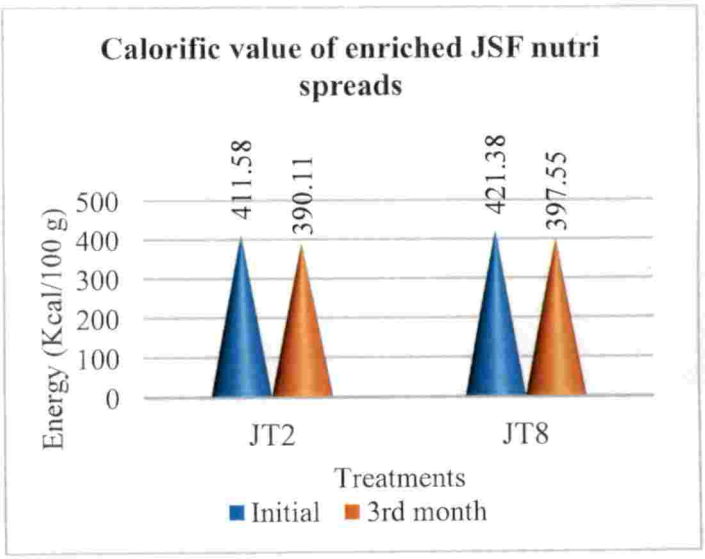
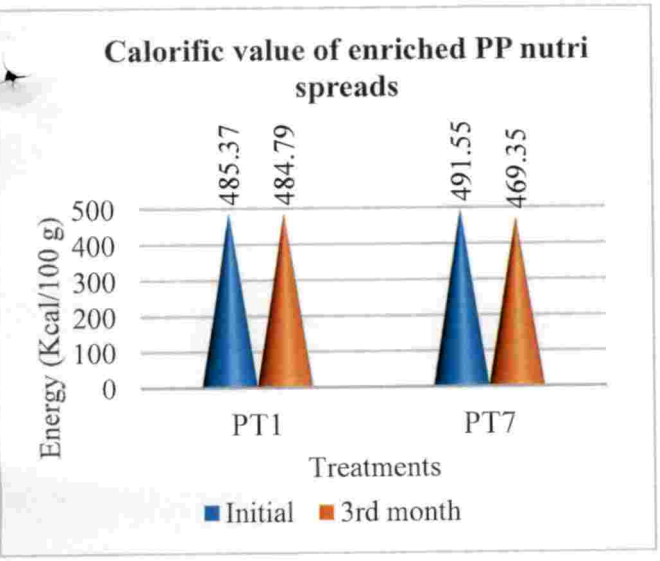


Fig.23a. Calorific value (Kcal/100 g) of enriched nutri spreads stored under ambient condition



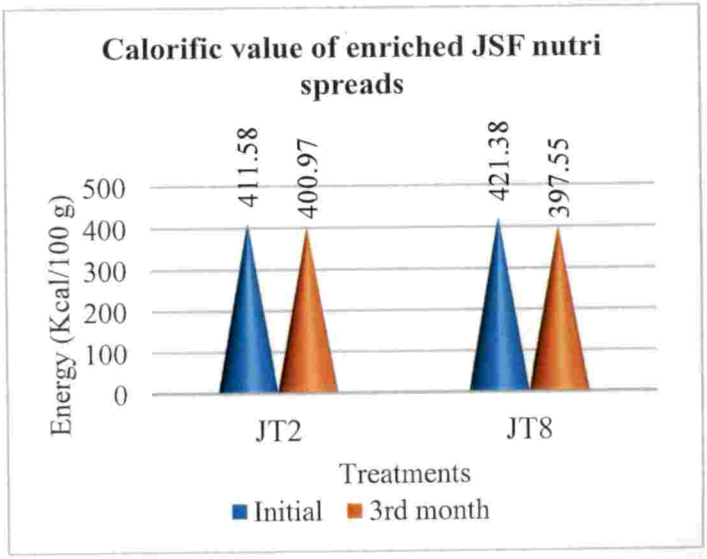
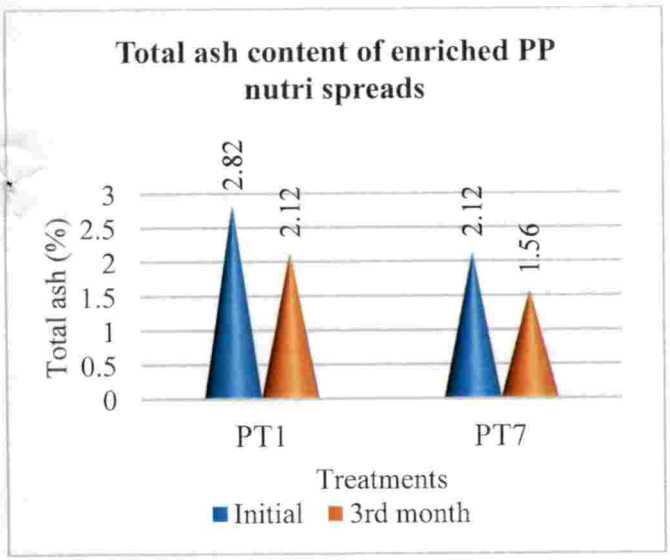


Fig.23b. Calorific value (Kcal/100 g) of enriched nutri spreads stored under refrigerated condition

PP- Peanut paste, JSF- Jackfruit seed flour
PT_1 (90% PP+ 10% DSF)
PT_7 (80% PP+ 20% SMP)
JT_2 (80% PP+ 20% DSF)
JT_8 (70% PP + 30% SMP)



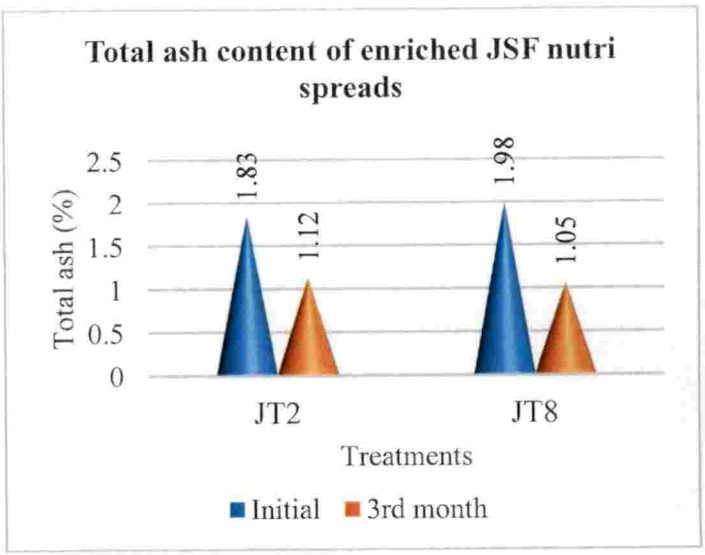
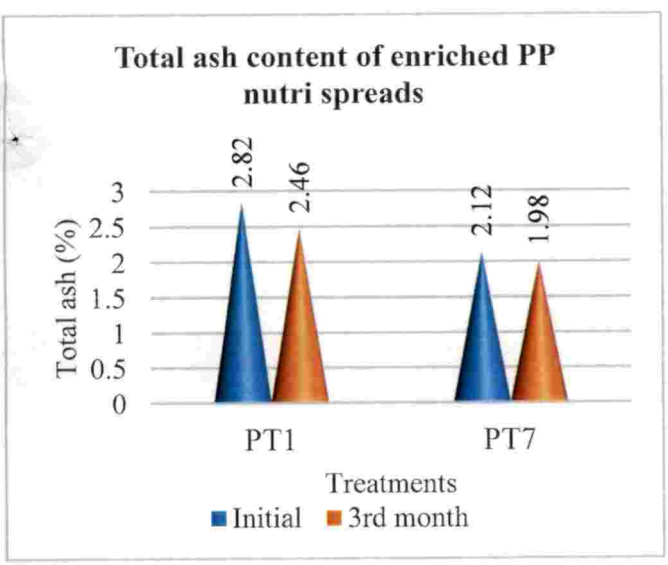


Fig.24a. Total ash (%) of enriched nutri spreads stored under ambient condition



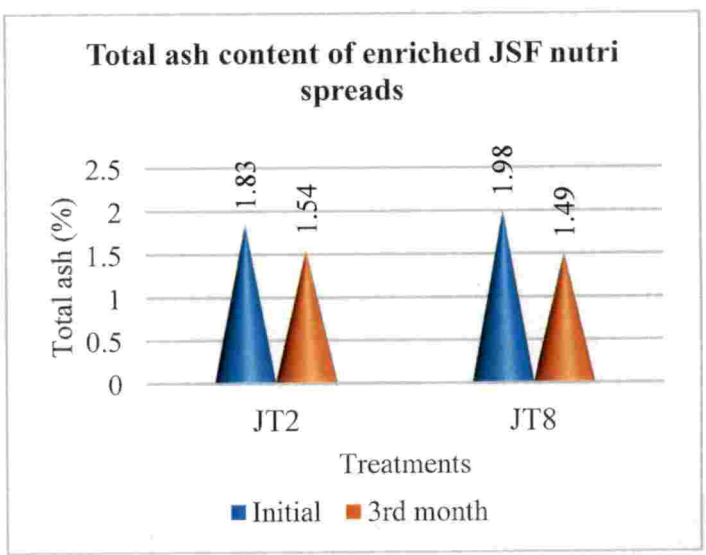


Fig.24b. Total ash (%) of enriched nutri spreads stored under refrigerated condition

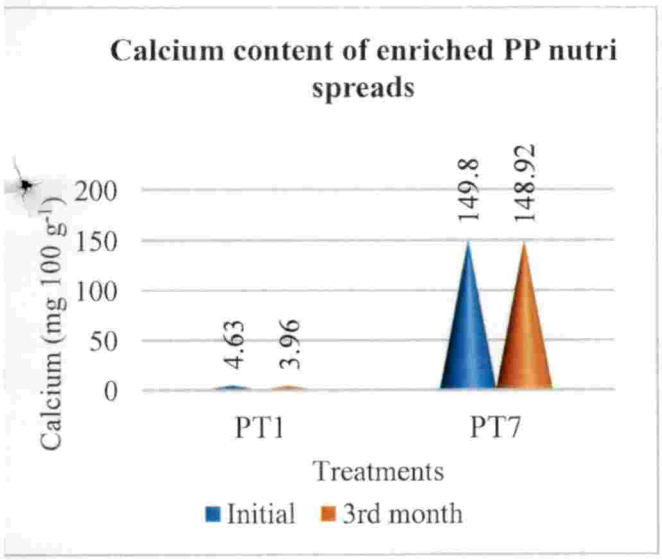
PP- Peanut paste, JSF- Jackfruit seed flour
PT_1 (90% PP+ 10% DSF)
PT_7 (80% PP+ 20% SMP)
JT_2 (80% PP+ 20% DSF)
JT_8 (70% PP + 30% SMP)

1.87g/100 g. Sivakumar *et al.* (2013) observed that the total ash content of low fat dairy spread varied from 2.03 g to 2.56 g/100 g.

Initially, the mineral content of enriched nutri spreads were noted with a variation of 4.63 to 149.80 mg 100 g^{-1} (calcium) , 0.98 to 1.13mg 100 g^{-1} (iron), 1.40 to 130.10 mg 100 g^{-1} (phosphorus), 0.017 to 0.081 mg 100 g^{-1} (zinc), 4.54 to 6.46 mg 100 g^{-1} (sodium) and 27.45 to 39.64 mg 100 g^{-1} (potassium) respectively. At end of the storage, the mineral content of enriched nutri spreads were noted with a variation of 3.96 to 138.09 mg 100 g^{-1} (calcium), 0.38 to 0.84 mg 100 g^{-1} (iron), 1.12 to 128.67 mg 100 g^{-1} (phosphorus), 0.009 to 0.072 mg 100 g^{-1} (zinc), 3.97 to 5.97 mg 100 g^{-1} (sodium) and 26.89 to 38.93 mg 100 g^{-1} (potassium) respectively (Fig. 25a, 26a, 27a, 28a, 29a and 30a). The mineral content decreased on storage. Similar trend was observed in enriched nutri spreads stored at refrigerated condition also. The decrease in mineral content of the sample stored at refrigeration temperature was slightly lesser than the sample stored at room temperature and are presented in Figure 25b, 26b, 27b, 28b, 29b and 30b. Rangaswami and Bagyaraj (2000) stated that mineral content of the product reduced on storage because of the use of available nutrients by the microbes present within the products. Similar results were observed by Sharon (2010) and Reshma (2017) also they observed that mineral content of food products decreased on storage. Bouaziz *et al.* (2017) reported that the mineral content in Tunisian date seed fibers enriched chocolate were characterized by high potassium (37 mg/100 g) and calcium(158 mg/100 g of dry matter).

5.3.3. Changes in organoleptic qualities of enriched selected spreads

The selected nutri spreads were evaluated for the organoleptic evaluation. The evaluation was done initially and at monthly intervals, for a period of three months of storage under ambient and refrigerated conditions. The mean score obtained for enriched PP nutri spreads, the initial mean scores of enriched PP nutri spreads were 8.89 (PT_1- 90% PP+ 10% DSF) and 8.58 (PT_7- 80% PP+ 20% SMP) for appearance. The colour and flavour of the PP nutri spreads noticed 9.00 and 8.55 (PT_1) and 8.61 and 8.55 (PT_7). The texture and taste of the PP nutri spreads



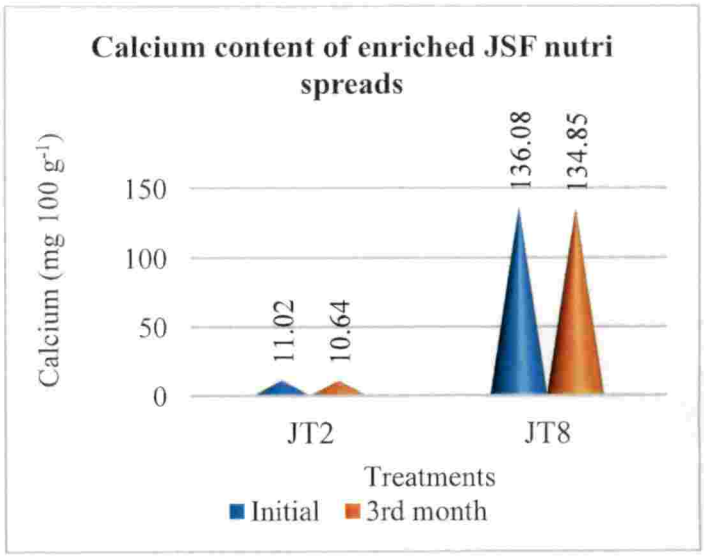
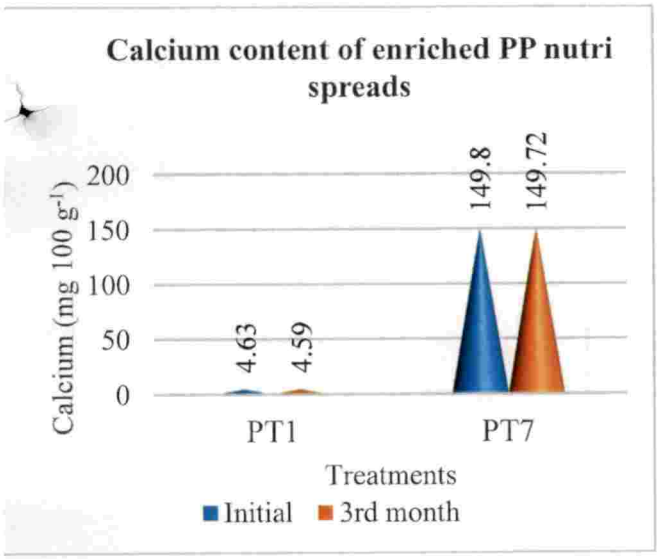


Fig.25a. Calcium content (mg 100 g^{-1}) of enriched nutri spreads stored under ambient condition



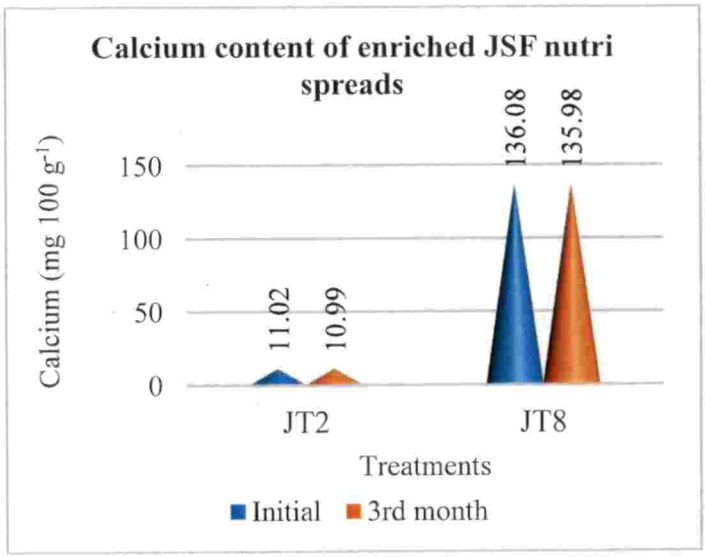
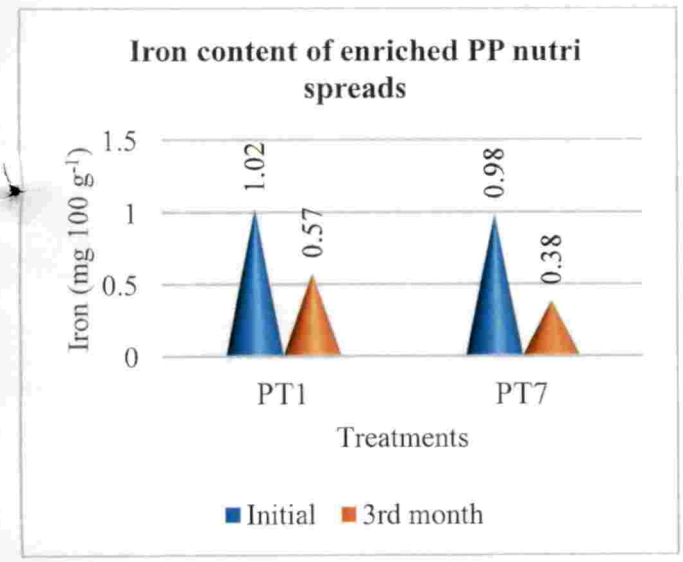


Fig.25b. Calcium content (mg 100 g^{-1}) of enriched nutri spreads stored under refrigerated condition

PP- Peanut paste, JSF- Jackfruit seed flour
PT_1 (90% PP+ 10% DSF)
PT_7 (80% PP+ 20% SMP)
JT_2 (80% PP+ 20% DSF)
JT_8 (70% PP + 30% SMP)



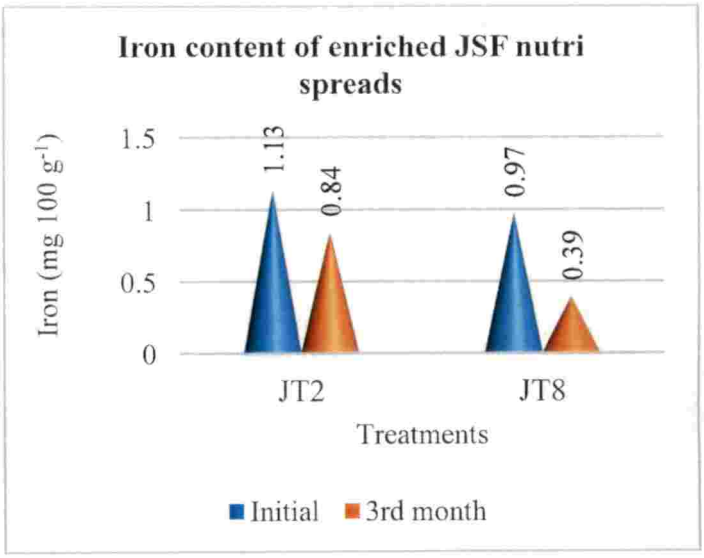
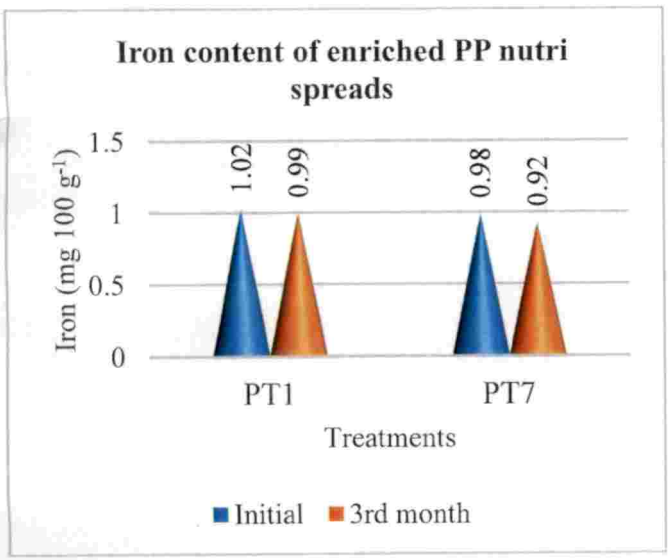


Fig.26a. Iron content (mg 100 g^{-1}) of enriched nutri spreads stored under ambient condition



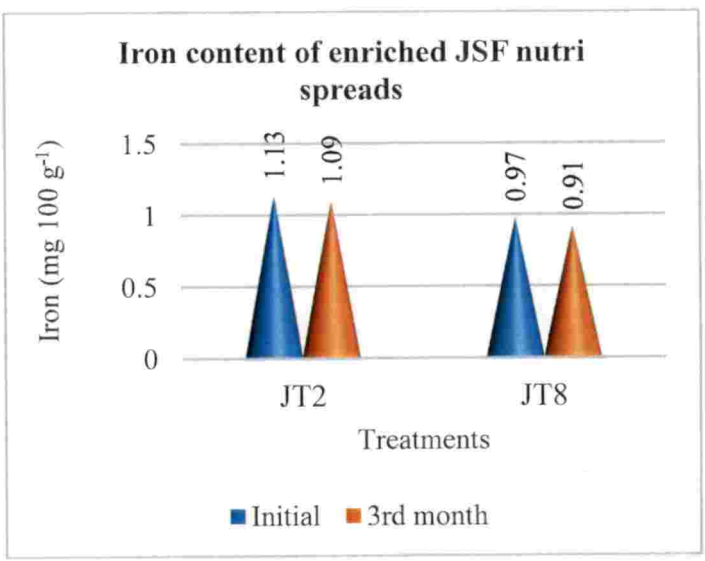
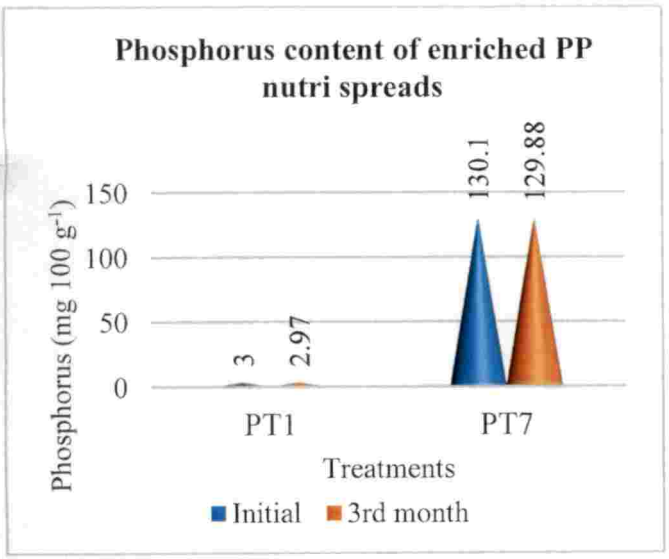


Fig.26b. Iron content (mg 100 g^{-1}) of enriched nutri spreads stored under refrigerated condition

PP- Peanut paste, JSF- Jackfruit seed flour
PT_1 (90% PP+ 10% DSF)
PT_7 (80% PP+ 20% SMP)
JT_2 (80% PP+ 20% DSF)
JT_8 (70% PP + 30% SMP)



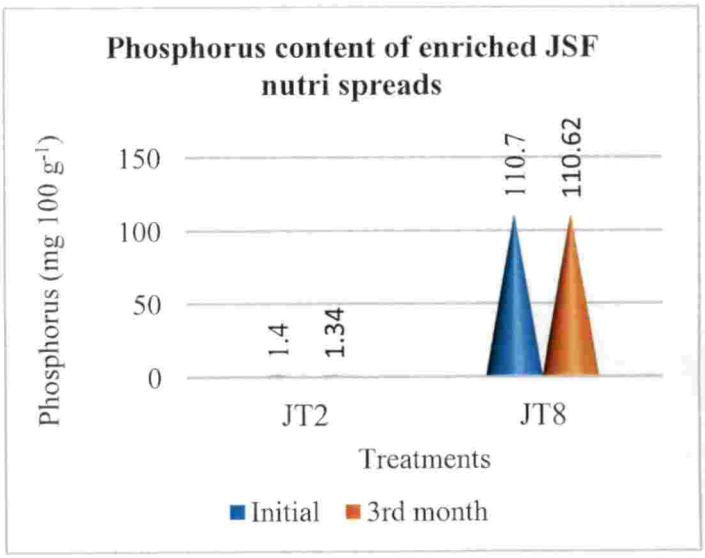
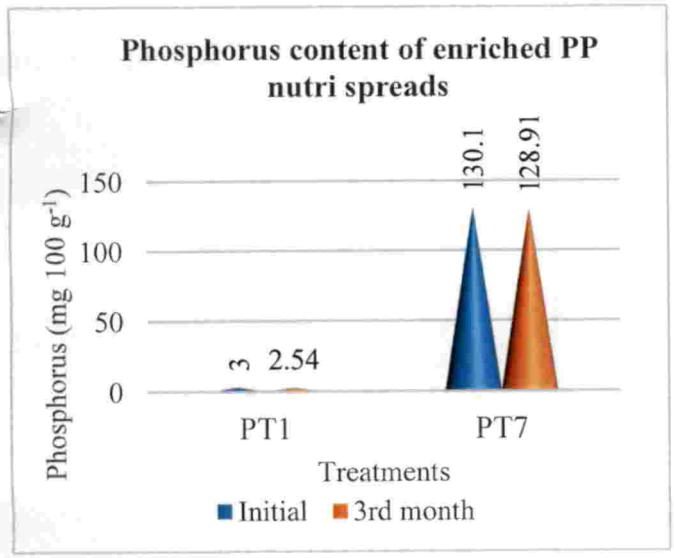


Fig.27a. Phosphorus content (mg 100 g^{-1}) of enriched nutri spreads stored under ambient condition



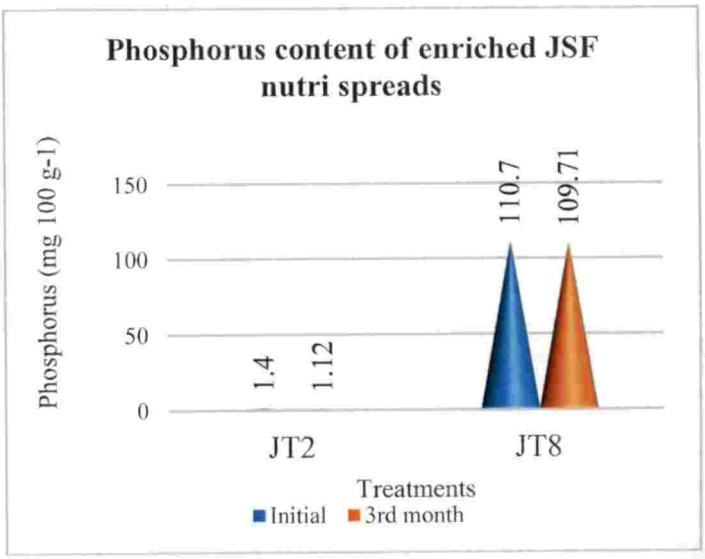
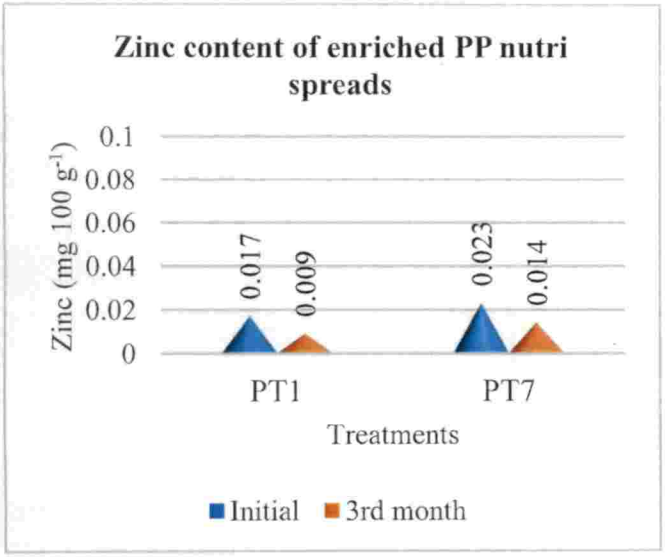


Fig.27b. Phosphorus content (mg 100 g^{-1}) of enriched nutri spreads stored under refrigerated condition

PP- Peanut paste, JSF- Jackfruit seed flour
PT_1 (90% PP+ 10% DSF)
PT_7 (80% PP+ 20% SMP)
JT_2 (80% PP+ 20% DSF)
JT_8 (70% PP + 30% SMP)



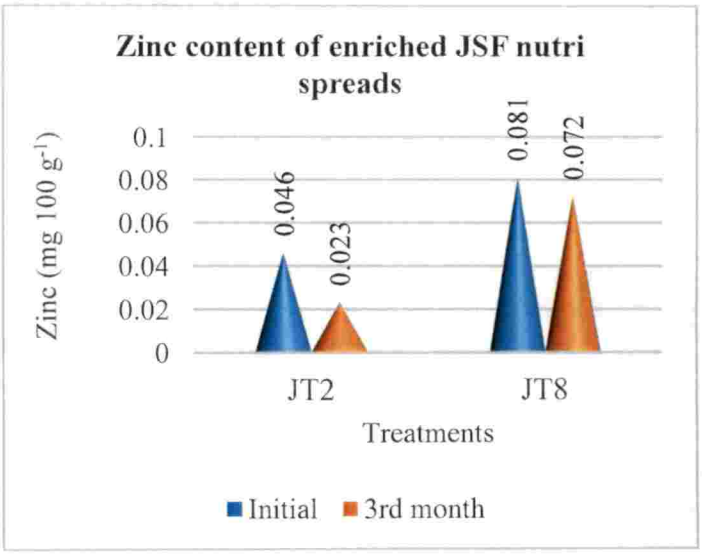
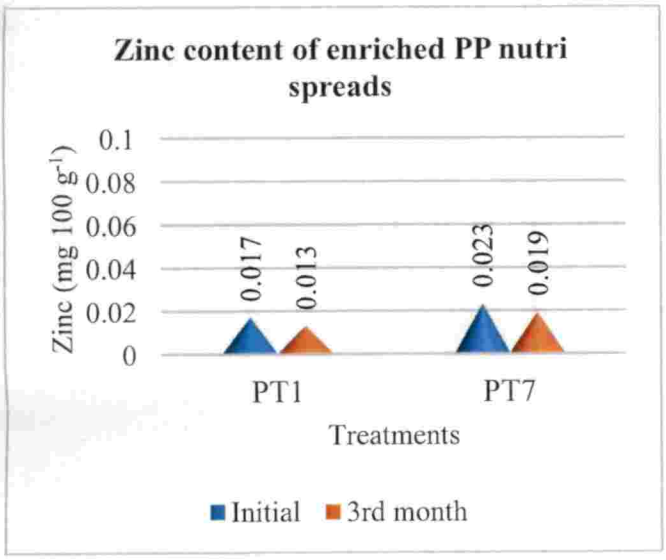


Fig.28a. Zinc content (mg 100 g^{-1}) of enriched nutri spreads stored under ambient condition



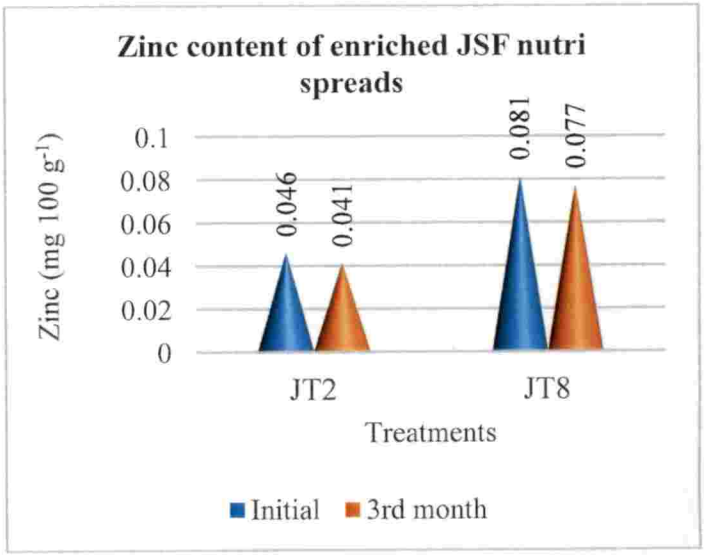
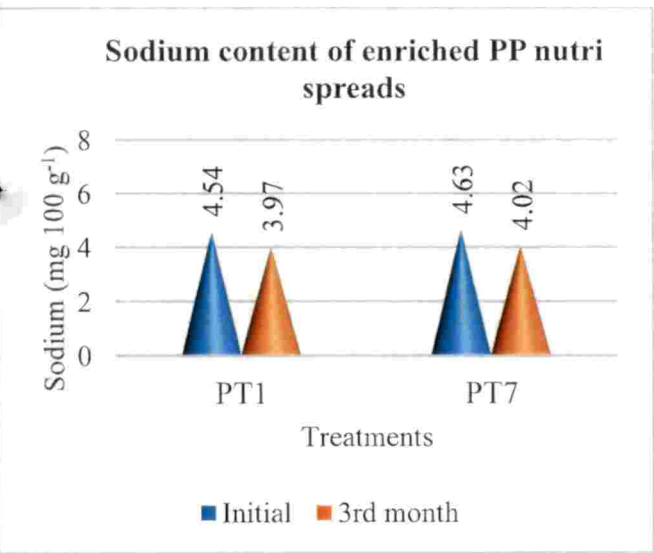


Fig.28b. Zinc content (mg 100 g^{-1}) of enriched nutri spreads stored under refrigerated condition

PP- Peanut paste, JSF- Jackfruit seed flour
PT_1 (90% PP+ 10% DSF)
PT_7 (80% PP+ 20% SMP)
JT_2 (80% PP+ 20% DSF)
JT_8 (70% PP + 30% SMP)



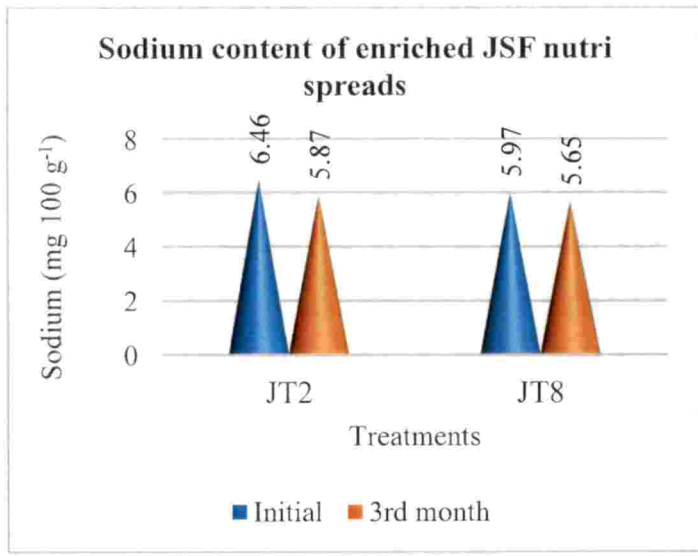
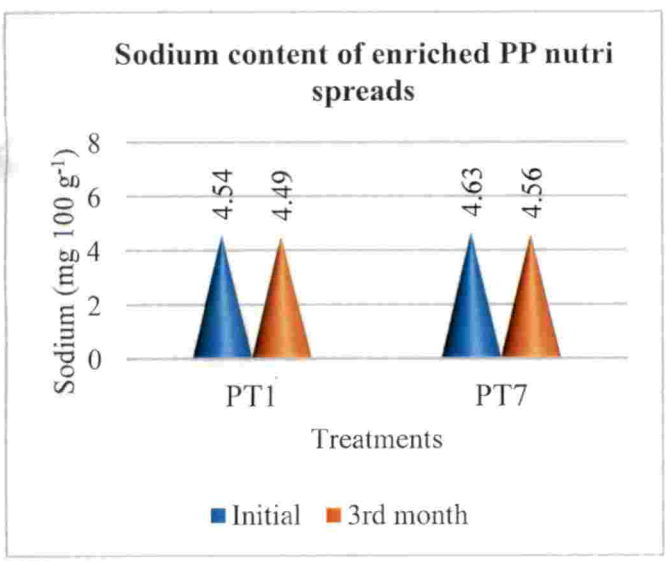


Fig.29a. Sodium content (mg 100 g^{-1}) of enriched nutri spreads stored under ambient condition



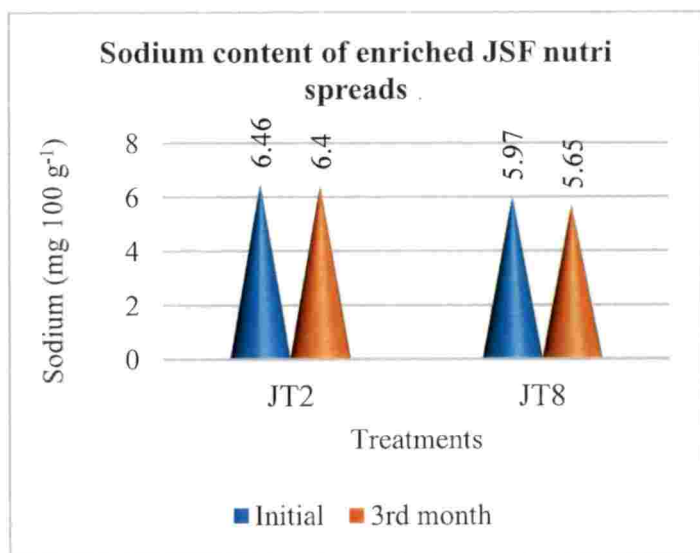
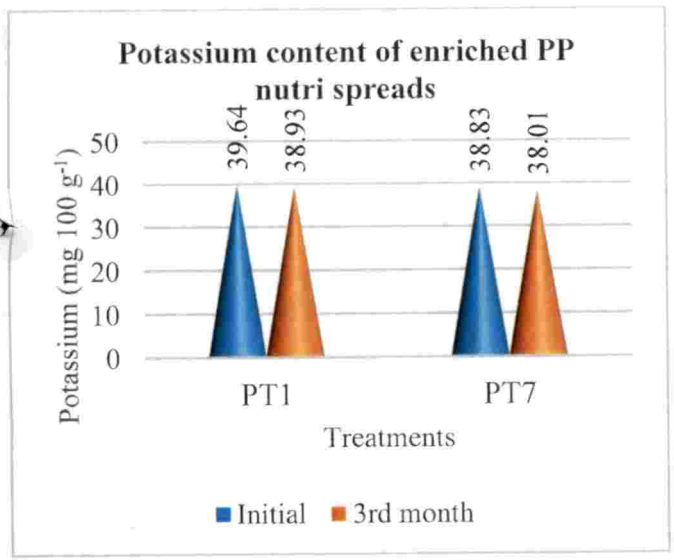


Fig.29b. Sodium content (mg 100 g^{-1}) of enriched nutri spreads stored under refrigerated condition

PP- Peanut paste, JSF- Jackfruit seed flour
PT_1 (90% PP+ 10% DSF)
PT_7 (80% PP+ 20% SMP)
JT_2 (80% PP+ 20% DSF)
JT_8 (70% PP + 30% SMP)



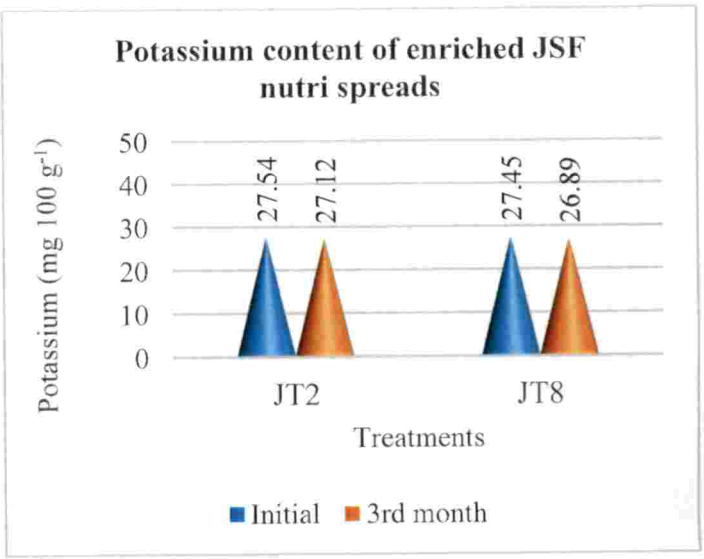
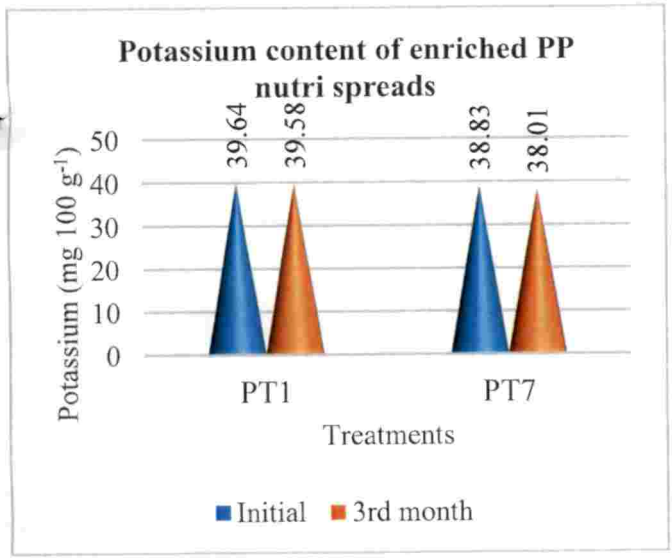


Fig.30a. Potassium content (mg 100 g^{-1}) of enriched nutri spreads stored under ambient condition



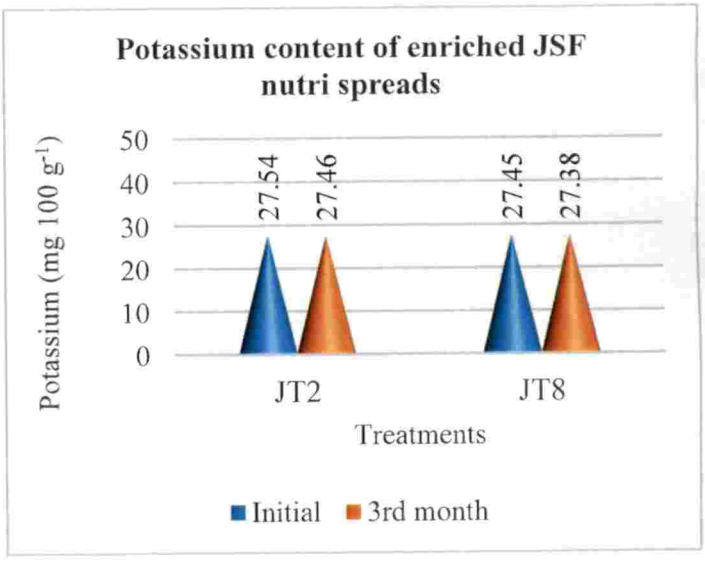


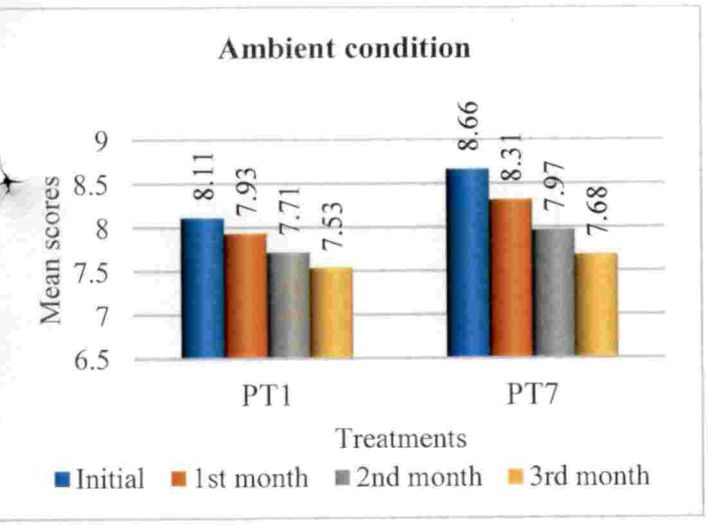
Fig.30b. Potassium content (mg 100 g^{-1}) of enriched nutri spreads stored under refrigerated condition

PP- Peanut paste, JSF- Jackfruit seed flour
PT_1 (90% PP+ 10% DSF)
PT_7 (80% PP+ 20% SMP)
JT_2 (80% PP+ 20% DSF)
JT_8 (70% PP + 30% SMP)

noticed 8.22 and 8.11 (PT_1) and 8.55 and 8.66 (PT_7). The mean scores obtained for overall acceptability of the PP nutri spreads were 8.11 (PT_1) and 8.55 (PT_7) and are presented in Figure 31. The mean score obtained for enriched JSF nutri spreads, the initial mean scores of enriched JSF nutri spreads were 8.66 (JT_2- 80% JSF+ 20% DSF) and 8.88 (JT_8- 70% JSF+ 30% SMP) for appearance. The colour and flavour of the JSF nutri spreads noticed 8.55 and 8.22 (JT_2) and 7.91 and 7.94 (JT_8). The texture and taste of the PP nutri spreads noticed 8.44 and 8.44 (JT_2) and 9.00 and 8.66 (JT_8). The mean scores obtained for overall acceptability of the PP nutri spreads were 8.43 (JT_2) and 8.66 (JT_8) and are presented in Figure 32. After enrichment, the overall acceptability has been found to be increased. The overall acceptability observed the selected peanut paste nutri spread (PT_{15}) was 8.08. In JSF nutri spreads, the overall acceptability observed the selected jackfruit seed flour spread (JT_{16}) was 8.66.

The enriched PP nutri spreads were subjected to organoleptic evaluation during initial, first, second and third months of storage. Among various PP nutri spreads, the mean score for overall acceptability was found to be the highest in PT_7 throughout the storage at ambient and refrigerated condition. Among JSF nutri spread, mean score for overall acceptability was found to be highest in JT_8 throughout the storage period at ambient and refrigerated condition. This indicate that the organoleptic qualities retained in enriched nutri spreads by the end of storage period.

Chauhan *et al.* (2012) observed that the jam prepared from tender coconut pulp and pineapple pulp showed a good sensory acceptability after 6 months of storage at room and refrigerated conditions. Shahanas (2014) formulated fruit based spreads and packed in glass bottles. They reported that fruit based spreads were found to be highly acceptable in sensory properties upto 6 months of storage. Sindumathi and Amutha (2014) observed that the mean score for all the quality attributes was initially 9.00 for all the products packed in glass bottles and PET containers. Slight changes were observed in product after 180 days storage. Though there was high sensory scores was observed in refrigerated coconut based jam



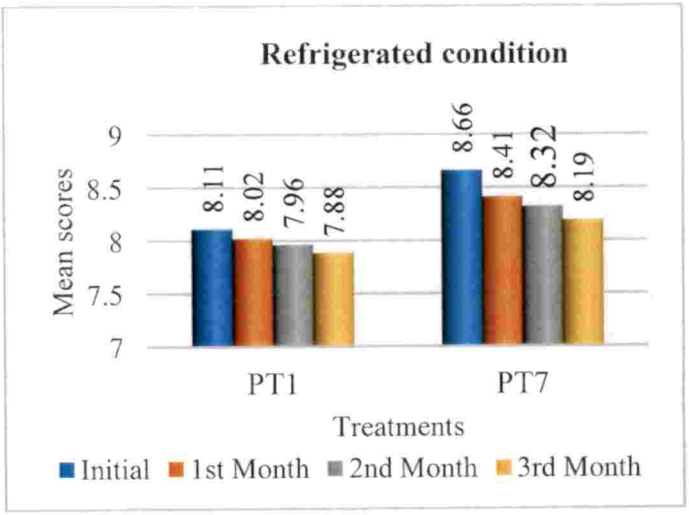
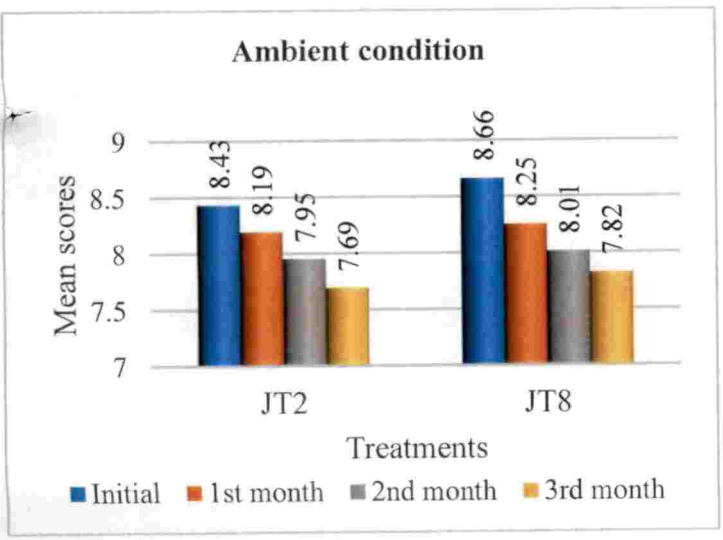


Fig. 31. Mean scores for overall acceptability of enriched PP nutri spreads during storage



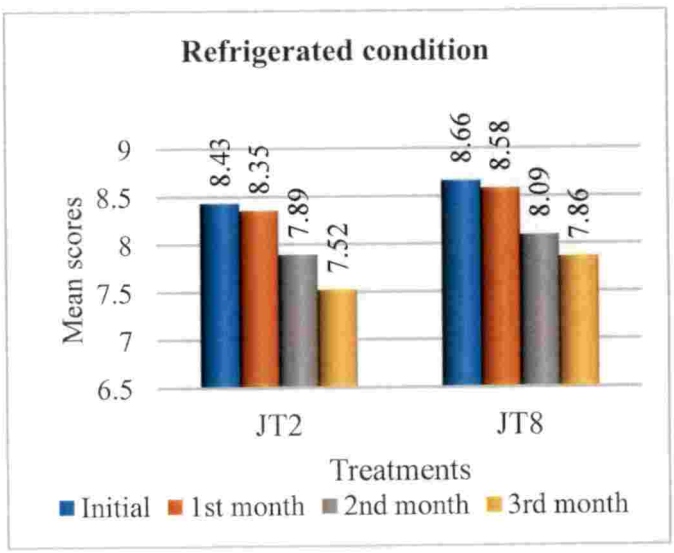


Fig. 32. Mean scores for overall acceptability of enriched JSF nutri spreads during storage

PP- Peanut paste, JSF- Jackfruit seed flour
PT_1 (90% PP+ 10% DSF)
PT_7 (80% PP+ 20% SMP)
JT_2 (80% PP+ 20% DSF)
JT_8 (70% PP + 30% SMP)

during storage. Rahman *et al.* (2015) reported that the mean score for all the quality parameters of soy milk fat spread was initially 9.2 for taste and consistency, 9 for flavor, 8.3 for appearance and 8 for color. A slight decrease were observed in all the parameters after 20 days of storage.

5.3.4. Changes in microbial qualities of the enriched spreads

In the present study, initially, the bacterial counts were not detected in enriched nutri spreads. The bacterial count was found to be increased gradually to 0.48×10^6 cfu/g (PT_1), 0.41x 10^6 cfu/g (PT_7), 0.39 x 10^6 cfu/g (JT_2) and 0.43x 10^6 cfu/g (JT_8) after third month of storage. At end of storage, the fungal growth of 0.09×10^3 cfu/g (PT_1), 0.07x 10^3 cfu/g (PT_7), 0.11 x 10^3 cfu/g (JT_2) and 0.12x 10^3 cfu/g (JT_8) were detected and it was increased after third month of storage. The yeast count was not detected in any of the enriched nutri spreads during the entire storage period.

Under refrigerated condition, the fungal colonies and yeast colonies were not detected throughout the storage. Shanti *et al.* (2000) observed that tiny amount of free water present in dried food product doesn't support the growth of microorganisms. The low moisture content and water activity shows higher storability of the period. Within the present study microbic growth raised on storage it may due to moisture absorption capacity of the product. Rahman *et al.* (2015) reported that the initially there was no microbial load in soymilk fat spread during storage. After 20 days of storage, the microbial load increased to 3.6 X 10^3. Minimum increase in microbial growth was observed when the soymilk fat spread was stored at refrigerated condition. The observed microbial growth was within the safe limits of FSSAI specification (10000 cfu/g).

5.4. Cost of production for the selected nutri spreads

The cost for selected PP based nutri spread was Rs. 66.18 and for JSF based nutri spread was Rs. 45.13/ 100 g. The cost varied from Rs. 55.25 to Rs. 80.35 / 100 g for selected enriched nutri spreads. The cost incurred for the production of defatted soya flour added PP based nutri spread was Rs. 78.73/ 100 g and the cost

for the skimmed milk powder added PP based nutri spread was found to be Rs. 80.34 /100g. The cost incurred for the production of defatted soya flour added JSF based nutri spread was Rs. 47.51 /100 g and the cost for the skimmed milk powder added JSF based nutri spread was found to be Rs. 55.23 /100g. The market price of different nut spreads available in the market was observed as Rs. 130 to 180 for 100 g. The cost of the developed nutri spreads were lower compared to the market price. The present study found that good quality, nutritious and healthy nutri spreads using locally available ingredients could be prepared without adding any preservatives.

Summary

6. SUMMARY

The study entitled 'Standardisation and quality evaluation of nutri spreads' was carried out with the objective of standardising nutritionally superior spreads. The study was also aimed to evaluate the nutritional, organoleptic and shelf life qualities of the developed nutri spreads.

Two sets of nutri spreads, one based on peanut paste (PP) and another one based on jackfruit seed flour (JSF) were standardised. Cocoa powder, cane sugar, salt and soya lecithin were the other ingredients used in nutri spreads. The amount of other ingredients were kept in a fixed proportion of 20 per cent. Three sets of nutri spreads were prepared using peanut paste (PP) as the base added with three different fat sources in varying proportions ranging from 50 per cent to 70 per cent. Three different fat sources used were cocoa butter (CB), unsalted butter (UB) and hydrogenated palm oil (HPO).

In jackfruit seed flour based nutri spreads, JSF was added with three different fat sources like cocoa butter, unsalted butter and hydrogenated palm oil. The set of treatments for peanut paste based nutri spreads (T_1- T_{18}) were repeated by replacing peanut paste with jackfruit seed flour in various proportions starting from 25 per cent to 50 per cent. Nutri spreads were standardised using 36 different combinations based on peanut paste (PP) and jackfruit seed flour (JSF). The suitability of three different fat sources *viz.* cocoa butter (CB), unsalted butter (UB) and hydrogenated palm oil (HPO) were also assessed in both PP and JSF nutri spreads.

The most acceptable combination of PP based spread and JSF based spread from each fat source were selected for further studies. In PP nutri spreads, the selected combinations were PT_4 (60% PP+20% CB), PT_9 (65% PP+15% UB) and PT_{15} (65% PP+15% HPO) based on organoleptic evaluation. In nutri spreads based on JSF, the treatments JT_{12} (25% JSF+ 55% UB) and JT_{16} (35% JSF+45% HPO) were selected for further studies. These organoleptically best nutri spreads were prepared and packed in PET containers and was stored under ambient and

refrigerated conditions for a period of three months and evaluated for various quality parameters throughout the storage. The physico-chemical, organoleptic and microbiological qualities of these products were evaluated initially and at monthly intervals.

The physico-chemical qualities of the developed nutri spreads revealed that the gel strength value in the selected nutri spreads varied from 1.057 N (PT_4) to 4.975 (JT_{16}) N. The Rupture strength value in the selected nutri spreads varied from 5.438 N (JT_{16}) to 12.844 N (PT_4 & PT_{15}). The brittleness and adhesiveness in the selected nutri spreads varied from 18.705 mm (PT_9) to 25.808 mm (PT_{15}) and 2.789 N (JT_{12}) to 144.131 N (PT_4). pH of the selected nutri spreads varied from 4.98 to 5.33. The pH increased during storage. The moisture content varied from1.71 to 3.35 per cent. The moisture content of nutri spreads increased significantly during three months of storage. The reducing sugar content in nutri spreads showed a significant increase during storage. Initially the reducing sugar content varied from 0.21 to 0.30 per cent. Treatment PT_9 had the highest reducing sugar content throughout the storage period. An increase in total sugar content was observed in the PP based nutri spreads during the storage period. Initially, the total sugar content of PP nutri spreads varied from 8.97 to 12.95 per cent with the highest in PT_4 (60% PP+ 20% CB) and the lowest in JT_{16} (35% JSF + 45% HPO).

Fat content present in the selected PP based nutri spreads varied from 28.32 (PT_9) to 40.49 g/100 g (PT_{15}). The fat content present in the selected JSF based nutri spreads were 31.09 (JT_{12}) and 46.02 g/100 g (JT_{16}). There was a decrease in fat content for all the treatments during storage. There was a decrease in protein content for all the treatment during storage. The carbohydrate content in selected PP based nutri spread significantly varied from 21.95 to 23.62 g/100 g and the carbohydrate content present in the selected JSF based nutri spreads were 36.78 g/ 100 g (JT_{12}) and 19.86 g/100 g (JT_{16}). The calorific value in the selected PP based nutri spreads varied from 422.00 Kcal to 519.21 Kcal which decreased during storage. The calorific value was observed in JT_{12} (450.65 Kcal) and in JT_{16} (520.02 Kcal). End

of the storage, the calorific value was observed in JT_{12} is 458.35 Kcal and in JT_{16} was 518.65 Kcal.

The total ash content in the selected PP based nutri spreads varied from 1.86 to 2.58 per cent which decreased during storage. On third month of storage, the total ash content varied from 1.76 to 2.31 per cent. The total ash content in the selected JSF based nutri spreads were 1.21 (JT_{12}) and 0.90 (JT_{16}) per cent which decreased during three months of storage.

Initially, the mineral content of the selected nutri spreads were observed as 5.09 to 16.50 mg 100 g^{-1} (calcium) , 1.67 to 2.59 mg 100 g^{-1} (iron), 2.03 to 3.15 mg 100 g^{-1} (phosphorus), 0.21 to 0.67 mg 100 g^{-1} (zinc), 4.99 to 12.59 mg 100 g^{-1} (sodium) and 27.60 to 41.41 mg 100 g^{-1} (potassium) respectively. The mineral content decreased on storage.

The selected PP and JSF based nutri spreads were subjected to organoleptic evaluation during initial, first, second and third months of storage. Among PP based nutri spreads, the mean score for overall acceptability was found to be the highest in PT_{15} (7.46) and the lowest in PT_4 (5.91) by the end of the storage. Among JSF based nutri spreads, the mean score for overall acceptability was found to be the highest in JT_{16} (7.06) throughout the storage period.

The bacterial growth was not observed in all the treatments initially, but by the end of third month of storage, a slight increase in the range 0.73 x 10^6 cfu/g to 0.96 x 10^6 cfu/g was observed in PP nutri spreads. In JSF nutri spreads, by the end of storage, bacterial colonies were increased to 1.02 x 10^6 cfu/g in JT_{12} and 0.47 x 10^6 cfu/g in JT_{16} respectively.

The initial and first month fungi count in the selected nutri spreads were not detected. But by the end of third month of storage, a slight increase in the range of 0.03 x 10^3 cfu/g to 0.09 x 10^3 cfu/g were observed in PP nutri spreads. In JSF based nutri spreads, the fungi count in the treatment JT_{12} was 0.83 x 10^3 and in JT_{16} was 0.05 x 10^3 cfu/g respectively. The yeast count was not detected in any of the selected nutri spreads during the entire storage period.

When various PP based combinations are compared, PT_{15} had high nutritional qualities and had the highest organoleptic scores throughout the storage and retained all qualities upto 3 months of storage. Hence, PT_{15} with 65 per cent PP and 15 per cent HPO was selected as the best PP based nutri spread combination. Similarly various JSF based combinations were compared, JT_{16} had high nutritional qualities and had the highest organoleptic scores throughout the storage and retained all qualities upto 3 months of storage. Hence, JT_{16} with 35 per cent JSF and 45 per cent of HPO was selected as the best JSF based nutri spread combination.

The selected two combinations one each from PP and JSF were enriched using two protein sources *viz.* defatted soya flour (DSF) and skimmed milk powder (SMP). These protein sources were incorporated to the base material in both selected spreads in varying percentage levels (10%, 20%, 30%, 40% and 50%). The selected nutri spreads without enrichment serve as the control (T_0).

Four best protein enriched combinations of spreads, two each from peanut paste (one with defatted soya flour and one with skimmed milk powder) and two each from jackfruit seed flour (one with defatted soya flour and one with skimmed milk powder) were selected based on the organoleptic qualities. The selected enriched nutri spreads were packed in PET containers and kept in ambient and refrigerant condition for a period of three months. The quality evaluation was done initially and at monthly intervals of the storage period.

Enriched nutri spreads were developed using 22 different combinations based on peanut paste (PP) and jackfruit seed flour (JSF). The most acceptable combination of enriched PP nutri spread and JSF nutri spread from each protein sources were selected for further studies. In PP nutri spreads, the selected combinations were PT_1 (90% PP+10% DSF), PT_7 (80% PP+20% SMP) based on organoleptic evaluation. In nutri spreads based on JSF, the treatments JT_2 (80% JSF+ 20% DSF) and JT_8 (70% JSF+30% SMP) were selected for further studies.

pH observed was 4.53 (PT_1) and 4.82 (PT_7) initially. After 3rd month of storage an increase in pH of the PP nutri spreads was observed in both PT_1 (5.35)

and in PT_7 (5.67). In enriched JSF nutri spreads, the pH was found to be 4.87 in JT_2 and 4.97 in JT_8 initially. After 3rd month of storage, an increased pH of 5.32 (JT_2) and 5.63 (JT_8) was observed. The moisture content of PP nutri spreads were 3.67 per cent (PT_1 – 90% PP +10% DSF) and 3.24 per cent (PT_7 – 80% PP +20% SMP). The moisture content of JSF nutri spreads were 3.79 per cent (JT_2 – 80% JSF +20% DSF) and 3.64 per cent (JT_8 – 70% JSF +30% SMP). The moisture content increased on storage.

The reducing sugar content were observed that 0.26 (PT_1) and 0.24 (PT_7) initially. The reducing sugar content of JSF nutri spreads were 0.23 per cent (JT_2 – 80% JSF +20% DSF) and 0.27 per cent (JT_8 – 70% JSF +30% SMP). After 3rd month of storage an increase in reducing sugar content was observed. The total sugar content of the PP nutri spreads were 11.57 per cent (PT_1) and 11.89 per cent (PT_7) and total sugar content of the enriched JSF nutri spreads were 10.12 per cent (JT_2) and 9.98 per cent (JT_8) initially. After 3rd month of storage an increase in total sugar of the nutri spreads was observed.

The fat content present in the selected enriched PP nutri spreads were 35.02 (PT_1) and 36.31 g/ 100 g (PT_7) and the fat content of the selected JSF nutri spreads are 30.54 g (JT_2) and 30.42 g/ 100 g (JT_8). After 3rd month of storage decrease in fat content of the JSF nutri spreads was observed. The protein content of the enriched PP nutri spreads were 20.78 g/100 g (PT_1) and 20.76 g/100 g (PT_7). In JSF nutri spreads, initially the protein content of the selected treatments were 14.23 (JT_2) and 14.34 g/100 g (JT_8). A slight decrease in protein content was observed in the selected enriched nutri spreads in storage period at ambient and refrigerated condition. The carbohydrate content of the enriched PP nutri spreads were 21.68 g/100 g (PT_1) and 20.43 g/100 g (PT_7). In JSF nutri spreads, initially the carbohydrate content of the selected treatments were 19.95 (JT_2) and 22.56 g/100 g (JT_8).

Initially, the calorific value of the enriched PP nutri spreads are 485.37 Kcal (PT_1) and 491.55 Kcal (PT_7). In JSF nutri spreads, initially the calorific value of the

selected treatments were 411.58 Kcal (JT_2) and 421.38 Kcal (JT_8). Decrease in calorific value was observed in the selected enriched nutri spreads in storage period at ambient and refrigerated condition. The total ash content of PP nutri spreads were 2.82 per cent (PT_1 – 90% PP +10% DSF) and 2.12per cent (PT_7 – 80% PP +20% SMP) and in JSF nutri spreads, the total ash content found that 1.83 per cent (JT_2 – 80% JSF +20% DSF) and 1.98 per cent (JT_8 – 70% JSF +30% SMP). A decrease in calorific value were observed in selected treatments throughout the storage period. Initially, the mineral content of enriched nutri spreads were noted with a variation of 4.63 to 149.80 mg 100 g^{-1} (calcium) , 0.98 to 1.13mg 100 g^{-1} (iron), 1.40 to 130.10 mg 100 g^{-1} (phosphorus), 0.017 to 0.081 mg 100 g^{-1} (zinc), 4.54 to 6.46 mg 100 g^{-1} (sodium) and 27.45 to 39.64 mg 100 g^{-1} (potassium) respectively. The mineral content decreased on storage.

The selected enriched PP and JSF nutri spreads were subjected to organoleptic evaluation during initial, first, second and third months of storage. Among PP nutri spreads, the mean score for overall acceptability was found to be the highest in PT_7 (80% PP+ 20% SMP) throughout the storage at ambient and refrigerated condition. Among JSF nutri spread, mean score for overall acceptability was found to be highest in JT_8 (70% JSF+ 30% SMP) throughout the storage period at ambient and refrigerated condition.

Initially, the bacterial counts were not detected in the enriched nutri spreads. The bacterial count was found to be slightly increased to 0.48×10^6 cfu/g (PT_1), 0.41×10^6 cfu/g (PT_7), 0.39×10^6 cfu/g (JT_2) and 0.43×10^6 cfu/g (JT_8) after third month of storage. Fungal growth was not detected during initial and first month of storage. At end of storage, the fungal growth of 0.09×10^3 cfu/g (PT_1), 0.07×10^3 cfu/g (PT_7), 0.11×10^3 cfu/g (JT_2) and 0.12×10^3 cfu/g (JT_8) were detected and it was increased after third month of storage. The observed microbial growth was within the safe limits of FSSAI specification (10000 cfu/g).

The cost for selected PP based nutri spread was Rs. 66.18 and for JSF based nutri spread was Rs. 45.13/ 100 g. The cost varied from Rs. 55.25 to Rs. 80.35 / 100 g for selected enriched nutri spreads. The cost incurred for the production of

defatted soya flour added PP based nutri spread was Rs. 78.73/ 100 g and the cost for the skimmed milk powder added PP based nutri spread was found to be Rs. 80.34 /100g. The cost incurred for the production of defatted soya flour added JSF based nutri spread was Rs. 47.51 /100 g and the cost for the skimmed milk powder added JSF based nutri spread was found to be Rs. 55.23 /100g.

The present study found that good quality, nutritious and healthy nutri spreads using locally available ingredients could be prepared without adding any preservatives. The developed nutri spreads contain good amount of nutrients, which is essential for the growth and development of children. These nutri spreads were very cost effective compared to commercially available spreads. The developed nutri spreads have immense scope for popularisation and commercialisation through technology transfer.

References

REFERENCES

[Anonymous] 2004. [On line]. Amul Lite bread spread. Available:*http://www.amul.com.*

A.O.A.C.1980. *Official and Tentative Methods of Analysis* (13th Ed.). Association of Official Analytical Chemists. Washington D.C. 1018p.

Abegas, E.G. and Kerr, W.L. 2006. Effect of moisture, sugar and TBHQ on colour, texture and microstructure of peanut paste. *J. Food Qual.* 29:643-657.

Abraham, A. and Jayamuthunagai, J. 2014. An analytical study on jackfruit seed flour and its incorporation in Pasta. *Res. J. Pharma. Biol. Chem. Sci.* 15(2): 1597.

Agarwal, G.P. and Hasija, S.K. 1986. *Microorganisms in the Laboratory*. Print house India Ltd, Lucknow, 155p.

Ajisha, K.H. 2017. Process optimisation and quality evaluation of jackfruit (*koozha* type) based vermicelli. MSc. (Community Science) thesis, Kerala Agricultural University, Thrissur, India, 126p.

Albany, G.A. 2002. Harward study shows half serving of peanut butter or full serving of peanuts eaten daily significantly cuts risk of type 2 diabetes. *J. Am. Med. Assoc.* 23(12):55-61.

Amevor, M. P., Laryea, D., and Barimah, J. 2018. Sensory evaluation, nutrient composition and microbial load of cashew nut–chocolate spread. *Cogent Food Agric.* 4: 1-10.

Amitraj, K., Khamrui, K., Devaraja, H. C., and Mandal, S. 2015. Optimisation of ingredients of a low-fat, Chhana (heat-acid-coagulated milk curd)-based spread using response surface methodology. *Int. J. Dairy Technol.* 69(3): 393-400.

Amundsen, L. A., Ose, L., Nenseter, S. M., and Ntanios, Y. F. 2002. Plant sterol ester–enriched spread lowers plasma total and LDL cholesterol in children with familial hypercholesterolemia. *Am. J. Clin. Nutr.* 76:338–344.

Anaveri, R. 2016. Standardisation of functional baked products utilizing using underexploited tubers. MSc. (Home Science) thesis, Kerala Agricultural University, Thrissur, India, 126p.

ARS [Agricultural Research Services]. 2001. *Nutritive Value of Foods.* U.S. Department of Agriculture, Agricultural Research Service, Washington, D.C. 89p.

Arya, S. S. 1984. Traditional Indian foods – some recent developments. *J. Dev. Sci.* 34: 173 – 178.

Aydjn, S. and Ozdemir, Y. 2017. Development and characterization of carob flour based functional spread for increasing use as nutritious snack for children. *J. Food Qual.* 23(5):1-7.

Aziah, N.A. 2012. Organoleptic and physiochemical evaluation of bread supplemented with jackfruit seed flour. *Asian Food J.* 14(2): 123-130.

Babubhai, N.S. 1999. Technological studies on production of low fat sweetened dairy spreads. MSc thesis, National Dairy Research Institute, Karnal, Haryana, 210p.

Balasubramanyam, B.V. and Kulkarni, 1999. Technology standardisation for production of cream based dairy spread. *Int. J. dairy Biosci.* 10:71-74.

Bera, M.B., Singh, C.J., Shrivastava, D.C., Kumar, K.S., and Sharma, Y.K. 2001. Storage stability of coloured substances in thermally processed dry chili powder. *J. Food Sci. Technol.* 38:8-11.

Berwal, J. S., Grewal, R. B., Kapoor, C. M., and Garg, M. K. 2004. *Practical Methods in Food Analysis.* Agrotech Publishing Academy, Udaipur. 252p.

Besbes, S., Drira, L., Blecker, C., Deroanne, C., and Attia, H. 2009. Adding value to hard date (*Phoenix dactylifera* L.): compositional, functional and sensory characteristics of date jam. *Food Chem.* 112:406–411.

Bhardwaj, R., Balasubramanyam, B. V., and Mishra, D. 2017. Fatty acid profile, proximate composition and consumer acceptability of cream based fat spread incorporated with olive oil and rice bran oil. *Int. J. Pure App. Biosci.* 5 (6): 346-351.

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Bhardwaj, S., Misra, A., Khurana, L., Gulati, S., Shah, P., and Vikram, K. N. 2008. Childhood obesity in Asian Indians: a burgeoning cause of insulin resistance, diabetes and sub-clinical inflammation. *Asia Pac. J. Clin. Nutr.* 17(S1):172-175.

Bouaziz, A.M., Abbes, F., Mokni, A., Blecker, C., Attia, H., and Besbes, H. 2017. The addition effect of Tunisian date seed fibres on the quality of chocolate spreads. *J. Texture Stud.* 48: 143-150.

Brunner, A. T., Horst, K. V., and Siegrist, M. 2010. Convenience food products. Drivers for consumption. *Appetite* 50: 498-506.

Bullock, D.H. and Kenney, A.R. 1969. Effect of emulsion characteristics of a low-fat dairy spread on bacterial growth. *J. Dairy Sci.* 52: 625-638.

Caglar, A., Erol, N., and Elgun, M. S. 2013. Effect of carob flour substitution on chemical and functional properties of tarhana. *J. Food Processing Preservation* 37(5):670–675.

Campos, R., Narine, S.S. and Marrangoni, A.G. 2002. Effect of cooling rate on the structure and mechanical properties of milk fat and lard. *J. Texture Stud.* 35: 971–981.

Chandraprabha, S. 2017. Standardisation and quality evaluation of millet based designer vermicelli. MSc. (Community Science) thesis, Kerala Agricultural University, Thrissur, India, 145p.

Charteris, W.P. 1995. Minor ingredients of edible table spread. *J. Dairy Sci. Technol.* 48 (4):101-106.

Chauhan, O. P., Archana, B. S., Singh, A., Raju, P. S., and Bawa, A. S. 2012. Utilisation of tender coconut for jam making and its quality evaluation during storage. *Food Bioprocess Technol.* 10: 8-13.

CODEX. 2007. Standard for fat spreads and blended spreads. Food and Agricultural Organization, Rome, Italy, 5p.

Dalaly, B.K., Spurgeon, K.R., and seas, S.W. 1968. Factors in body and water holding capacity of a low-fat spread –type dairy product. *J. Dairy Sci.* 51:938-939.

Deshmukh, M.S., Patil, G.R., Sontakke, A.T., Kalyankar, S.D., Padghan, P.V. 2003. Storage study of low-fat spread from safflower milk blended with buffalo milk. *J Dairy Foods Home Sci.* 22:63–66.

Deshpande, D. 1998. Formulation of table spread from UF retentate. M.Sc. Thesis, National Dairy Research Institute, Deemed University, Karnal, Haryana, India.

Deshpande, D. and Thompkinson, D.K. 2000. Tale Spread-A Review. *Indian J. Dairy Sci.* 53(3): 154-168.

Devarya, A. 1996. Engineering system for convenience foods. *Indian Food Ind.* 15: 31p.

Devdhara, V.D., Murthi, T.N., Punjrath, J.S., and Aneja, R.P. 1991. Low calorie butter spreads from cream: Part 1 Manufacture, physical properties and keeping quality. *Indian J. Dairy Sci.* 44(1): 111p.

Donald, M. 1996. The shelflife of dairy product: Intermediate and long life dairy product. *J. Dairy Technol.* 49: 119p.

Dostalova, J. 2003. Low-fat spreads. In: *Enclycopedia of Food Science and Nutrition.* 2nd Edn. Academic Press, London. 6: 3617.

Downs, E., Carreon, L., Guillermo, J., Jacob, E., Jacson, S., Panopio, G., Jr., and Rosalinas, S. 2013. Consumer acceptability and physico-chemical content of red flesh dragon fruit spread. *Aust. J. Basic Appl. Sci.* 9:18p.

EFSA [European Food Safety Authority] 2004. Nutrition applications: Regulations and guidance. *EFSA J.* 5(1):54pp.

Ereifej, K.I., Rababh, T.M., and Al-Rababh, M.A. 2005. Quality attributes of halwa by utilization of proteins, non-hydrogenated palm oil, emulsifiers, gum arabic sucrose and calcium chloride. *Int. J. Food Prop.* 8:415-422.

Faridha, S. and Aziah, N.A. 2012. Development of reduced calorie chocolate cake with jackfruit seed flour and poly dextrose using surface response methodology. *Int. Food J.* 19(2):515-519.

Felland, S.L. and Koehler, P.E. 1997. Sensory chemical and physical changes in inceased water activity peanut butter products. *J. Food Qual.* 20:145-156.

Formo, M.W., Jungermann, E., Norris, F.A., and Sonntag, N.O. 1979. In: *Bailey's industrial Oil and Fat Products.* Eds. Y. H. Hui. John wiley and Son. Inc. pp. 289-478.

Frankel, E.N. 1991. Recent advances in lipid oxidation. *J. Sci. Food Agric.* 54: 495-511.

Frede, E. and Buchheim, W. 1984. Butter making and churning of blended fat emulsions. *J. Soc. Dairy Technol.* 47(1): 17-22.

Frewer, L., Scholderer, J., and Lambert, N. 2003. Consumer acceptance of functional foods: issues for the future. *Br. Food J.* 10: 477-484.

FSSAI [Food safety and Standard Authority of India]. 2006. *Annual report 2006.* Food Safety and Standard authority of India, New Delhi. 85p.

FSSAI [Food Safety and Standards Authority of India] 2015. *Annual report 2015.* Food safety and Standard Authority of India, New Delhi. 76p.

Gavrilović, M. 2003. *The Technology of the Confectionery Products*, University of Novi Sad, Faculty of Technology, Novi Sad. 110p.

Genovese, D. B., Ye, A., and Singh, H. 2010. High methoxyl pectin/apple particlescompositegels: effect ofparticlesizeand particle concentration on mechanical properties and gel structure. *J. Texture Stud.* 41:171–189.

Goldin, B.R. 1998. Health benefits of probiotics. *Br. J. Nutr.* 80:203-207.

Gopalan, C., Sastri, B. V. R., and Balasubramanian, S.C. 1989. Nutritive value of Indian Foods. NIN, Hyberabad, 161p.

Gunesar, O. and Zorba, M. 2011. Effect of emulsifiers on oil separation problem and quality characteristics of *Tahin Helva* during storage. *J. Food Sci. Technol.* 14:1-9.

Guy, E. J., Vettel, H. E., and Pallansch, M. J. C. 1972. Stabilization of milk fat/cheese whey emulsion. *Food Technol.* 26(2): 50-54.

He, H. and Hoseney, R.C. 1990. Changes in bread firmness and moisture during long term storage. *Cereal Chem.* 67(6):603-605.

Hendriks, H. F. J., Weststrate, J. A., Vliet, V. T., and Meijer, G. W.1999. Spreads enriched with three different levels of vegetable oil sterols and the degree

of cholesterol lowering in normocholesterolaemic and mildly hypercholesterolaemic subjects. *Eur. J. Clin. Nutr.* 53: 319-327.

Honfo, G.F., Hell, K., Akissoe, N., Coulibaly, O., Fandohan, P., and Hounhouigan, J. 2011. Effect of storage conditions on microbiological and physicochemical quality of shea butter. *J. Food Sci. Technol.* 48(3): 274-279.

ISI (Indian Standards Institute). 1980. Determination of ash. Part I: milk and milk products, 31p.

Islam, M. S., Begum, R., Khatun, M., and Deyl, K. C. 2015. A study on nutritional and functional properties analysis of jackfruit seed flour and value addition to biscuits. *Int. J. Eng. Res. Technol.* 4 (12): 139-147.

Jackson M. L. 1973. *Soil Chemical Analysis*. Prentice Hall of India Private Ltd, New Delhi, 299p.

Jellinek, G. 1985. *Sensory Evaluation of Food: Theory and Practice*. Ellis Horwood, Chichester, England, 596p.

Jeyarani, T., Banerjee, T., Ravi, R., and Krishna, A. G. G. 2015. Omega-3 fatty acids enriched chocolate spreads using soybean and coconut oils. *J. Food Sci. Technol.* 52(2):1082–1088.

Kharb, S. and Thompkinson, K. 2007. Formulation of low fat table spread. *Indian J. Dairy Sci.* 52; 421-426.

Kiitchevsky, D., Tepper, S. A., Lloyd, L. M., Davidson, L.M., and Klurfeld, D. M. 1988. Serum and liver lipids of rats fed cocoa butter, corn oil, palm kernel oil, coconut oil and cholesterol. *Nutri. Res.* 8(3): 287–294.

Kirse, A and Karklina, D. 2014. Nutritional evaluation of pulse spreads in comparison to nutrient recommendations. *Foodbalt* 23:138-143.

Kulkarni, S. and Rama Murthy, M. K. 1988. Studies on rheological characteristics of diary spreads from buffalo cream butter. *Indian J. Dairy Sci.* 41:437–440.

Kumar, A. and Rao, R. 2006. Development of various paneer based spreads [abstract]. In: Abstracts, 18th Indian Convention of Food Scientists &

Technologists-2006 (ICFOST-2006), 16-17, November, 2006, Hyderabad, India pp.**3**.

Kumar, H. A., Ramachandr Rao, H.G., Venkateshaiah, B.V. and Venkatesh, M. 2010. Effect of processing parameters on the quality of paneer spread. *Indian J. Dairy Sci.* 63(5): 381-385.

Kumar, P. 2015. Process optimisation for the preparation of chocolate spread incorporating whey protein concentrate, cocoa powder, olive oil and butter fat using response surface methodology. *J. Food Processing Preservation* 39:745-757.

Lakshmy, P.S. 2011. Standardisation and quality evaluation of Temph and temph based instant food mixes. Ph.D. (Home Science) thesis, Kerala Agricultural University, Thrissur, India, 208p.

Leaflet, Y. H. Robert, L., Lee, H., and Akoh, C. C. 2004. Sensory evaluation of butterfat-vegetable oil blend spread prepared with structured lipid containing canola oil and caprylic acid. *J. Food Sci.* 70(7): 406- 412.

Lee, Y. J. and Lin. H. B. 2013. A Study of the Demand for Convenience Food. *J. Food Products Mark.* 19(1): 1-14.

Lee, Y. Y. 2001. Effect of size distribution of oil particles with emulsifiers and stabilizers on the emulsion stability of mayonnaise. *J. Korean. Soci. Food Sci. Nutr.* 30(2): 204-209.

Li, H., Fan, Y.W., Li, J., Tang, L., Hu, J.N., and Deng, Z.Y. 2013. Evaluating and predicting the oxidative stability of vegetable oils with different fatty acid compositions. *J. Food Sci.* 78(4):633-641.

Liedl, F. G. and Rowe, K. F. 2007. Nut butter and related products and method of making same. U.S. Patent No 7235277. Available: www.google.co.in/patents/US7235277 [20Dec.2016].

Liu, S., Willett, W. C., Stampfer, M. J., Hu, F. B., Franz, M., Sampson, L., Hennekens, C. H., and Manson, J. E. 2000. A prospective study of dietary glycemic load, carbohydrate intake, and risk of coronary heart disease in US women. *Am. J. Clin. Nutr.* 71(14):1455–1461.

Loncarevic, I., Pajin, B., Dokic, L., Seres, Z., Fister, A., Simovic, D. S., and Krstonosic, V. 2014. Rheological and textural properties of cocoa spread cream with sunflower lecithin. *Acta Tehnica Corviniensis – Bulletin of Eng.* 7: 47-50.

Lotha, R. E. 1992. Studies on processing and storage of kinnow mandarin juice. Ph.D thesis, Indian Agricultural Research Institute, New Delhi. 160p.

Madsen, J. 1976. Ingredient requirements, development technique for low calorie table spreads. *Food Prod. Develop.* 10(3): 72-80.

Manary, M., Nbkeha, M., Ashorn, P., Meleta, K., and Briend, A. 2004. Home based therapy for severe malnutrition with ready-to-use food. *Arch. Dis. Childhood.* 89(6):557-561.

Mohan, S. 2014. Standardisation and quality evaluation of coconut based filled paneer. MSc. (Home Science) thesis, Kerala Agricultural University, Thrissur, Kerala, 107p.

Moran, D.P.J. 1993. Yellow fat spread. *J. Soc. Dairy Technol.* 46(1):2-3.

Morrissey, R. B., Burkholder, B. D., White, D. M., and TarkaJr, S. M. 1986. Sub chronic effects of feeding graded levels of cocoa butter to rats. *Nutri. Res.* 6(3): 319–326.

Murugkar, D.K. and Jha, K. 2011. Influence of storage and packaging conditions on the quality evaluation of sensory attributes of biscuits developed using single and multiple blend nutraceuticals. *Int. J. Pure Appl. Bio Sci.* 5(2):433-440.

Muttagi, G., Joshi, N., Shadakshari Y., and Chandru, R. 2014. Starage stability of value added products from sunflower kernals. *J. Food Sci. Technol.* 51(9):18806-1816.

Naran, V. B. 2005. Studies on preparation and properties of protein enriched ground nut spreads. Ph. D. (Dairy Chemistry) thesis, Anand Agricultural University, Anand (Gujrat), India, 157p.

Nesma, N. M., El- Hadad, and Youssef, M. M. 2011. Utilisation of red palm olein in formulating functional chocolate spread. *Food Chem.* 124: 285-290.

Nielsen, S.S. 2010. *Food Analysis*, Springer: New York, USA. 649p.

Ocloo, F.C.K., Bansa, D., Boatin, R., Adom, T., and Agbemavor, W.S. 2010. Physico-chemic al, functional and pasting characteristics of flour produced from jackfruit (*Atrocarpus heterophyllus* Lam.) seeds. *Agric. Biol. J. N. Am.* 1(5):903-908.

Owusu, A.A. 2012. Formulation and shelf life evaluation of avocado *(Persea Americana)* fruit spread. BSc (Food Science and Technology) thesis, Kwame Nkrumah University of Science and Technology, Kumasi, 62p.

Pajin, B., Karlovic, D., and Hadnadev, L. D. M. 2006. Characterization of creamy-spread products. *Uljarstvo.* 37:1-2.

Pandeay, S. 2004. Value added products and byproducts from jack fruit, Ph. D. (HSc.) thesis, Kerala Agricultural University, Vellayani, Kerala, 308p.

Patange, D. D. 2005. Studies on manufacture of low fat spread using ghee. Ph.D Thesis. Mahatma Phule Krishi Vidyapeeth, Rahuri, Ahmeddnagar, Maharashtra, India. 321p.

Patange, D. D., Patel, A. A., Singh, R. R. B., Patil, G. R., and Bhosle, D. N. 2013. Storage related changes in ghee-based low-fat spread. *J. Food Sci. Technol.* 50(2):346–352.

Patel, A. A. and Gupta, S. K. 1988. Studies on soy-based low fat spread. *J. Food Sci.* 53(2): 455-59.

Patil, A. A. 2001. *Novel approaches in development of health spreads: Recent development in health foods and nutraceuticals.* Centre of Advanced studies in Dairy Technology, National Dairy Research Institute, Karnal (Haryana), pp. 167-181.

Pelto, G. H. and Klemesu, A. M. 2011. Balancing nurturance, Cost and Time: Complementary Feeding in Accra, Ghana. *Maternal and Child Nutr.* 7(3): 66-81.

Perkin- Elmer. 1982. *Analytical Methods for Atomic Absorption Spectrophotometry*. Perkin- Elmer Corporation, USA, 114p.

Petrowski, G.E. 1976. Emulsion stability and its relation to food. In: *Advances in Food Research.* Eds: Chichester, C., Dimark, E. and Mistewart, G.F. Academic Press, London, pp.306.

Prajapati, P.S., Gupta, S.K., Patel, A.A. and Patil, G.R. 1991. Processing of low-fat butter flavoured spread. *J. Food Sci. Technol.* 28: 208-211.

Pruthi, J. S., Manna, J. K., Tectia M. S., Radhakrishna, S. G., Eipeson, W.E., Saroja, S. and Chikkappaji, K.L. 1994. Studies on the utilization of kinnow and malta orange. *J. Food Sci. Technol.* 21: 121-127.

Rahman, M., Pimpley, V.A., Kulkarni, T.S., and Naik, R.R. 2015. Development and storage studies of soymilk fat spread. *Int. J. Sci. Res*. 4(10):23-26.

Raj, A. and Khamrui, K. 2013. Development of technology for reduced fat chana based dairy spread with improved functional attributes. *Indian J. Dairy Sci.* 54:257-258.

Raljic, J. V. P., Petronijevic, J. G. L., Dimic, E. B., Popov, V. S., Vujasinovic, V. B., Blesic, I. V., and Portic, M. J. 2013. Quality parameters of mixed milk and cocoa spreads. *Hem. Ind.* 67 (5): 781-793.

Ranganna, S. 1986. *Manual of Analysis of Fruits and Vegetable Products.* Tata Mc Graw Hill Publishing Co. Ltd, New Delhi, 1-13p.

Rangaswami, G. and Bagyaraj, D.J. 2000. *Agricultural Microbiology* (2nd Ed.). Prentice Hall of India private Ltd, New Delhi, 422p.

Rao, M. N., Rao, B.V.R., and Rao, T.J. 1984. Paneer from buffalo milk. *Int. J. Food Dairy Sci.* 31(1):50-53.

Rasic, J., Mitic, P., and Bozic, Z. 1976. Development of new dairy spreads. *Food Sci. Technol.* 8(11):21-33.

Reshma, T.R. 2017. Standardisation and quality evaluation of millet based composite nutrimixes for adolescents. MSc. (Community Science) thesis, Kerala Agricultural University, Thrissur, India, 129p.

Robinson, R.K. 1986. *Modern Dairy Technology: Vol.1. Advances in Milk Processing.* Elsevier Applied Science Publisher, London and New York, 116p.

Rousseau, D., Forestiere, K., Hill, A.R., and Marangoni, A. G. 1996. Restructuring butterfat through blending and chemical inter esterification, melting behavior and triacylglycerol modifications. *J. Am. Oil Chem. Soc.* 73 (8): 963–972.

Rozail. M. H. N., Chin, N. L., Yusof, Y.A., and Mahyudin, N. 2016. Quality changes of stabilizer-free natural peanut butter during storage. *J. Food Sci. Technol.* 53(1):694-702.

Ryan, I. Cowan, C. Mc Carthy, M., and O'Sullivan, C. 2002. Food related lifestyle segments in Ireland with a convenience orientation. *J. Int. Food Agri. Business. Mark.* 14(4): 29 - 47.

Sadasivam S. and Manickam, A. 1997. *Biochemical Methods* (2nd Ed.). New Age International private limited, New Delhi and Tamil Nadu Agricultural University, Coimbatore, 254p.

Samsudin, S.Y. 2006. Low fat chocolate spread based on palm oil. *Palm oil Dev.* 45: 27-30.

Schaap, J.E. 1993. Process for preparing a spread having reduced fat content. European Patent Application EP 0545 489 A1: 6. *Dairy Sci.* 55: 8037-8038.

Scott, W.J. 1975. Water relations of food spoilage microorganisms. *Adv. Food Res.* 7:83-127.

Sea, W.S and SpurgeonK.R. 1975. Development of cheese flavoured type dairy spreads with controlled fat content. *Food Product Dev.*9:68-72.

Shahanas, E. 2014. Standardisation and quality evaluation of blended tender coconut products. MSc. (Home Science) thesis, Kerala Agricultural University, Thrissur, India, 92p.

Shahanas, E., Panjikkaran, T. S., Aneena E. R., and Sharon C.L. 2015. Standardisation and quality evaluation of spreads using fruit extracts and tender coconut pulp. *J. Agric. Res.* 1(8): 1-14.

Shakerardekani, A. and Karim, R. 2013. Effect of different types of plastic packaging films on the moisture and aflatoxin contents of pistachio nuts during storage. *J. Food Sci. Technol.* 50(2):409–411.

Shakerardekani, A., Karim, R., Ghazali, H. M., and Chin, N.L. 2013. Textural, rheological and sensory properties and oxidative stability of nut spreads. *Int. J. Mol. Sci.* 14: 4223-4241.

Shakir, I., Hussain, I., Zeb, A., and Durrani, I.Y. 2009. Sensory evaluation and microbial analysis of apple and pear mixed fruit jam prepared from varieties grown in Azad Jammu and Kashmir. *World J. Dairy Food Sci.* 4(2):201-204.

Shanti, D., Manimegalai, U., and Chitra, P. 2000. Studies on the storage behaviour of instant *vada* mix. *Indian Food Packer* 54(5):72-76.

Sharon, C.L. 2010. Standardisation and quality evaluation of banana based probiotic fermented food products. Ph.D. (Home Science) thesis, Kerala Agricultural University, Thrissur (Kerala), India, 208p.

Shazad, N., Butt, M.S., Rehman, S., and Sharif, K. 2005. Chemical characteristics of various composite flours. *Int. J. Agric. Biol.* 7(1):105-108.

Simelane, B. D. 2008. The acceptability and use of convenience. 2008. MSc. (Department of consumer science) thesis. Faculty of natural and agricultural sciences, University of Pretoria, Pretoria, 211p.

Sindumathi, G. and Amutha, I. S. 2014. Processing and quality evaluation of coconut based jam. *J. Environ. Sci., Toxicol. Food. Tech.* 8 (1):10-14.

Sivakumar, G.M., Dhanalakshmi, B., and Gawdaman, G. 2013. Rheology and sensory characteristics of low fat dairy spread. *Int. J. Vet. Sci.* 1(2):15-24.

Spios, F.E. and Szuhaj, F.B. 1996. Edible oil and fat products: oil and oil seeds. In *Bailey's Industrial oil and fat products.* Vol. 2, Y. H. Hui., Ed. John Wiley and Sons, Inc. New York. pp. 497.

Spurgeon, K. R., Seas, S. W., and Dalaly, B. K. 1973. Effect of non-milk solids and stabilizers on body, texture and water retention in low fat dairy spread. *Food Prod. Develop.* 7(3):34, 36, 43, 44.

Spurgeon, K.R., Seas, S.W., and Young J.O. 1970. Physico-chemical factors and changes affecting storage of a new low-fat dairy spread. XVIII international Dairy Congress.

Steeg, G. D., Otten, M., Alderliesten, D. E., Weijer, G., Naktgerboran, J., Bijl, A. J., Wasbinder, L., Kershof, A. M., and Dujvendijk, V. 2001. Modeling the effects of (green) antifungal, droplet size distribution and temperature and mold outgrowth in water-in-oil emulsion. *Int. J. Food Microbiol.* 67(3): 227-233.

Sugasini, D. 2003. Value added vermicelli. MSc thesis, Tamil Nadu Agricultural University, Coimbatore, 98p.

Swam, S. B., Thakor, N.J., Sanjay, O., and Kalse, S.B. 2014. Development of osmo-tray dried ripe jackfruit bulb. *J. Food Res. Technol.* 2(2): 77-86.

Swami, B. S., Thakor, N. J., Haldankar, P. M., and Kalse, S. B. 2012. Jackfruit and its many functional components as related to human health: A review. *Comprehensive Rev. Food Sci. Food Safety* 11(6): 565-576.

Swanson, R. B. and Perry, J. M. 2007. Modified oatmeal and chocolate chip cookies: evaluation of the partial replacement of sugar and fat to reduce calories. *Int. J. Consumer Stud.* 31(3):265–271.

Talbot, G. 1999. Vegetable fats. In: Beckett, S. T. (ed.), *Industrial chocolate manufacture and use* (3rd Ed.). Blackwell Science, Oxford, pp. 307–322.

Tanaka, L.; Tanaka, K.; Yamato, S.; Ueno, S.; Sato, K. 2009. Microbeam X-ray diffraction study of granular crystals formed in water-in-oil emulsion. *Food Biophys.* 4: 331–339.

Tarar, O. M. 2013. Development, characterization and shelf life optimization of a prototype nutrient dense food bar. M.Sc. (Food Technology) thesis. National institute of food science and technology, University of Agriculture, Pakistan. 271p.

Thilagavathi, T., Kanchana, S., Banumathi, P., and Ilamaran, M. 2015. Standardisation of extruded products using modified millet flour and pulse flour. *Int. J. Food Nutr. Sci.* 4(4): 73-79.

Tossavainen, O., Pyykkonen, P., Vastamakki, P. and Huotari, H. 1996. Effect of milk protein on the stability of a model low fat spread. *Int. Dairy J.* 6: 74-75.

Verma, R. B., Prajapati, P. S., Upadhyay, K. G. and Thakar, P. N. 1998. By products utilization in development of cream based low fat butter spread. *Indian Dairy Industry in the emerging world scenario.* XXIX Dairy Industry Conference, Nov 28-29, 1998, NDRI, Karnal, pp. 140.

Vernam, A. H. And Sutherland, J. P. 1994. Butter, margarine and spreads. In: *Milk and Milk products. New York*: Chapman and Hall. pp. 23-274.

Vidya, R. and Narain, A. 2011. Formulation and evaluation of preserved products utilizing underexploited fruit, wood apple (*Limonia Acidissima*). *Am. Eurasian J. Agric. Environ. Sci.* 10(1):112-118.

Weckel, K.G. 1965. Dairy Spreads. *Manufactured Milk Prod. J.* 57(7): 5-7.

Wilson, I. and David, J. 2017. Studies on quality parameters of soya spread incorporated with soy protein isolate. *Int. J. Chem. Stud.* 5(3): 319-322.

Woodroof, J.G. 1983. Peanut Butter. In: *Peanuts: Production, Processing, Products.* The AVI Publishing Company, Westport, Connecticut, pp 181–225.

Zillen, M. 1977. New development in butter and uses of butter. *Milk Ind.* 79:19–22.

Appendices

APPENDIX – I

Score card for the organoleptic evaluation of nutri spreads

Name:

Date: Signature

Parameters	Cocoa butter						Unsalted butter						Hydrogenated palmoil					
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}	T_{11}	T_{12}	T_{13}	T_{14}	T_{15}	T_{16}	T_{17}	T_{18}
Appearance																		
Colour																		
Flavour																		
Texture																		
Taste																		
Overall acceptability																		

9 point hedonic scale

Like extremely	- 9	Dislike slightly	- 4
Like very much	- 8	Dislike moderately	- 3
Like moderately	- 7	Dislike very much	- 2
Like slightly	- 6	Dislike extremely	- 1
Neither like or dislike	- 5		

APPENDIX – II

Score card for the organoleptic evaluation of enriched nutri spreads

Name:

Date: **Signature:**

Sl. No.	Parameters	Treatments										
		Defatted soya flour						Skimmed milk powder				
		T_0	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}
1.	Appearance											
2.	Colour											
3.	Flavour											
4.	Texture											
5.	Taste											
6	Overall acceptability											

9 point hedonic scale

Like extremely	- 9	Dislike slightly	- 4
Like very much	- 8	Dislike moderately	- 3
Like moderately	- 7	Dislike very much	- 2
Like slightly	- 6	Dislike extremely	- 1
Neither like or dislike	- 5		

STANDARDISATION AND QUALITY EVALUATION OF NUTRI SPREADS

By
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ABSTRACT OF THE THESIS
Submitted in partial fulfilment of the requirement
for the degree of

Master of Science in Community Science
(FOOD SCIENCE AND NUTRITION)
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2018

ABSTRACT

Spreads are confectionary products based on vegetable fat, powdered sugar, cocoa powder and other ingredients. Spreads are popular and widely accepted by consumers due to its taste, flavour and suitability for consumption either alone or in combination with a variety of other foods. Spreads are very popular among children and hence its nutritional qualities demands special attention. But most of the commercially available spreads are loaded with heavy fat, sugar and many preservatives, which may lead to severe health problems. Moreover the cost of these spreads is also very high. With increasing health awareness among people, much consumer attention has focused on nutritious and healthy spreads. The present study entitled 'Standardisation and quality evaluation of nutri spreads' was conducted to standardise nutritionally superior spreads and to evaluate its nutritional, organoleptic and shelf life qualities.

Nutri spreads were standardised using 36 different combinations based on peanut paste (PP) and jackfruit seed flour (JSF). The suitability of three different fat sources *viz.* cocoa butter (CB), unsalted butter (UB) and hydrogenated palm oil (HPO) were also assessed in both PP and JSF nutri spreads. The most acceptable combination of PP based spread and JSF based spread from each fat source were selected for further studies. In PP nutri spreads, the treatments PT_4 (60% PP+20% CB), PT_9 (65% PP+15% UB) and PT_{15} (65% PP+15% HPO) were the best based on organoleptic qualities. In nutri spreads based on JSF, the treatments JT_{12} (25% JSF+ 55% UB) and JT_{15} (35% JSF+45% HPO) were the found to be the best. These organoleptically best nutri spreads were prepared and packed in PET containers and stored under ambient and refrigerated conditions for a period of three months and evaluated for various quality parameters throughout the storage. The physico-chemical, organoleptic and microbiological qualities of these products were evaluated initially and at monthly intervals.

The textural properties revealed that the brittleness and adhesiveness in the selected nutri spreads varied from 18.705 mm (PT_9) to 25.808 mm (PT_{15}) and 2.789 N (JT_{12}) to 144.131 N (PT_4).

Among various fat sources tried, nutri spread combinations with hydrogenated palm oil (HPO) retained organoleptic and shelf life qualities upto three months of storage. The nutrients present in 100 g of PP and JSF nutri spreads were 519.21 Kcal and 520.02 Kcal (energy), 15.08 g and 6.60 g (protein), 40.49 g and 46.02 g (fat), 5.13 mg and 16.5 mg (calcium), 2.59 mg and 1.86 mg (iron), 3.05 mg and 3.15 mg (phosphorus), 0.35 mg and 0.67 mg (zinc), 5.27 mg and 8.29 mg (sodium) and 40.70 and 27.60 (potassium) respectively.

The selected nutri spreads were evaluated for bacteria, fungi and yeast. The presence of bacteria, yeast or mould was not detected initially. After first month of the storage, the bacterial load present in selected nutri spreads varied from 0.02 x 10^6 cfu/g to 0.43 x 10^6 cfu/g. The fungal colony for the selected nutri spreads were not observed in initial and first month of storage. After second month of storage, the fungal colony was observed with a variation of 0.01 x 10^3 cfu/g (PT_{15}) to 0.83 (JT_{12}) x 10^3 cfu/g. At end of the storage, the fungal colonies were increased and varied from 0.03 x 10^3 cfu/g (PT_{15}) to 1.02 (JT_{12}) x 10^3 cfu/g. There was no yeast in any of the selected nutri spreads throughout the storage period.

Based on nutritional, organoleptic and shelf life qualities, treatments PT_{15} (65% PP+15% HPO) and JT_{16} (35% JSF+ 45% HPO) were found to be the best combinations and were selected for enrichment.

The selected two combinations were enriched using two protein sources *viz.* defatted soya flour (DSF) and skimmed milk powder (SMP) in varying per cent levels (10% to 50%). Based on organoleptic evaluation among PP nutri spreads, PP nutri spread replaced with 10% DSF and 20% SMP were found to be the best. Among JSF

nutri spreads, the treatments replaced with with 20% DSF and with 30% SMP were the best and these four treatments were selected for storage studies.

Protein content increased in PT_1 (20.78g/100 g) and PT_7 (20.76 g/100g) after enrichment when compared to control (15.08g/100 g). In JSF nutri spreads, a considerable increase in protein content was observed in JT_8 (14.23 g/ 100 g) when compared with control (6.60 g/ 100 g). The mean scores for the overall acceptability of enriched nutri spreads were above 7.00 throughout the storage. The enriched nutri spreads were evaluated initially and during first, second and third month for bacteria, fungal and yeast for a period of three months. The bacteria, fungal and yeast colonies were not detected initially. An increase in bacterial and fungal count were noticed after third month of storage in all the products. Yeast colony was not detected throughout storage period.

The selected nutri spreads were shelf stable without any deterioration upto three months of storage in PET containers at both ambient and refrigerated conditions. The cost for selected PP based nutri spread was Rs. 66.18 and for JSF based nutri spread was Rs. 45.13/ 100 g. The cost varied from Rs. 55.25 to Rs. 80.35 / 100 g for selected enriched nutri spreads.

The present study found that good quality, nutritious and healthy nutri spreads using locally available ingredients could be prepared without adding any preservatives. The developed nutri spreads contain good amount of nutrients, which is essential for the growth and development of children. These nutri spreads were very cost effective compared to commercially available spreads. The developed nutri spreads have immense scope for popularisation and commercialisation through technology transfer.