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Full Length Research Article

Quality Characteristics, Nutritional Evaluation and Storage Studies of Sesame (*Sesamum indicum* L.) Spread

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Abstract

Breakfast spreads are foods that are spread onto another food and frequently accompany breakfast-type bakery products such as breads, biscuits, pancakes, and waffles. The aim of this study was to formulate sesame spread with sesame seed, coconut, brown sugar, and oil in various proportions such as SS_1 (30:30:30:10), SS_2 (40:20:30:10), SS_3 (50:10:30:10), SS_4 (20:40:30:10) and compared with the control. Hence the study determined the physical properties, microbial quality, sensory evaluation, nutritional and antioxidant characterization, and storage study was carried out for about 30 days in a glass jar of refrigerate temperature of 4 °C. Themicrobial analysis revealed the total plate count was 5×10^4 cfu/gm and there is no growth in the total yeast and mould count. Among all the proportions SS_2 was highly acceptable in terms of sensory evaluation. The proximate composition was analyzed such as carbohydrates (17.4±1.13g), protein (27.15±2.20g), fat (27.1±0.78g), calcium (752.19±3.45mg), and iron (4.5±0.99mg). The result revealed that phenol content (0.036mg/g), peroxide value (0.42±0.05meq), TBARs value (1.9±0.8 MDA), rich in antioxidants (67.52%), and phytochemicals. The overall result of this study demonstrated the sesame spread was rich in nutrients and cost-effective and it can be considered a convenience food.

***Key words*:** Convenience food, Sesame seed, Antioxidant characterization, Breakfast spreads, Phytochemicals

India has a diverse cuisine culture. It serves both classic and trendy cuisine. Because of the influence of modern society, consumption patterns have altered over time. Nowadays, convenient foods have altered the entire scenario. Socioeconomic circumstances have also evolved with the altering global scene, resulting in a large need for convenience foods. India will soon be recognized as a global center for yield and a maker of processed and packaged food, and it will be known as a "sunrise industry". Convenience food become popular due to its innovative technology, ease to handle, transportation, storage, social society, politics, economical force, and trends in the younger generation (Verma *et al.*, 2020). The gendered divisions of labour and job patterns have a significant impact on the demand for convenience foods, which in turn affects the amount of time available for home meal preparation (Bava *et al.* 2008).

Several processed foods, such as biscuits, crisps, bread, pies, sandwiches, and rolls, dairy goods (milk, cheese, spreads), prepared salad and vegetables, and fruit, can be categorized as RTE products. The list can be very long, and as more and more goods join the food market each day, it keeps growing (Fast, 1999).

Spreadable goods are typically used to enhance the flavour or texture of foods like bread and crackers. Commercially available spreadable goods include chicken meat spread, peanut butter spread, cheese spread, mayonnaise, jam, and jelly (Karnjanapratum *et al.* 2022).

Sesame seed (*Sesamum indicum* L.) is an herbaceous annual plant that belongs to the order tubiflorae and the family pedaliaceae. It is used for its edible seed, oil, and flavour. Due to its exceptional resistance to oxidation and rancidity, it is also known as gingelly, until, benne seed, and popularly as the "queen of oil seeds"(Pathak *et al.*, 2014). Sesame seeds include a significant amount of fat, protein, minerals, vitamins, and fibre. According to studies, they have found that sesame seeds contain 21.9% protein and 61.7% fat, and are abundant in minerals such as Fe and Ca (Rout *et al.*, 2018).

Sesame seeds are a common ingredient and are used in a variety of dishes such as bread meals, soup, crackers, and meat cuisines, and they have health benefits such as preventing diabetes, lowering the risk of cancer, protecting DNA from radiation damage, reducing signs of ageing, facilitating digestion, improving oral health, and lowering the risk of cardiovascular disease (De 2020). One of the most adaptable natural items in the world is coconut, which has a wide range of uses. Because it is nourishing and good for health, this pleasant beverage was enjoyed all over the world. The numerous uses of coconut were supported by its distinctive chemical composition, which includes carbohydrates, protein, total minerals, phytic acid, and salts (Prades *et al.* 2012).

Nut spread is a spreadable product having at least 40% nut ingredients and can be added in various forms like nuts, a paste, or a slurry (Nielsen 2010). It can be used in various forms like spreads in a sandwich, toppings for edible crackers or dips for vegetables, and in baking. It is popular because of its taste, flavour, and good nutritional value and is suitable for consumption with a combination of other foods or alone (Shakerardekani *et al*. 2013). Nearly all available spreads are packed with heavy fat, sugar, and many preservatives, which leads to health problems (Rammayamolu *et al.* 2022).

Hence, the aim of this study is to focus on standardizing and formulation of nutritious bread spread using sesame seed *(Sesamum indicum L.)*, which is nutrient-dense without any preservatives. Sesame spread was evaluated in terms of physical properties, sensory evaluation, nutritional and antioxidant characterization, microbial quality, and storage study.

MATERIALS AND METHODS

The study entitled "Quality characteristics, nutritional evaluation and storage studies of sesame *(sesamum indicum L.)* spread" has been approved by the independent human Ethics Committee (IHEC) dated: 01/10/2021 (Protocol No. SDNBVC/HSC/IHEC/2021/13), conducted by the department of home science, Shrimathi Devkunvar Nanalal Bhatt Vaishnav College for Women, Chrompet, India.

Formulation of sesame spread

The sesame spread was developed by using the ingredients such as coconut, brown sugar, refined oil, and sesame seed purchased from the local supermarket. Sesame seeds were authenticated by the National Institute of Herbal Science, Plant Anatomy Research Centre, West Tambaram, Chennai, India**.** For the preparation of the spread, the method of Mulindwa *et al.* 2019was followed with modification. All the ingredients such as sesame seeds and coconut were washed to remove the dirt and dried. Weighing of desired quantity of ingredients was made to 100g of spread, sesame seed was roasted at 180^0 C for 2 minutes and allowed to cool to room temperature (24^0C), ground for about 1 minute, and with freshly grated coconut, brown sugar, and refined oil for 150 seconds until it becomes a smooth paste. Cooled at 28^0C for 24 hours and filled into the sterilized glass jar. Then the spread was stored in the refrigerator at 4^0C. The sesame spread was prepared with varying proportions mentioned in the below (Table 1) respectively.

Table 1 Different formulations of sesame spread variations

Ingredients	Control (SS_0)	(SS_1)	(SS_2)	(SS_3)	(SS_4)
Peanut (g)	60	-	-	-	-
Sesame seed (g)	-	30	40	50	20
Coconut (g)	-	30	20	10	40
Brown sugar (g)	30	30	30	30	30
Refined oil (ml)	10	10	10	10	10

The accepted spread was done based on the organoleptic evaluation. SS_2 of the sesame spread was chosen among the other variations based on the sensory evaluation and it was discussed in table (5). It has a significantly higher overall acceptability of the product. Hence, SS_2 has been used to conduct an analysis of the sesame spread including physical characterization, microbial quality, sensory evaluation, nutritional and antioxidant characterization, and storage study.

Fig 1 Formulation of sesame spread

Physical properties

The formulated spread was analyzed for physical properties such as texture property, colour profile, and viscosity. The texture property such as hardness, cohesiveness, and adhesiveness of the spread was analyzed with the texture analyzer of the TA XT plus model (Mazaheri-Tehrani *et al*., 2009). The colour measurement of the spread was carried out by using hunter colour on the basis of the CIE L*, a*, and b* colour system (Ansorena 1997). The viscosity of sesame seed fat spread was measured using the method described by Sravani (2020).

Microbial quality

The total plate count (TPC) of the spread sample was estimated by the procedure laid down in the method of Ahmed *et al.* (2020) using nutrient agar (NA) media, Potato dextrose agar (PDA) was used to enumerate yeast and mould count as per the procedure laid down in the method of (Ruth Bekele Mijena 2015).

Sensory evaluation

The sensory characteristics of the sesame seed spread were determined in terms of colour, appearance, texture, flavour, and overall acceptance according to the sensory evaluation technique described by (Ranganna 1986).

Nutritional and antioxidant characterization

The proximate composition of the sesame spread was determined by ash content, moisture content, carbohydrates, protein, fat, iron, and calcium were carried out by (AOAC, 2000) Method. The total phenolic content in the spread was evaluated as per the method of the Folin-Ciocalteu technique by Sadeghi *et al.*, 2020**.** Phytochemical was analyzed by using the procedure of Harborne, 1998. The antioxidant activity was analyzed by DPPH Assay by following Blois, 1958**.**TBARs value and peroxide value are two measures of oxidation stability.The peroxide value was carried out (AOAC, 2004) and the TBARs Assay was determined by using the procedure (AOCS, 2004).

Storage study

According to Krause *et al.*, 2008with modifications, Storage studies were carried out for the prepared sample and quality parameters like microbial quality and sensory evaluation were evaluated during storage on the interval of 0^{th}, 1^{st}, 15^{th}, and 30^{th} day in a glass jar ofrefrigerate temperature at (4 ℃).

Cost calculation

According to the method described by Kumar Jain *et al.*, 2018production cost for the sesame spread was calculated on the basis of raw material cost and processing cost. The following formula was employed to calculate the price per kg of sesame spread:

$$\text{Cost of production (per kg)} = \frac{\text{Cost A}+\text{Cost B}}{Q}$$

Where, Cost A indicates the cost of raw materials
Cost B indicates the cost of processing
Cost Q indicates the quantity of sesame spread (per kg)

RESULTS AND DISCUSSION

Physical properties

The hardness of spread (185.5±103.8g), and control(98.3±54.8g), shows a lower value than that of the hardness of the fat(hemp-oil) based spread which is (565.00±11.27g) **(**Radocaj *et al*., 2011). Then the hardness of the sesame spread is due to the disruption of the continuous fat phase and cellular component aggregation involved. The adhesiveness of spread (-4.377±3.67g) and control (0.06±0.13g) the result of the spread resembles the adhesiveness of the peanut butter fortified with soy flour of 6.16g (Mazaheri-Tehrani *et al.*, 2009). The force required to remove anything that sticks to the mouth (usually the palate) during the mastication process is known as adhesiveness and thus spread is not sticky. The cohesiveness of spread was (0.52±0.037g) and control (0.95±0.98g) and the obtained result of the spread was at the lower level when compared to the studyby Mohamed *et al.*, 2016reported the value of cohesiveness 0.866g of the processed cheese analogue spreads made with apricot pulp. It indicated that the spread can be easily broken down and swallowed while eating.

Table 2 Texture properties of sesame spread

Type of the sample	Texture property		
	Hardness (g)	Adhesiveness (g)	Cohesiveness (g)
Control	98.3 ± 54.8	0.06 ± 0.13	0.95± 0.98
Sesame spread	185.5±103.8	-4.377 ±3.67	0.52± 0.037

Values are expressed as mean ± standard deviation

Table 3 Colour profile and viscosity of sesame spread

Type of the sample	Colour profile			Viscosity		
	L*	a*	b*	Rpm	Cp	Temp °C
Control	64.35±0.96	6.67±0.76	31.05±1.10	100	1527000±100	29.5
Sesame spread	37.86±0.09	7.15±0.13	13.4±0.33	100	2249±483.7	29.4

Values are expressed as mean ± standard deviation

The value of L* indicates that spread (37.86±0.09) has low lightness than control (64.35±0.96), a* shows that more redness in spread (7.15±0.13) than control (6.67±0.76), b* reveals that spread (13.4±0.33) than control (31.05±1.10), respectively, and the results of the spread show the relevant colour parameters on the study of pistachio spread (L* - 33.7, a*- 5.4, b*- 14.7) (Shakerardekani *et al.*, 2013). The darkness of the spread is due to the addition of brown sugar and the non-enzymatic reaction which results in the Millard and Caramelization reaction as same as sesame seeds containing sugar and amine groups.

The viscosity of the sesame spread(2249±483.7Cp) was lower than the control (1527000±100Cp). The viscosity reported by Olaleye *et al.*, 2021for the peanut butter was (3535±0.35 Cp), which is higher than the sample spread. Higher viscosity as it reduces the flow of the spread, as the spread shows 2249 Cp of viscosity, it can be able to spread in the bread. This may be due to the addition of fresh coconut in the spread.

Table 4 Microbial quality of sesame spread

Type of sample	Total bacterial count (Cfu/g)	Yeast and mould (Cfu/g)
Control	5×10^4	No growth
Sesame spread	5×10^4	No growth

Microbial quality

The total bacterial count was found to be 5×10^4 in both the control and spread. As for the ready-to-ready guideline for butter, the bacterial limit can be up to 10^5 - $<10^7$ cfu/g (Bolton *et al.*, 2009). Hence as per the mentioned above the total bacterial count of the sesame spread was within the safety levels and it is safer for the consumption recommended. There is no growth of mould and yeast observed in both the spread and the control, because the product was prepared in a hygienic condition.

Sensory evaluation

For the evaluation, the un-trained panelist of 15 members with constituted to evaluate the samples. All the panelists were associated with the Shrimathi Devkunvar Nanalal Bhatt Vaishnav College for Women, Chromepet. From the bite until complete mastication, untrained panelists characterize a product's behavior in their mouth in terms of quality and quantity using mechanical, geometrical, fat, and moisture properties (Shakerardekani *et al.*, 2013).

The spread was evaluated by the panelists for its appearance and the most accepted was SS_2 (8.4± 0.73) because it has a gloss and appealing to the eyes and is brown in colour. The colour, on the other hand, was unique to each spread and it was determined by the raw material and its proportion. The most attractive colour has occurred in SS_2 (8.66 ± 0.48) than the other variations. The accepted taste has occurred in the SS_2 (8.6 ± 0.63) and tastes like a commercial spread in the market which was described by the panelists. The most accepted flavor was found in SS_2 (8.55 ± 0.51) and it gives a nutty flavour. The accepted texture occurred in SS_2 (8.33 ± 0.61), because it has the best spreadability. The overall acceptability found in SS_2 (8.46 ± 0.51) indicates the five characteristics such as colour, flavor, texture, taste, and appearance of the product. The result revealed that amongst the different variations, SS_2 is the most accepted one among the panelist and showed the better value of texture, flavour, taste, aroma, appearance, and overall acceptability of the spread.

Table 5 Sensory evaluation of sesame spread

	Appearance	Colour	Taste	Flavour	Texture	Overall acceptability
Control (SS_0)	7.6 ± 1.05	7.73 ± 0.67	7.6 ± 0.81	7.66 ± 0.74	7.73 ± 0.88	7.53 ± 0.99
SS_1	6.33 ± 1.3	6.53 ± 0.74	6.6 ± 0.63	6.33 ± 0.97	6.4 ± 1.18	6.86 ± 0.83
SS_2	8.4 ± 0.73	8.66 ± 0.48	8.6 ± 0.63	8.55 ± 0.51	8.33 ± 0.61	8.46 ± 0.51
SS_3	5.73 ± 1.03	5.7 ± 1.16	5.9 ± 0.79	5.86 ± 0.91	5.66 ± 1.17	6.13 ± 0.99
SS_4	5.4 ± 1.12	5.2 ± 1.2	5.4 ± 1.6	5.53 ± 1.3	5.33 ± 1.3	5.06 ± 1.33

Values are expressed as mean ± standard deviation

Nutritional and antioxidant characterization

Proximate composition

Table 6 Proximate composition of sesame spread

Nutrients	Control	Sesame spread
Ash (g/100g)	2.22±0.57	2.33±0.73
Moisture (g/100g)	2.77±1	8.82±1.0
Protein (g/100g)	29.28±1	27.15±2.20
Fat (g/100g)	38.9±1	27.1±0.78
Carbohydrates (g/100g)	14.66 ±1.002	17.4±1.13
Iron(mg/100g)	2.19±1	4.5± 0.99
Calcium(mg/100g)	165.4±1	752.19±3.45

Values are expressed as mean ± standard deviation

Ash and moisture content

The ash content of spread (2.33) and control (2.22) is slightly lower than the peanut spread fortified with soy flour (3.25) by Mazaheri-Tehrani *et al.,* 2009. The moisture content of spread (8.82) and control (2.77) was found to be lower than that of soy butter (14.10 ±1.61) which was found in the study by Matsiko *et al.,* 2014. Then the moisture content was high in the spread due to the addition of coconut.

Carbohydrate

Carbohydrates are the primary source of energy consumed by the human body (Caffall *et al.,* 2009). The carbohydrate content of spread (17.4g) and control (14.66g) and was similar to the result of 80% cashew nut butter (18.80g) (Ogunwolu *et al.,* 2010). The carbohydrates were increased in the spread, due to the sesame, coconut, and brown sugar as these are the sources of carbohydrates in the diet.

Protein

Protein requirement is defined as the amount of protein required as part of a nutritionally adequate diet to achieve growth in neonates, children, and pregnant women and maintenance in adults and the elderly (Arentson-Lantz *et al.,* 2015). The protein content of spread (27.15g) and control (29.28g) shows a closer value of sesame butter (26.0g) (AP, 2009). As peanut is an essential legume and they offer more protein than any other nut.

Fat

Fats are naturally present in many foods and serve important functions in the human body such as structural units of cellular membranes, in energy storage, and as precursors to metabolic compounds involved in inflammatory and immune responses (Arab, 2003). The fat content of control (38.9g) washigher than spread (27.1g) and the multi-nut spread developed byKaur *et al.,* 2018has a fat content of 42g which is higher than spread. The fat content in the spread was derived from sesame, coconut, and oil.

Iron

Iron is an abundant element on earth (Quintero-Gutiérrez *et al.,* 2008) and a biologically necessary component of all living organisms (Aisen *et al.,* 2001; Lieu *et al.,* 2001). The iron content of spread(4.5mg) is higher when compared with control(2.19mg) and the above-mentioned value of iron content was higher than 1.96mg/100 of the peanut butter which was shown in the study peanut butter from indigenous peanut cultivars of Pakistan (Shibli *et al.,* 2019). The increased iron content of the spread may be attributed to the incorporation of the sesame seed in the spread.

Calcium

Calcium is a mineral that is involved in a wide range of vital functions (World Health Organization, 2004). The calcium content of control (165.4) and spread (752.19mg) was higher than the multi-nut spread (589.4 mg) which is made in the combination of peanut, sesame, walnut, and flaxseeds (Kaur *et al.,* 2018). The rise in calcium in the spread was due to the sesame seeds. As sesame seeds can provide calcium between 250 to 600 mg per 100 grams.

Total phenol

The total phenolic of control and spreadwas 0.027mg/g and 0.036mg/g respectively. The highest phenolic content was recorded in the spread. The result was lower than the value reported by Thakaeng *et al.* 2020 for value-added butter was 0.10 mg GAE/g. Numerous studies throughout the years have suggested that the Folin-Ciocalteu reagent interacts with antioxidants besides phenols. These include, among others such as proteins, amino acids, vitamins, amines, and aldehydes (Everette *et al.* 2010). The sesame seed is an excellent source of calcium and other compounds that can interfere with the determination of phenolic compounds in this assay, making their estimation inaccurate.

Table 7 Total phenol of sesame spread

Name of sample	OD	Phenol content (mg/gram)
Control	0.201	0.027±0.5
Sesame spread	0.262	0.036 ±0.01

Values are expressed as mean ± standard deviation

Phytochemicals and antioxidant activity

Table 8 Phytochemicals of sesame spread

Tests	Control	Sesame spread
Alkaloids	-	++
Phenol	+	++
Flavonoids	-	++
Coumarins	+	++
Terpenoids	++	++
Quinones	-	-
Amino acids	-	-
Anthracyanine	-	-
Saponin	-	-
Cardiac glycosides	++	++

Prakash (2020) stated that phytochemicals have great antioxidant potential and are of great interest because of their beneficial effects on human health, and they provide enormous

health benefits to consumers. Consumption of phytochemicals is associated with a lower risk of several types of chronic diseases because of their antioxidant and free radical scavenging effects (Zhang *et al.,* 2015). Quantitative analysis of the spread showed the presence of phytochemicals presented as larger content, the compounds such as alkaloids, phenol, flavonoids, coumarins, terpenoids, and cardiac glycosides than the control.

Table 9 Antioxidant activity- DPPH Assay of sesame spread

Name of sample	Initial OD	Final OD	Scavenging %
Control	0.945	0.436	53.86
Sesame spread	0.945	0.307	67.52

Antioxidants are groups of compounds that prevent the cell from being damaged by free radicals and reactive oxygen species (ROS) (Abuajah *et al.,* 2015). The development of many chronic diseases, such as cardiovascular diseases, ageing, heart disease, anaemia, cancer, and inflammation, was significantly influenced by the presence of antioxidants, which offer protection against the damage caused by free radicals (Vaibhav *et al.,* 2011). DPPH scavenging activity ofcontrol was 53.86% while the case of spread has a higher activity of 67.52% which was made out of sesame seed and coconut. However, the study reported by Rohini *et al.* 2021shows an antioxidant activity of 40% in the mango and pumpkin seed powder spread. This shows that the spread made with sesame has 27% of higher antioxidant activity.

Oxidation stability

Table 10 Oxidation stability of sesame spread

Name of the sample	Peroxide value (meq/kg)	TBARs value (ng/ml MDA)
Control	1.55±0.9	5.00±0.08
Sesame spread	0.42 ±0.05	1.9 ±0.8

Values are expressed as mean ± standard deviation

The peroxide value of spread was (0.42 meq/kg) and this was significantly lower than the control (1.55 meq/kg). This peroxide value (0.44 meq/kg) of sesame spread was lower than the range (1.03 meq/kg) of shea butter and unrefined shea butter (2.57 meq/kg) (Samuel *et al.,* 2017). Thus, the result obtained on the peroxide value has the lower range which shows it has a longer shelf life and can delay the rancidity of the sesame spread.

The TBARs value of spread was (1.9 ±0.8 ng/ml MDA) recorded as the lowest value while control has the highest value of (5.00±0.08 ng/ml MDA). The study by Pidatala *et al.* 2021 reported that malonaldehyde was (1.14 ng/ml MDA) of peanut butter which is similar to sesame spread. Hence the TBARs of the sesame spread are high compared with the control and can be stored for a longer period of time.

Storage study

Microbial activity

A total bacterial count of less than 50,000/g is considered acceptable in terms of microbiological quality, according to the (FSSAI, 2015). The spread met the FSSAI criteria for microbiological quality up to 30 days, as shown in (Table 11), with a total bacterial count of 50,000/g on the 30th day of storage. The bacterial growth on the spread was within the safer limit of consumption even after 30 days of storage. This is due to that the spread was prepared, stored in an aseptic condition, and maintained at the proper temperature (4°C) to keep a longer period of time without spoilage. The count of yeast and mould was zero (0) in spreads stored at refrigeration temperature (4°C) for 30 days, indicating that there was no yeast or mould growth in the product and that it was safe to consume and this could be attributed to the heat treatment employed during preparation and the care taken to avoid contamination during packing. Hence the spread is prepared and maintained at optimal temperature and the growth of microorganisms was within the safer limits than the control.

Table 11 Changes in microbial activity on storage of sesame spread

Storage temperature	Name of sample	Parameter	0^{th}day	1^{st} day	15^{th} day	30^{th} day
Refrigeration temperature	Sesame spread	Total bacterial count	1×10^4	2×10^4	3×10^4	4×10^4
		Yeast and mould	Nil	Nil	Nil	Nil
Refrigeration temperature	Control	Total bacterial count	1×10^4	2×10^4	3×10^4	12×10^4
		Yeast and mould	Nil	Nil	Nil	Nil

Table 12 Sensory evaluation on storage of sesame spread

	Parameters	0^{th} day	1^{st} day	15^{th} day	30^{th} day
Control	Appearance	7.46±0.73	7.3±0.63	7.2±0.59	6.14±0.91
	Colour	7.6±0.74	7.57±0.43	7.46±0.72	6.35±0.30
	Taste	7.4±0.51	7.39±1.3	7.23±0.86	6.11±0.98
	Flavour	7.73±0.08	7.66±2.56	7.57±0.14	6.47±0.87
	Texture	7.46±0.32	7.36±0.12	7.21±0.98	6.14±0.51
	Overall acceptability	7.4±1.12	7.3±0.04	7.29±0.50	6.18±0.63
Sesame spread	Appearance	8.53±0.63	8.43±0.4	8.35±0.51	7.9±0.7
	Colour	8.65±0.86	8.45±0.12	8.25±0.12	7.85±0.21
	Taste	8.66±0.56	8.56±0.16	8.35±0.18	7.86±0.14
	Flavour	8.79±1.45	8.59±0.32	8.47±0.21	7.56±0.27
	Texture	8.54±0.3	8.47±0.36	8.35±0.36	7.45±0.49
	Overall acceptability	8.46±0.12	8.33±0.4	8.21±0.45	7.3±0.63

Values are expressed as mean ± standard deviation

Sensory evaluation

The major factors that influence consumer approval are colour, appearance, flavour, texture, taste, and overall acceptability of the product. During storage, physiochemical and microbiological changes have occurred in the spread. The colour score occurred in spread on the 0^{th} day (8.65), 1^{st} day (8.45), 15^{th} day (8.25), and 30^{th} day (7.85) and it was very slightly decreased from the 0^{th} day to the 30^{th} day. The appearance score of the spread was also reduced from the 0^{th} day (8.53) to the 30^{th} day (7.9). The taste, flavour, and texture

scores in the spread were lowered from 8.66 to 7.86, 8.79 to 7.56, and 8.54 to 7.45 between the 0th and 30th day. The overall acceptability score of the spread was reduced from 8.46 to 7.3 between the 0th day and to 30th day.

The drop in colour, appearance, texture, taste, flavour, and overall acceptability was related but it was accepted by the consumer more than the control. Hence spread may be considered the most appropriate variation for edible.

Cost calculation

Food prices are a key factor in determining consumption patterns, and high food prices, particularly for poor people, may have significant negative effects on health and nutritional status (Davis 2002). The cost of the sesame spread was found to be per kg (Rs 236.75) and per 100 grams (Rs 23.67) and it was cost-effective when compared to the commercial spread.

CONCLUSION

Bread spreads are one of the convenience foods. Commercial spreads are loaded with high sugar and fat and cause non-communicable disorders. Sesame seed is an herbaceous annual plant and it has a significant amount of fat, protein, minerals, vitamins, and fibre. The current study revealed that preparing a spread using local ingredients improves the nutritional quality of the spread without any artificial additives. The spread prepared with the sesame and coconut was accepted by the panelist and their microbial quality were within safer limits, the developed spread was a good source of nutrient like carbohydrates, protein, iron, calcium and low in fat. The result indicates that the sesame spread is highly rich in antioxidants and phytochemicals like alkaloids, phenol, flavonoids, coumarins, terpenoids, and cardiac glycosides. It has less rancidity which does not give off flavour or taste and the spread can be stored in the refrigerator (4°C) for about 1 month. Hence the spread developed with the combination of nuts and oil seeds are rich in essential nutrients and provide a wide range of health benefits and can be consumed by adult, children, and the general population than the commercial spread like jam, marmalades which are loaded with fat which is a healthier option. It is more cost-effective than commercial spread. However, the developed sesame spread is more highly nutrient-dense than the commercially available spread. Then it can be used in different varieties preferable to the consumers.

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