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Development and Storage Studies of Soymilk Fat Spread

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Abstract: ***An experiment was conducted to study the feasibility of blending soymilk and sunflower oil in combination with different natural flavouring components in the same ratios, for preparation of Soymilk Fat Spread. The Soymilk Fat Spread was analysed for its different chemical as well as sensory qualities by adopting 9 point Hedonic Rating Scale.Soybeans provide high quality proteins, while containing no cholesterol, lactose or gluten. Among different blended flavoursof coffee, vanilla, mango and Indian blackberry for preparing Soymilk Fat Spread, the ratio of 1:2 soymilk: oil added with coffee flavour and dry form of okara reached the highest sensory scores for overall acceptability i.e., 8.7.The Soymilk Fat Spread was analysed for its chemical constituents for a storage period of 20 days. In this analysis a slight increase in pH and acidity was found whereas a slight decrease in other chemical constituents like protein, fat, carbohydrate, moisture, ash and iron was found. Microbial enumeration study has also proved that the product is self stableupto 20 days under refrigeration temperature.***

Keywords: Soymilk Fat Spread, Soymilk, Sunflower oil, Okara

1. Introduction

Soymilk Fat spread is a condiment that can generally be used along with various products in order to increase its overall taste and acceptability. Till date there were no attempts made for formulating non bovine milk and eggless spreads, so, a soymilk based spread was formulated to act as a substitute to commercial egg, bovine milk and cream based spreads. Nowadays, there is a huge increase in population with allergies and intolerances, mainly the one with lactose intolerance and egg protein based allergies so, there was a need to formulate a substitute to all the commercially available egg and milk based spreads.

Soybeans (*Glycine max*) have been an integral part of human diet and it belongs to *leguminaceae* family. Soybeans are an important source of inexpensive protein. However, they have not been widely accepted. Soybeans used in Asian countries for production of many traditional foods such as tofu and miso are considered one of the most economical sources of food protein[1].Soybeans provide high quality proteins, while containing no cholesterol, lactose or gluten [2]. Soybean is rich in minerals especially calcium, magnesium, iron, zinc and copper [3]. It is also excellent source of thiamine, riboflavin and niacin vitamin [4]. The nutritive value of soybean protein is at the highest level of food sources available from the plant world.When compared to cow's milk, the high amounts of arginine and aspartate should be mentioned [5]. Daily consumption of 25 gmsoyproteinhas been shown to lower cholesterol by 10% [6]. The most abundant fatty acid in soybeans is linoleic acid representing approximately half of the total content, although it also contains considerable level of other essential fatty acids i.e. linolenic acid [7],[8].Isoflavones are phytochemicals present in soybeans and they have been implicated in health benefits; including the potential to reduce the risk of age related and hormone related diseases, including cancer, menopausal symptoms, cardiovascular disease and osteoporosis [9]. The higher content of indigestible raffinose and stachyose, the flatulence factors, limit the consumption of soybean as a raw food material [10].As raw soybeans cannot be consumed as such, therefore it needs to be converted into various processed products. A variety of processed products can be prepared from soybeans like soymilk, tofu, miso, soymilk residue okara, soy sauce etc.

Soymilk is a water extract of soybeans that is a source of protein and calories for human consumption. Soymilk has been given considerable attention as an economical and nutritive beverage. Soymilk is composed of 94% moisture, 3% protein, 1.5% fat, 1.5% carbohydrates and ash [11]. Soymilk is an excellent dietary supplement for lactose intolerant consumers, vegetarians and milk allergy patients[2].Soymilk provides more iron than cow milk; it also contains more copper and magnesium than cow milk. In order to absorb calcium one needs magnesium, copper also aids in bone formation. Soymilk contains 12 times the amount of copper as does cow's milk. It also contains 42 times the amount of magnesium as does the cow's milk [12]. Total lipid content was 23% for soybeans, 4.4% for okara and 1.4% for soymilk. In soybeans, the major fatty acid is linoleic acid (58%) followed by oleic acid (21%), palmitic acid (9.6%), α-linolenic acid (7.8%) and stearic acid (3.4%). This pattern was similarly repeated both in soymilk and okara. Both soymilk and okara maintain the proportion of 63% and 62% PUFA (polyunsaturated fatty acid) respectively. The thermal treatment during the elaboration of soymilk does not promote trans fatty acid formation [13].Soymilk contains 10.73 mg/100g of isoflavones. Soy based isoflavones are modestly effective in relieving menopausal symptoms. Genistein and Daidzeinisoflavones are found in high amounts in soybeans and soy products. Soy isoflavones may suppress bone resorption and minimize bone loss under some conditions. Reduction in blood pressure may be another mechanism by which soy isoflavones improve cardiovascular health [14].

The soymilk residue which is a byproduct and is known as okara is used as a food material for its high content of protein and fiber. Okara is the pulp fiber residue generated as a by-product in large quantities from the soymilk production process. Raw okara contains about 75% of moisture (wet basis), 25% of protein, 10-15% oil and bulk amount of crude fiber [15].Bowles and Demiate [16], showed that approx. 1/3 of isoflavones present in the soybean remains in the okara indicating that the okara protein is of extremely high quality suggesting that it is good low cost source of nutrients for human nutrition. The presence of 95% of solid grain solid components in okara makes it a very high nutritional value [17] and may be utilized as an ingredient in variety of processed foods [18]-[20] because it reduces calorie intake and increases dietary fiber. The high quality protein fraction is responsible for water and fat binding, emulsifying and foaming properties and anti-hypertension effects and these non-nutritional properties influence the production and quality of a determined food [21],[22].Wet okara normally cannot be stored for more than 2 days but dried okara can be stored for 28 days without any changes of nutritional property. The color, aroma, texture of wet okara is not so much accepted like dried okara. Dried okara is whitish yellow in color and has sweet aroma but wet okara is white in color and has little beany flavor. The texture of wet okara is creamy soft whereas dried okara is little hard. When okara is properly dried, the proportion of all the constituents of dried okara gets increased. Dried okara has higher protein, fat, carbohydrate with 25% of protein[23].

Sunflower (*Helianthus annus*) plant is a miraculous oil seed crop which is cultivated globally for its seeds.Sunflower seeds, a nutritional dense food have been found to have a potential role in chronic inflammatory conditions, bacterial and fungal infections, cardiovascular diseases, skin diseases and even cancers. These benefits of sunflower oil are attributed to the presence of phytosterols, proteins and a variety of vitamins and minerals [24]. Sunflower oil is high in oleic acid and linoleic acid. These fatty acids reduce the LDL cholesterol and total cholesterol decreasing the chances of coronary artery disease [25]. Sunflower oil is an excellent source of vitamin E which neutralizes free radicals, scavenge them and prevent oxidative damage to cellular and molecular components exhibiting anti-inflammatory, cardio protective and anti tumor action [26],[27].

Guar gum is mainly consisting of the high molecular weight (approximately 50,000-8,000,000) polysaccharides composed of galactomannans and is obtained from the endosperm of the seed of the guar plant, *(Cyamopsistetragonaloba* (L) Taub.) (Syn. *Cyamopsispsoraloides*). It is used as thickener, stabilizer and emulsifier, and approved in most areas of the world (e.g. EU, USA, Japan, and Australia). The gum is a white to yellowish white, nearly odourless, free-flowing powder with a bland taste. The gum is soluble in cold water without heating to form a highly viscous solution [28]

Coffee arabica beans are mostly valued because of their delicate flavour. *Coffee robusta*beans are less delicate with an earthy flavour but have higher caffeine than *Coffee arabica.* Globally, coffee is used principally as a beverage. It is also used to flavour desserts and ice creams. Coffee contains chlorogenic acid, caffeic acid, trigonelline, starch pentosans, cellulose, hemicelluloses, sucrose, proteins and oil. Coffee's bitterness balances savoury and other taste profiles. Sugar is usually added to decrease coffee's bitterness [29].

Soymilk fat Spread made from above components is a type of condiment which can be used to enhance the palatability of various bakery products. This spread is basically an eggless spread made out of an oil in water emulsion of soya milk and sunflower oil. This emulsion is then enhanced in its taste by adding sugar and different flavours like coffee, vanilla or pulp of different fruits. In order to add more nutritional value to this spread, it is fortified with soy milk residue called okara. This emulsion is stabilized by adding Guar gum. Blending all these components together forms the Spread thus providing many nutrients in one blend.

2. Materials and Methodology

2.1 Procurement of Raw Materials

Fine quality soybeans were procured from local market of Nashik, Maharashtra, India. These soybeans were used to prepare soymilk. Refined sunflower oil, coffee powder, sugar and guar gum were purchased from supermarket of the same city. All the raw materials were subjected to cleaning and grading operations and were then used for further processing and development of the desired product.

2.2 Preparation of Soymilk

Soybeans were washed and soaked in water overnight. Soaked soybeans were dehulled and blanched adding sodium bi-carbonate in water, at 80º-90ºC for 10-15 minutes. Blanched soybeans were then grinded with hot water and the obtained slurry was cooked for 15 minutes. The enzyme believed to be responsible for the undesirable beany flavor in soymilk is inactivated by using boiling water in grinding stage of the production. The use of hot water and sodium bi carbonate blanch before grinding also reduces off flavor [30]. Soymilk was obtained after straining the slurry through muslin cloth. This soymilk was then boiled for 10 minutes and the residue (okara) obtained as a by-product during straining process, was dried in vacuum tray drier which was kept at 60ºC[23] and maintained at 300 mmHg and it was then grinded to prepare okara powder

2.3 Preparation of Soymilk Fat Spread

Soymilk and sunflower oil were taken in the ratio of 1:2 and were blended with the help of high shear blender. Sugar, okara powder and different flavor components were added in the desired ratio in different samples prepared. Guar gum solution was prepared and added to the emulsion prepared. This mixture was blended uniformly and then filled in sanitized polypropylene containers. The final product was stored under refrigeration.

Table 1: Variations in formulation of Soymilk Fat Spread

Ingredients	A	B	C	D
Soymilk(ml)	100	100	100	100
Oil(ml)	200	200	200	200
Flavour	Mango pulp	Vanilla extract	Coffee powder	Indian blackberry pulp
Form of okara	Wet	Wet	Dry	Dry

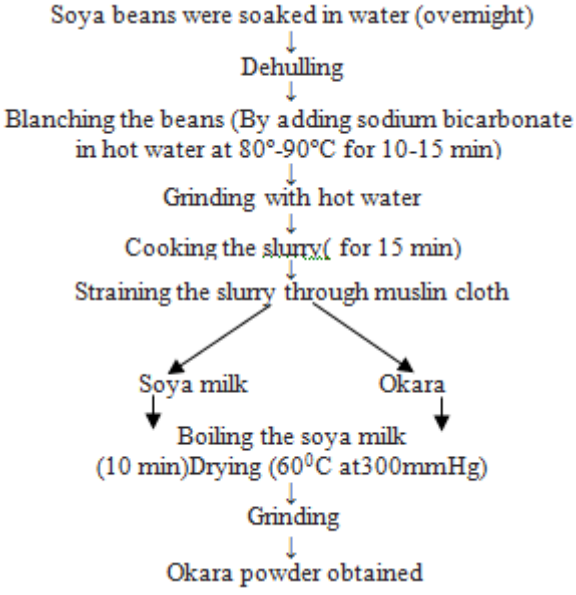
2.4 Storage Study

The sample selected by the sensory panelists was studied for its shelf life at refrigeration temperature. Chemical analysis of the product was done once in 10 days up to 20 days of storage. Carbohydrate, protein, fat, iron, moisture and ash were the parameters checked during chemical analysis. pH is defined as the logarithm of the reciprocal of hydrogen ion concentration in grams per litre of the samples and it was calculated using pH meter. For determining acidity of the product, 1 gram sample was diluted with 49ml distill water to make up the volume upto 50ml and 10ml was taken for estimation. This diluted aliquot was then titrated with 0.1N NaOH using 1% phenolphthalein solution as indicator and the results were calculated as present anhydrous citric acid [31]. Protein was estimated using micro Kjeldahl method which is based on the determination of the amount of reduced nitrogen present in the sample [32]. Fat was estimated according to method of [33]. Ash content and iron content was determined using the method described by Ranganna [31]. Carbohydrate was determined using USFDA method [34]. Moisture content was determined using Hot air oven method [35]. Sensory analysis was conducted. Overall acceptability of the Soymilk Fat Spread was determined on 9 point Hedonic Rating Scale by 10-12 semi-trained panelists.

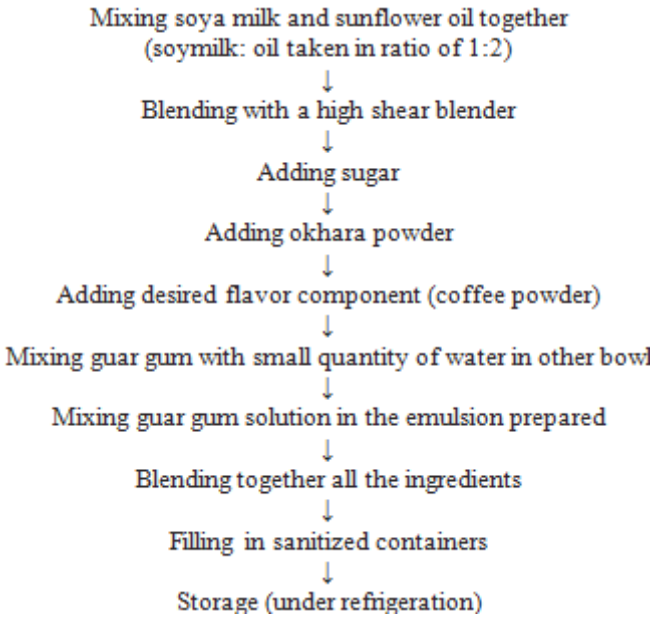
2.5 Microbial examination of the product

Sample was serially diluted. Dilutions of 10^0, 10^{-1}, 10^{-2}, 10^{-3} and 10^{-4} were taken for the analysis. 1 ml of serially diluted sample was taken in petridishes which were appropriately filled with media for specific organism. Plates were incubated at room temperature for 24 hours for bacteria and the colonies were counted [36].

a) Preparation of soya milk [37],[23]



b) Preparation of spread



3. Results and Discussions

3.1 Development and Standardization of Soymilk Fat Spread

Soymilk and sunflower oil were blended in 1:2 ratio and different flavors were added to check the acceptability of the product.

The flavor and taste of the Soymilk Fat Spread was good as it is evident from the mean scores obtained for these attributes. When coffee was used as flavoring component and dry form of okara was used, all the sensory attributes were having good results as compared with other flavoring components and wet form of okara. In soymilk, the presence of compounds such as aldehydes, ketones, and alcohols has been implicated as the source for the "beany" flavour[1]but soymilk, when blended with oil in 1: 2 proportion and added with coffee powder and dry form of okara, improves the nutritional as well as sensory qualities of Soymilk Fat Spread which was found acceptable upto 20 days at refrigeration temperature. The spread with mango flavor had very less scores for all the attributes. Although the overall acceptability was the same for spread with Indian blackberry and vanilla flavor, their scores for color, flavor and taste varied widely.

Table 2: Mean sensory scores obtained for the Soymilk Fat Spread

Characteristics	Samples of Soymilk Fat Spread added with different flavors			
	A	B	C	D
Color	7	7.5	8	8.2
Appearance	7.9	8	8.3	8.4
Flavor	7.3	8	9	7.8
Taste	7.2	8.6	9.2	7.8
Consistency	8.7	9	9.2	8.9
Overall Acceptability	7.6	8.2	8.7	8.2

Where, A= Mango flavor B= Vanilla flavorC= Coffee flavor D= Indian blackberry flavor

3.2 Chemical properties of Soymilk Fat Spread

Chemical analysis of Soymilk Fat Spread was done on 0th day, 10th day and 20th day of its storage life. The data obtained on chemical properties such as carbohydrate, fat, protein, moisture, ash and iron were recorded and changes in chemical properties of Soymilk Fat Spread were studied.

3.2.1 pH
There was a fall in pH value from 8.6 to 7.6 in Soymilk Fat Spread. A slight decrease in pH was observed in soymilk stored at different temperatures during 10 days of storage [38].

3.2.2 Titrable acidity
A gradual increase in titrable acidity in terms of lactic acid of the Soymilk Fat Spread was observed during storage. Initial acidity 0.04% increased to 0.09%. Same results were obtained by [38] in storage studies of soymilk.

3.2.3 Protein content
The data clearly indicates that there was a slight decrease in protein content of the Soymilk Fat Spread. Initially on 0th day, protein content was 25.1gm per 100gm of the spread, which was decreased to 24.9gm per 100gm of the spread after 20 days of storage. Similar findings were cited by Osundahunsi [39] in scientific literature.

3.2.4 Fat content
The slight decrease in fat content in the Soymilk Fat Spread may be attributed to the development of rancidity as a result of lipid hydrolysis that occurs during storage. The fat deterioration during storage may be attributed to activity of lipase enzyme which split off the fat into free fatty acids and glycerol in the presence of moisture, light and heat [40]. Fat content found on 0th day was 13.6gm per 100gm of the spread which decreased to 13.2gm per 100gm of the spread on 20th day of storage.

3.2.5 Carbohydrate
The data clearly indicated that there was a slight decrease in carbohydrate content of Soymilk Fat Spread. On 0th day it was found to be 31.6gm per 100gm of the spread whereas on 20th day it was 30.1gm. These results are confirmative with the scientific literature by Sumathi*et al.*[41].

3.2.6 Ash content
A significant decrease was observed in ash content of Soymilk Fat Spread with increase in storage period from 0 to 20 days. The ash content on 0th day was 0.9% which decreased to 0.8% on 20th day. Similar results were obtained from scientific literature by El- Samahy[42].

3.2.7 Iron content
Iron content was found decreasing from 24.8 mg per 100gm of the spread to 24.3mg as the storage life increased from 0-20 days.

3.2.8 Moisture
The moisture content on the 0th day was found to be 40% which was reduced to 37% on the 20th day of storage under refrigeration. Similar results of decrease in moisture content with increase in storage time were observed by Bajwa*et al.*[43].

Table 3: Chemical properties of soymilk fat spread

Chemical properties	Storage days		
	0	10	20
pH	8.6	8.1	7.6
Titrable acidity (%)	0.04	0.06	0.09
Proteins (gm)	25.1	25.1	24.9
Fats (gm)	13.6	13.4	13.2
Carbohydrates (gm)	31.6	30.8	30.1
Ash (%)	0.9	0.8	0.8
Iron (mg)	24.8	24.5	24.3
Moisture (%)	40	39	37

3.3 Enumeration of microbial load in Soymilk Fat Spread

Initially there was no microbial load in Soymilk Fat Spread during storage. Using Total Plate Countit was found that the microbial load increased to 3.6 X 10^3after 20 days. This growth in the bacterial colonies may be because no preservatives were added to the spread. There was no fungal growth observed in the spread. Minimum increase in microbial population was recorded when the Soymilk Fat Spread was stored at refrigeration temperature and use of dry okara to helped to maintain the shelf life of Soymilk Fat Spread till 20 days, as initially dry okara has a shelf life of 28 days [23].

3.4 Organoleptic attributes of Soymilk Fat Spread

Table 2 describes the mean score for all the quality attributes which was initially 9.2 for taste and consistency, 9 for flavor, 8.3 for appearance and 8 for color. Slight changes were observed in all the attributes after 20 days of storage. The color of the Soymilk Fat Spread changes to a slight lighter shade on 20th day than that observed on the 0th day. This change in color is attributed to degradation of pigments. The loss in flavor may be due to increase in acidity and lowering pH.Soymilk Fat Spread becomes more viscous on 20th day.This may be due to collapse of air cells, causing the spread to lose its volume and thus leading to shrinkage. Because of this shrinkage the spread becomes heavy, viscous and dense.

Table 4: Organoleptic characteristics of Soymilk Fat Spread during storage

Storage days	Sensory attributes					
	Color	Appearance	Flavor	Taste	Consistency	Overall acceptability
0	8	8.3	9	9.2	9.2	8.74
10	7.9	8.2	8.7	9	9.1	8.58
20	7.7	8	8.5	8.7	9	8.38

4. Conclusion

On the basis of the above results, it is possible to prepare Soymilk Fat Spread by blending coffee as the flavoring component. It is also evaluated that this spread is highly acceptable as it is rich in protein and has extremely good flavor. It can be stored for 20 days at refrigeration temperature without showing any symptoms of microbial spoilage. Hence, it is finally concluded that when compared to other spreads that are available in market, Soymilk Fat

Spread provides nutrients like proteins, iron and isoflavones which are essential to maintain health.

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