

DEVELOPMENT OF FUNCTIONAL DAIRY SPREAD

ABSTRACT

Aims: The study aimed to develop functional dairy spread which can be spreadable at refrigeration temperature and low in fat content.

Study design: Development of functional dairy spread and its analysis.

Place and Duration of Study: Department of Dairy Technology, Dairy Science College, Hebbal, Bengaluru, Karnataka Veterinary, Animal and Fisheries Sciences University, Bidar, Karnataka, India. Between June 2022 and March 2023.

Methodology: Ingredients for the functional dairy spread were optimized through sensory analysis by a panel using a 9-point hedonic scale. The optimized spread was then analyzed for its techno-functional attributes and microbiological quality.

Results: The optimized dairy spread contained skim milk powder (14%), whey protein concentrate (4%), and salt (1%), with cream, flaxseed oil, sunflower oil, carboxymethyl cellulose, and glycerol monostearate as constant ingredients. The spice blend of ginger, garlic, coriander, and white pepper powder was

optimized at 2%. The optimized functional dairy spread had 30.20% fat, 7.46% protein, and 53.2% moisture, with total solids at 47.6% and ash at 2.57%. Acidity was at 0.42% LA, viscosity at 123 cP, and hardness index at 0.47mm. Water activity was 0.932, spreadability was 1.6 cm/hr, and color measured at L* 87.32, a* -1.65, b* 16.05. Coliforms, yeast and molds, staphylococci, and lipolytic counts were all nil.

Conclusion: The developed product exhibited excellent spreadability at refrigeration temperature and had a low fat content while being functional spread.

Key words: *Saturated fatty acid, Cream, Spreadability, Low fat, Functional spread*

1. INTRODUCTION

Spread is an emulsion; either the fat source is from milk or vegetable. Spread is commonly utilized with bread, toast, biscuits, chapatti, and similar food items. Spreadable products such as margarine, butter, and various fat blends are commonly used in households.

Among these spreads, butter is particularly favoured and widely consumed by common people (1). Despite butter being renowned for its delicious flavour, its high cost and calorie density, primarily due to its elevated fat content, have resulted in a decrease in its popularity among consumers who are more conscious of their calorie intake. Moreover, traditional butter poses a practical inconvenience as it tends to harden when refrigerated, making it difficult to spread, and becomes overly soft when left at room temperature (2). The increased hardness of butter samples is attributed to higher levels of saturated fatty acids, resulting in its poor spreadability when refrigerated. (3). Hence, efforts are being focused on development of spread that are spreadable when refrigerated, low in fat, enhance nutritional value and flavour, while also improving functionality.

In the pursuit of technological advancements, proposals have emerged to modify both the composition and physical attributes of milk fat-based systems. These endeavors involve incorporating blends of milk fat and unsaturated vegetable oils. Cream, chosen as a primary fat source due to its reduced saturated fatty acid content and lower fat contribution relative to butter, enhances spreadability owing to its diminished saturated fat levels. Additionally, the utilization of polyunsaturated fatty acids contributes to the enhancement of spread texture and spreadability (4). Therefore Flaxseed oil and sunflower oil was used as a PUFA source. Flaxseed stands out as the most abundant plant source of the omega-3 fatty acid α linolenic acid (ALA), with its oil containing relatively low levels of saturated fatty acids (5) and Sunflower oil is primarily composed of linoleic acid (a polyunsaturated fat) and oleic acid (a monounsaturated fat) (6), known for containing various phytochemicals and celebrated for its phenolic antioxidants (7).

Supplementation of protein in the spread involved incorporating sources such as skim milk powder and whey protein concentrates. Proteins aid in the emulsification of fat and the absorption of water, ensuring that the final product is stable (4). WPC and WPI are versatile in food applications due to their high protein content and multifunctional roles as water-binding, gelling, emulsifying, and foaming agents, offering benefits such as low calorie and

fat contents, excellent properties, and compatibility with other ingredients, all contributing to their perception as "natural" products (8).

Throughout history, herbs and spices have been employed in food fortification for their roles as preservatives, flavour enhancers, and therapeutic agents, and their incorporation into dairy foods could yield functional products with both nutritional and medicinal benefits. Phenolic compounds found in herbs and spices offer natural alternatives to artificial antimicrobial agents commonly used in food manufacturing, thereby extending the shelf life of food products (9).

The current investigation aimed to optimize the process for developing dairy spread. Furthermore, the study focused on optimizing the spices to prepare functional dairy spread. The resulting product underwent analysis for its techno-functional and quality attributes.

2. MATERIALS AND METHODS

2.1 Materials

For cream separation, Fresh cow milk was procured from the student's experimental dairy plant (SEDP), Dairy Science College, Bengaluru and this milk was subjected to centrifugal cream separation using Alfa Lavel Cream Separator at SEDP. Cream thus obtained was standardized to 40% milk fat using Pearson square method and used for preparation of Dairy Spread. Flaxseed oil was procured from Indic Wisdom Wood Pressed Flaxseed Oil, Indic Wisdom Pvt. Ltd., Maharashtra and sunflower oil was procured from Good Life, Vinayak Oils & Fats Pvt. Ltd., West Bengal. Skim milk powder (SMP) and Whey protein concentrate 80 (WPC) was used as a protein source. SMP was purchased from Nandini, Mother Dairy, A unit of KMF, Bengaluru and WPC 80 from Asitis, Medizen Labs Pvt.Ltd, Bengaluru. Carboxy methyl cellulose (CMC) was used as stabilizer and Glycerolmonostearate (GMS) as emulsifier procured from FR Products, Shariff Unani & ayurvedic Pharma. Common salt was procured from Ashirwad, Terapanth Foods Ltd, Gujarat and white pepper powder from Everest white pepper, Narendrakumar & Co., Mumbai. Ginger, garlic and coriander was procured from the local vegetable market and they cleaned and trimmed to get edible portion of it. Finely cut pieces of ginger and garlic were grinded with coriander using mechanical blender into fine and smooth paste and stored for further usage.

2.2 Methods

2.2.1 Process optimization for the development of Dairy spread

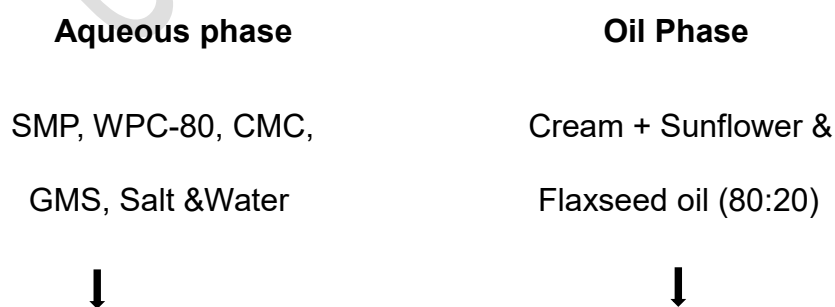
The dairy spread was prepared as described by (10) with a slight modification. Based on preliminary trials, the cream, flaxseed oil, sunflower oil, CMC, and GMS were kept constant, while the optimization of ingredients focused on varying levels of SMP at 12, 14, and 16%, WPC at 2, 4, and 6%, and salt at 0.5, 1, and 1.5%, as determined by sensory evaluation.

In the preparation of optimized dairy spread, emulsion consists of a fat phase and aqueous phase. Aqueous phase was prepared by adding ingredients like SMP 14%, WPC (80) 4%, Salt 1%, CMC 0.75% and GMS 1% into water, followed by blending using mechanical blender to form homogenous mixture, heating (63°C/15mins) and cooling it to 40°C. Fat phase was prepared by adding Cream (40% fat) and Vegetable Oil (Sunflower & Flaxseed oil) at the ratio of 80:20 and heating the mixture to 55°C followed by cooling to 40°C. Then emulsified by adding aqueous phase into the oil phase at 40°C for 3-5 mins. Pasteurized the emulsion at 75°C/15 mins, then filled the spread into Polypropylene cups (100g) and stored at refrigeration temperature 7±1°C.

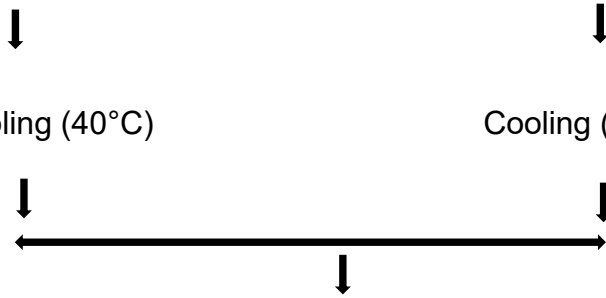
2.2.2 Optimization of spices level for the development of functional dairy spread

To enhance the flavour and functionality of the developed dairy spread, a mixture of ginger, garlic, coriander and white pepper powder in equal ratios was added at levels of 1.5, 2 and 2.5%, with the 2% mixture being optimized based on sensory evaluation. After emulsification, the spice mixture was blended into the spread for 1-2 minutes using mechanical blender, pasteurized at 75°C for 15 minutes, then filled into 100g polypropylene cups and stored at refrigeration temperature 7±1°C.

Figure 1: Preparation of Functional Dairy Spread



Blending (mechanical blender) Heating (55°C)
& Heating (63°C/15 mins)



Emulsification (3-5 mins at 40°C)



Addition of spices (2.0 %)

(Ginger+ Garlic+ Coriander + White Pepper powder)



Blending (mechanical blender, 1-2 mins)



Pasteurization (75°C/15min)



Spiced Functional Dairy Spread



Packaged (PP cups, 100g)



Storage (7±1°C)

2.2.3 Sensory evaluation

The sensory characteristics for the developed spread was assessed by five sensory panelists using 9-point hedonic scale ranging from 1 (disliked extremely) to 9 (liked extremely). The panelists assessed the spread for its colour and appearance, flavour, body and texture, and overall acceptability at refrigeration temperature ($7\pm 1^\circ\text{C}$) and spreadability was assessed by applying the sample onto a slice of bread at $7\pm 1^\circ\text{C}$.

2.2.4 Assessment of techno functional attributes for developed spread

2.2.4.1 Fat

Fat content of developed functional dairy spread was determined by Mojonnier's method (11).

2.2.4.2 Protein

Protein content of developed functional dairy spread was determined by Kjeldahl method (12).

2.2.4.3 Acidity

Acidity of developed functional dairy spread was determined by titration method (13).

2.2.4.4 Total solids

The total solid content of the developed functional dairy spread was assessed according to the method described in (13).

2.2.4.5 Moisture

Moisture content of developed functional dairy spread was determined by gravimetric method (11).

2.2.4.6 Free fatty acid

Free fatty acid content of developed functional dairy spread was assessed according to the method described in (12).

2.2.4.7 Peroxide value

Peroxide value of developed functional dairy spread was assessed according to the method described in (12).

2.2.4.8 Viscosity

Viscosity, or a fluid's resistance to flow, was measured for the developed dairy spreads using a Lamy viscometer (B-one plus LR module). This viscometer accommodates low (LV), medium, and high (RV)

viscosity measurements with different spindles, and spindle duration can be adjusted from 1s to n s to suit product characteristics.

2.2.4.9 Colour measurement

A tool used in colourimetry is a Spectrophotometer (3nh) which will calculate the intensity of colour in our developed product. It alludes to a machine that aids in the absorption of a certain wavelength of light by particular solutions. Using the Beer-Lambert law, it determines the concentration of known solutes in solutions.

2.2.4.10 Water activity

The LabSwift - aw system determines the fraction of free water in a test sample. For aw- value determination, the equilibrium air humidity over a sample (water - vapour pressure) was measured. This behaves proportional to the aw- value.

2.2.4.11 Hardness Index

Hardness index is the force necessary to attain a given deformation. Penetrometer (Spectro Lab) was used for evaluating hardness index of the developed functional dairy spreads. Penetrometer allows a weighted cone in contact with the food material to penetrate the surface under its own weight. The distance that it penetrates in a given time is the characteristic measure that was recorded.

2.2.4.12 Spreadability

Spreadability is a measure of how easily and uniformly they can be deformed and spread at end use temperatures. The spreadability was assessed by measuring the distance flowed by a spread in centimeters per hour.

2.2.4.13 Microbiological analysis

For microbiological analysis, dilutions of 2, 3, and 4 were used. Different media were employed for various tests: Violet red bile agar for coliforms, Potato dextrose agar for yeast and mold, Tributyrin agar for Lipolytic count, Mannitol salt agar for Staphylococci count, and Standard plate count agar for Total Bacterial Count (TBC). Coliforms were incubated at 37°C for 18-24 hours, TBC, Lipolytic, and Staphylococci counts at 37°C for 24-48 hours, and yeast and molds at 30°C for 3-5 days.

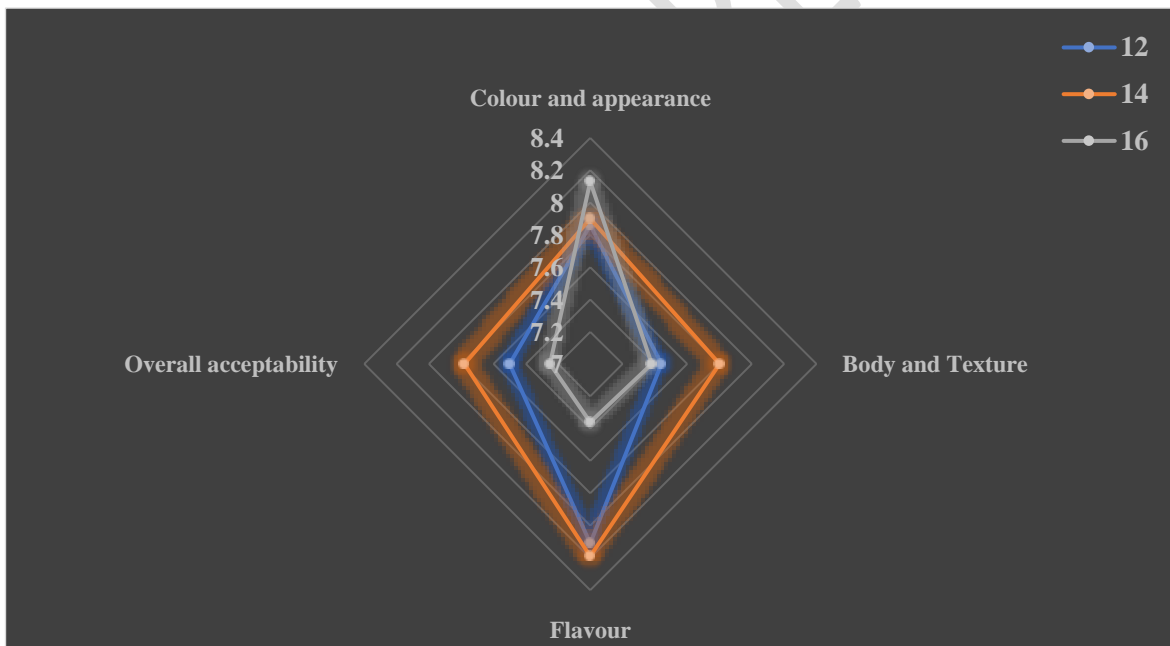
3. RESULTS AND DISCUSSION

3.1 Process optimization for the development of Dairy spread

3.1.1 Optimization of SMP

Higher colour and appearance scores were achieved with 16% SMP. The increase in SMP concentration improved these scores, although all samples exhibited a creamy white, smooth, and shiny appearance. The best body and texture scores were obtained with 14% SMP, resulting in a firm body and smooth texture. However, higher levels of SMP led to excessive firmness, surpassing the optimal texture, which was deemed unacceptable. Additionally, 14% SMP garnered higher flavour scores, whereas concentrations beyond 14% resulted in decreased flavour scores, likely due to the predominant milk powder flavour. Consequently, overall acceptability was higher for the 14% SMP added spread, thus optimizing it. These findings align with Bhardwaj's (14) study on cream based spreads.

Figure 2: Sensory scores for optimization of SMP

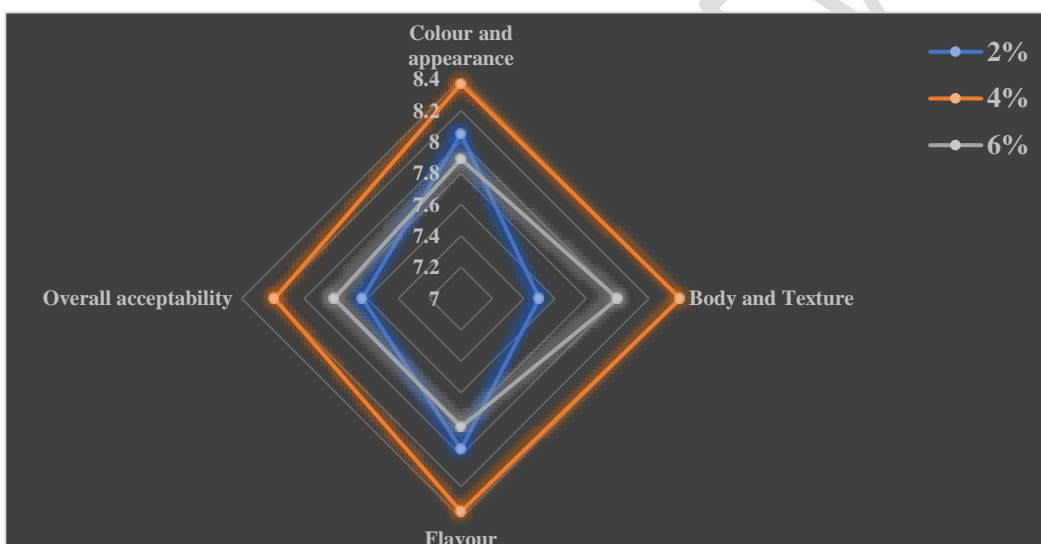


3.1.2 Optimization of WPC

In the optimization of WPC, the highest colour and appearance scores were obtained with 4%. Beyond this concentration, there was a decline in colour and appearance scores, with the spread containing 6% WPC receiving the least favourable score due to imparting a dull appearance, which previously exhibited a creamish white colour. The optimal body and

texture score was achieved with 4% WPC, while the lowest score was attributed to the spread with 2% WPC, resulting in weaker body characteristics. This disparity is attributed to the varying WPC concentrations, with 4% WPC providing an optimal thickness without making the spread overly thick or weak. Furthermore, 4% WPC received higher flavour scores, with increasing concentrations above 4% lead to a slight increase in acidic flavour, potentially masking the creamy flavour of the spread. Therefore, overall acceptability was higher for the 4% WPC added spread, thus optimizing it. The present findings were in accordance with study Shinde (15) who incorporated various levels of WPC into quarg cheese.

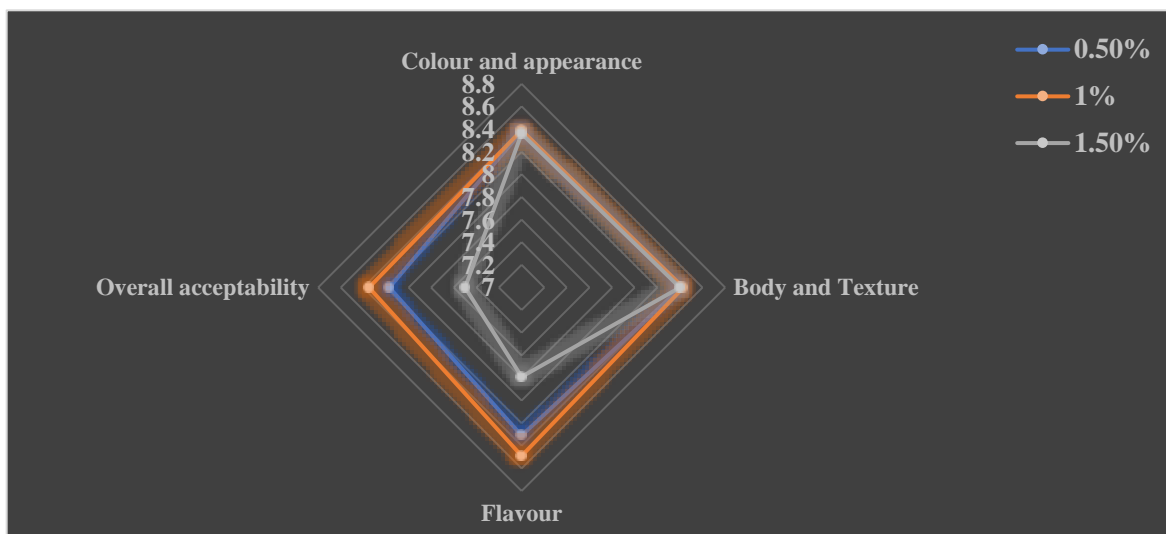
Figure 3: Sensory scores for optimization of WPC



3.1.3 Optimization of salt

In the optimization of salt, higher color and appearance scores, body and texture, flavor, and overall acceptability were observed with 1%. No significant differences were found among color and appearance and body and texture for all treatments. However, increasing the salt concentration above 1% intensified the saltiness of the spread, reaching unacceptable levels. These findings are consistent with Bhardwaj's (14) results on incorporating various salt levels into cream based spreads.

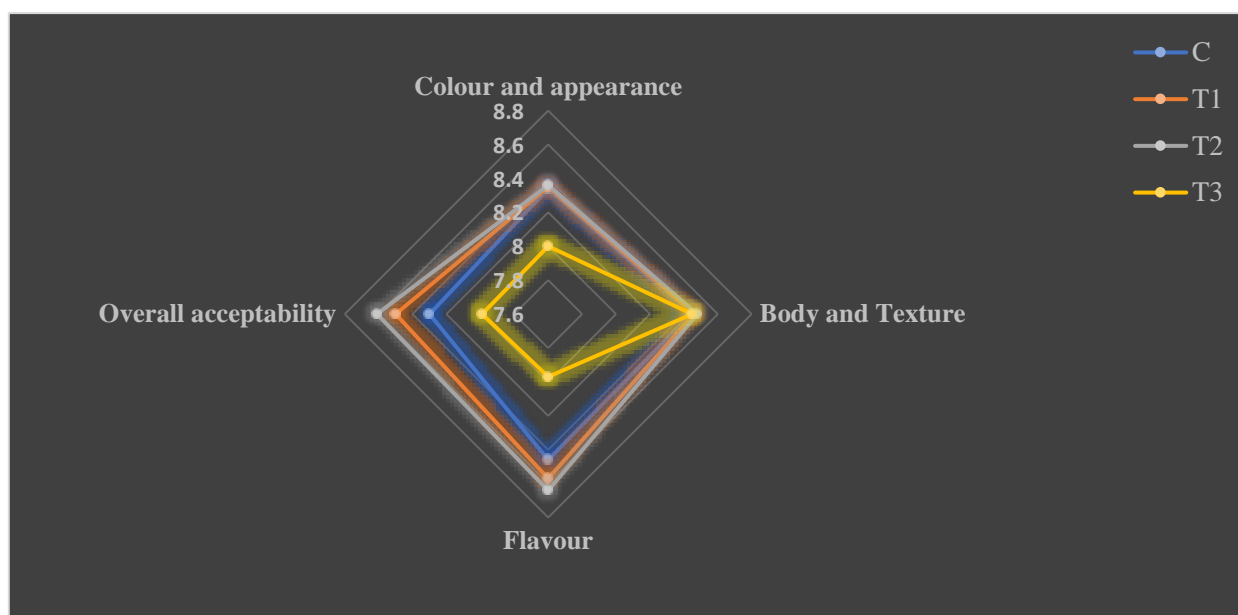
Figure 4: Sensory scores for optimization of salt



3.2 Optimization of spices for the development of functional dairy spread

The spread, enhanced with a spice blend, exhibited significant sensory improvement up to the 2% level of incorporation. Colour and appearance scores were highest at 8.36 for the 2% blend, with the control at 8.34 and a notable decline to 8.00 for the 2.5% blend due to intensified colour of spices. Similarly, body and texture scores were statistically non-significant among the control and spreads with varying spice blends, with the 2% blend receiving the highest score of 8.48. Bindu (16) found similar results on impact of ginger, garlic, and black pepper powders on the sensory characteristics of cottage cheese at levels of 0.5%, 1%, and 1.5%. In terms of flavour, the 2% blend achieved the highest score of 8.64, significantly higher than the 2.5% blend. Additionally, overall acceptability was highest for the spread with the 2% blend, scoring 8.61, while the 2.5% blend received the lowest score due to its darker colour and intense flavour. Kumar (17) observed similar findings in their study on mint flavoured yogurt spread. Thus, the spread with the 2% blend was optimized based on all sensory attributes.

Figure 5: Sensory scores for optimization of spices



*C= Control (Spread without spices) *T1= Dairy Spread with 1.5 % spices

*T2= Dairy Spread with 2.0 % spices *T3= Dairy Spread with 2.5% spices

3.3 Proximate analysis of developed functional spread

3.3.1 Fat

The maximum fat percentage was recorded for control spread of 30.22% and lowest was observed in functional spread of 30.20% attributed to the dilution effect on the spread's fat content, resulting in an overall lower fat percentage, as the added spices are inherently low in fat. The results coincide with the findings of Kaur (18) who prepared paneer spread with the incorporation of dried mint leaves from 0 to 2.5 %.

3.3.2 Protein

The higher protein percentage was found in functional spread of 7.46 % compared to control of 7.40 % may be attributed to the incorporation of protein content from the added spices. The results are in accordance with the Sandhya and Priya (19) who prepared Beetroot cream cheese spread.

3.3.3 Moisture

The maximum moisture percentage was recorded for control spread of 54.1 % and lowest in functional spread of 53.2%, this might be due to increase in the total solids content from the spices in the spread. Nazir et al (20) observed that yoghurt spread with added Spirulina (2.5%) exhibited a lower moisture content compared to yoghurt spread without added Spirulina, measuring 74.60% and 77.59%, respectively.

3.3.4 Total solids

The total solids of control and functional spread were 46.8 and 47.6 % respectively. The elevation in the total solids content in functional spread may be attributed to the incorporation of total solids from the spices. The obtain results are in agreement with Patange et al (21) prepared spiced quarg cheese with the incorporation of WPC at 10 %, ginger at 2 % and cumin at 1% had total solids of 35.86 total solids and control quarg cheese without spices had total solids of 36.54%.

3.3.5 Ash

The maximum ash percentage was recorded for functional spread (2.57%) and the lowest was observed in control spread (2.55%). The increase in ash percentage in functional spread compared to control could be attributed to the addition of mineral content from the spices. Similar results was confirmed by Nazir et al (20), in their study on the preparation of yoghurt spread fortified with spirulina.

3.3.6 Acidity

The highest acidity percentage was observed in functional spread (0.42% LA) comparing with control spread (0.34%). This higher acidity in functional spread could be attributed to the presence of organic acids present in the spices. The results were in accordance with the results found by Kaur (18) who developed the paneer spread with incorporation of dried mint leaves from 0 to 2.5 per cent level.

Sample	Fat (%)	Protein (%)	Moisture (%)	Total solids (%)	Ash (%)	Acidity (% LA)
Control	30.22 ^a	7.40 ^a	54.1 ^b	45.8 ^b	2.55 ^a	0.34 ^a
Functional dairy spread	30.20 ^a	7.46 ^a	53.2 ^a	46.8 ^a	2.57 ^a	0.42 ^a

Table 1: Proximate analysis of optimized functional dairy spreads

3.4 Study on rheological parameters of optimized functional dairy spreads

3.4.1 Viscosity

The highest viscosity was observed in functional spread of 123 cP while the lowest was observed in the control spread of 117 cP. could be attributed to the higher total solids content resulting from the added spices and the concurrent decrease in the moisture content of the spreads.

3.4.2 Hardness Index

The highest hardness index was obtained for functional spread of 0.47mm and lowest at control spread at 0.46 mm, may be attributed to the elevated total solids content resulting from the addition of spices.

3.4.3 Water activity

The highest water activity value was found for control spread (0.924) compared to functional spread (0.932) may be attributed to the reduced moisture percentage and the higher concentration of added dried spices. The present findings was confirmed with the report of Kaur (18) who prepared paneer spread with incorporation of dried basil leaves in the range of 0 to 2.5 %.

3.4.4 Spreadability

The higher spreadability observed in the control spread of 1.9 cm/hr compared to functional spread of 1.6 cm/hr may be attributed to its lower total solids content and higher moisture content. The results align with those of Kaur (18), who prepared paneer spread and found that the spreadability

score was higher for the control spread, while the addition of 1% dried mint leaves led to a decrease in the sensory score for spreadability.

The findings are parallel with those of a study (1) that prepared paneer spread and found that the spreadability score was higher for the control spread, while the addition of 1% dried mint leaves led to a decrease in the sensory score for spreadability.

3.4.5 Colour

The L* a* b* values of the control and functional spread were 90.93, -0.88, 16.97, 87.32, -1.65, 16.05, respectively. This disparity between control and functional spread can be attributed to the observed colour variation; the control exhibited a creamish white colour, while functional spread displayed a slight darker in colour due to addition of spices resulting in the control having the highest L* a* b* values. Meena et al (22) developed omega-3-rich mixed fat table spreads with L* a* b* values of 82.437, 4.353, and 27.87. Additionally, the spread incorporated with 0.25% thyme oil exhibited L* a* b* values of 83.86, 4.53, and 29.49, respectively.

Table 2: Study on rheological parameters of optimized functional dairy spreads

Sample	Viscosity (cP)	Hardness Index (mm)	Water activity	Spreadability (Cm/hr)	Colour		
					L*	a*	b*
Control	117 ^c	0.46 ^a	0.934 ^a	1.9 ^a	90.93 ^a	-0.88 ^a	16.97 ^a
Functional dairy spread	123 ^b	0.47 ^a	0.932 ^a	1.6 ^a	87.32 ^b	-1.65 ^b	16.05 ^b

* L* - Lightness from black to white on a scale of zero to 100, a* - Negative a* corresponds with green, positive a* corresponds with red, b* - Negative b* corresponds with blue and positive b* corresponds with yellow.

3.5 Evaluation of microbiological parameters on optimized functional dairy spreads

The counts recorded for coliforms, yeast and molds, staphylococci, and lipolytic counts for the control and functional spread were all nil for fresh spreads. This absence of coliform counts in the spreads indicates that hygienic conditions were maintained during product preparation. Additionally, nil counts of staphylococci and lipolytic organisms in the fresh samples suggest the absence of external contamination, possibly attributed to the sterile conditions under which the product was prepared. Prabhakarrrao (23) reported that there was no growth observed for coliforms and yeast and mold in fresh flavoured mayonnaise.

4. Conclusion

The developed dairy spread achieved excellent spreadability at refrigeration temperature ($7\pm 1^{\circ}\text{C}$) by enhancing its fatty acid profile through the incorporation of cream, which is low in saturated fatty acids, and vegetable oil rich in polyunsaturated fatty acids (PUFA). Furthermore, the functionality and overall acceptance of the spread were enhanced by augmenting its flavour with spices, while the addition of WPC, flaxseed, and sunflower oil contributed additional functionality to the spread.

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