
*Journal of Scientific Research and Reports*

***Volume 30, Issue 6, Page 690-700, 2024; Article no.JSRR.117254***
***ISSN: 2320-0227***

# Development of Functional Dairy Spread

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***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

***Article Information***

DOI: https://doi.org/10.9734/jsrr/2024/v30i62087

**Open Peer Review History:**
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/117254

***Original Research Article***

***Received: 07/05/2024***
***Accepted: 22/05/2024***
***Published: 29/05/2024***

## ABSTRACT

**Aims:** The study aimed to develop functional dairy spread that is 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 2023 and April 2024.

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***Cite as:*** *Pavithra S, Praveen A R, Devaraju R, Shilpashree B G, Malashree L, and Arun Kumar H. 2024. "Development of Functional Dairy Spread". Journal of Scientific Research and Reports 30 (6):690-700. https://doi.org/10.9734/jsrr/2024/v30i62087.*

**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 analysed 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 0.42% LA, viscosity was 123 cP, and the hardness index was 0.47 mm. Water activity was 0.932, spreadability was 1.6 cm/hr, and colour 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.

*Keywords: Saturated fatty acid; cream; spreadability; low fat; functional spread; staphylococci; lipolytic counts; butter consumption.*

## 1. INTRODUCTION

Spreads are emulsions with fat sources derived from milk or vegetables, commonly used with bread, toast, biscuits, chapatti, and similar food items. Popular spreadable products include margarine, butter, and various fat blends, with butter particularly favoured [1] for its sensory attributes such as flavour, aroma, and the pleasing mouthfeel resulting from its melting near body temperature [2]. However, butter has become less popular due to its high price and calorie content, attributed to its high levels of saturated fats. Increasing consumer awareness of calorie intake has led to a decline in butter consumption. Additionally, traditional butter presents a functional drawback: its spreadability diminishes when refrigerated due to its solid and stiff texture, a result of higher saturated fatty acid content [3].

To address these issues, the development of spreads incorporating milk fat and unsaturated vegetable oils has been explored [4]. These blends, with or without interesterification, improve spread texture and spreadability through the inclusion of polyunsaturated fatty acids. Typical constituents in fat spreads include milk proteins, milkfat, vegetable oils, salt, stabilizers, emulsifiers, and colourants, with proteins aiding in fat emulsification and water absorption to ensure product stability [5]. Dairy spreads are traditionally made using cream, butter, or butter oil [6].

Given the consumer demand for spreadable, low-fat, nutritionally enhanced, and flavourful spreads that maintain functionality even when refrigerated, our hypothesis proposes the addition of cream and vegetable oils (flaxseed and sunflower oils) as the fat phase. Cream is chosen for its reduced saturated fatty acid content and lower fat contribution compared to butter. Flaxseed oil, a rich source of the omega-3 fatty acid α-linolenic acid (ALA), contains relatively low levels of saturated fats [7]. Sunflower oil, primarily composed of linoleic acid (a polyunsaturated fat) and oleic acid (a monounsaturated fat) [8] is renowned for its phytochemicals and phenolic antioxidants [9].

The aqueous phase of the spread includes major ingredients such as skim milk powder (SMP) and whey protein concentrate (WPC) as protein sources. WPC and whey protein isolate (WPI) are valued in food applications for their high protein content and multifunctional roles, including water-binding, gelling, emulsifying, and foaming, which contribute to low-calorie and low-fat contents, excellent properties, and compatibility with other ingredients, enhancing their perception as "natural" products [10]. Spices were also incorporated to improve taste and functionality. Spices, known for their preservative, flavour-enhancing, and therapeutic properties, offer both nutritional and medicinal benefits, with phenolic compounds providing natural alternatives to artificial antimicrobial agents, thus extending food product shelf life [11].

This study aimed to optimize the process for developing a dairy spread that remains spreadable when refrigerated, is low in fat, nutritionally enhanced, and flavourful. The research focused on the optimization of spices to prepare a functional dairy spread, with the final product undergoing 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) at Dairy Science College, Bengaluru. This milk was subjected to centrifugal cream separation using an Alfa Laval Cream Separator at SEDP. The cream thus obtained was standardized to 40% milk fat using the Pearson square method and used for the 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 80) were used as protein sources. SMP was purchased from Nandini, Mother Dairy, a unit of KMF, Bengaluru, and WPC 80 from Asitis, Medizen Labs Pvt. Ltd., Bengaluru. Carboxymethyl cellulose (CMC) was used as a stabilizer and glycerol monostearate (GMS) as an emulsifier, both 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 were procured from the local vegetable market, cleaned, and trimmed to obtain the edible portions. Finely cut pieces of ginger and garlic were ground with coriander using a mechanical blender into a fine, 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 Thompkinson and Satish [12] with slight modifications. Based on preliminary trials, the amounts of 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 the optimized dairy spread, the emulsion consists of a fat phase and an aqueous phase. The aqueous phase was prepared by adding ingredients such as SMP (14%), WPC 80 (4%), salt (1%), CMC (0.75%), and GMS (1%) into water (35.25%), followed by blending with a mechanical blender to form a homogeneous mixture. This mixture was then heated to 63°C for 15 minutes and cooled to 40°C. The fat phase was prepared by adding cream (40% fat) and vegetable oil (sunflower and flaxseed oil) in a ratio of 80:20, heating the mixture to 55°C, and then cooling it to 40°C. The emulsion was formed by adding the aqueous phase into the oil phase at 40 °C and blending for 3-5 minutes. The emulsion was then pasteurized at 75°C for 15 minutes, filled into polypropylene cups (100g), and stored at a refrigeration temperature of 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 a mechanical blender, and then pasteurized at 75°C for 15 minutes, and filled into 100g polypropylene cups before being stored at a refrigeration temperature of 7±1 °C.

#### 2.2.3 Sensory evaluation

The sensory characteristics of the developed spread were assessed by five sensory panelists using a 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±1℃), while spreadability was assessed by applying the sample onto a slice of bread at 7±1℃.

#### 2.2.4 Assessment of techno functional and quality attributes for developed spread

Acidity (titration method) and total solids were measured as per ISI: SP18 Part (XI) 1981 [13]. The fat content (Mojonnier method) and moisture content (gravimetric method) of the developed functional dairy spread were determined

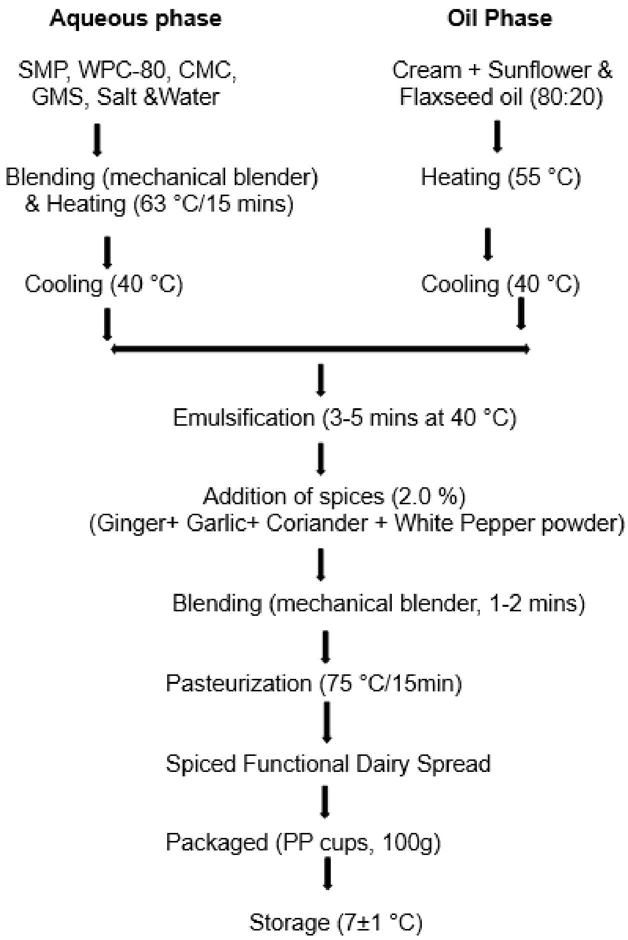


**Fig. 1. Preparation of Functional Dairy Spread**

according to ISI: SP18 Part (XI) 1981(b) [14]. Protein content (Kjeldahl method) and ash content (gravimetric method) were determined in accordance with AOAC (2005) [15].

Viscosity for the developed dairy spread was measured 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 1 second to n seconds to suit product characteristics. For this measurement, spindle L3 was used, with a spindle duration of 30 seconds.

A tool used for colour measurement was a spectrophotometer (3nh), which calculates the intensity of colour in the developed spread. It 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.

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

A penetrometer (Spectro Lab) was used for evaluating the hardness index of the developed functional dairy spread. The hardness index is the force necessary to attain a given deformation. The 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.

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

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, and Mannitol Salt Agar for Staphylococci count. Coliforms were incubated at 37 °C for 18-24 hours, 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

A cream based spread was prepared with varying levels of SMP: 12%, 14%, and 16%. Sensory scores for colour and appearance improved with increasing the concentration of SMP, with mean scores of 7.86, 7.90, and 8.13 for the 12%, 14%, and 16% SMP levels, respectively, and the highest score for the 16% SMP spread. All samples maintained a creamy white, smooth, and shiny appearance. The 14% SMP spread had the best body and texture score of 7.80, resulting in a firm body and smooth texture compared to 7.44 and 7.38 for the 12% and 16% levels, respectively, as higher SMP levels led to excessive firmness, surpassing the optimal texture, which was deemed unacceptable. Flavour scores were 8.11, 8.19, and 7.36 for the 12%, 14%, and 16% SMP spreads, respectively, with the highest score for the 14% SMP spread. Increasing SMP beyond 14% resulted in a decrease in flavour scores due to a predominant milk powder flavour, while the 12% SMP spread scored 8.11, attributed to its subtle flaxseed oil flavour. Overall acceptability was highest for the 14% SMP spread at 7.78, followed by 7.50 for the 12% SMP spread, and 7.25 for the 16% SMP spread.

These findings align with Bhardwaj's [16] study on cream based spread with 5%, 10%, and 15% SMP. Bhardwaj reported that the 10% SMP spread achieved the highest scores for colour and appearance, followed by the 15% and 5% SMP spreads. For body and texture, the 10% SMP spread scored highest at 7.8, with the 5% SMP spread scoring 7.48, and the 15% SMP spread scoring lowest due to increased hardness from lower free moisture. The 10% SMP spread also had the highest flavour score of 7.78, while the 15% SMP spread scored lowest due to a dominant salty and milk powder flavour. Overall, the 10% SMP spread had the highest acceptability score.

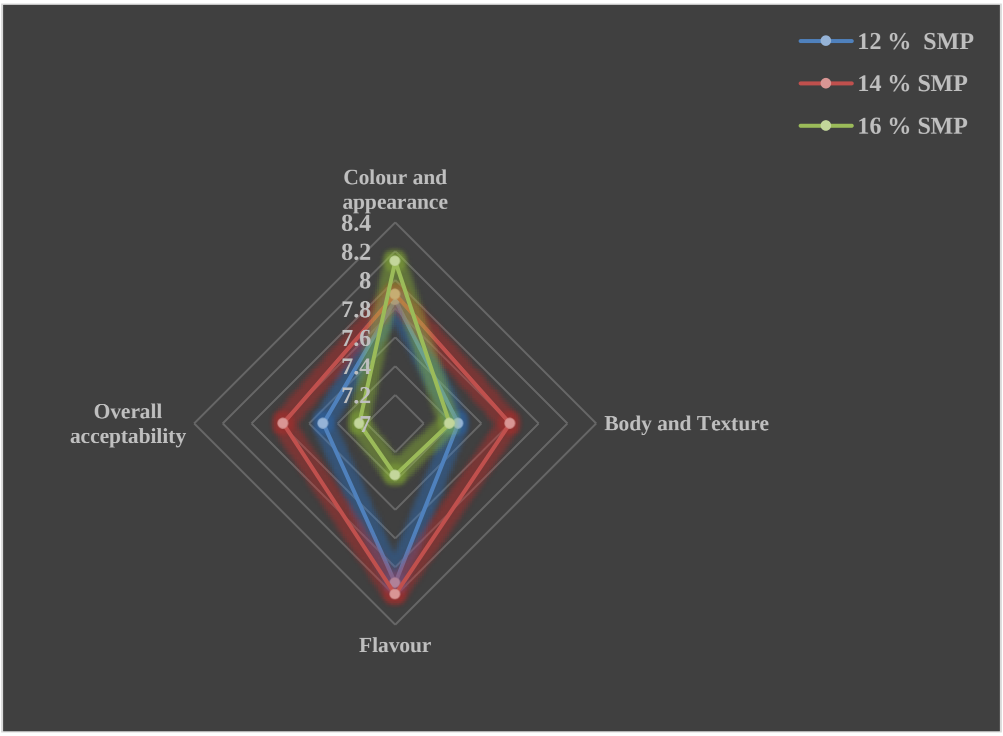


**Fig. 2. Sensory scores for optimization of SMP**

#### 3.1.2 Optimization of WPC

A cream based spread was prepared with varying levels of WPC (2%, 4%, and 6%) to enhance protein content and achieve the desired body and texture. The mean sensory scores for colour and appearance were 8.05, 8.37, and 7.89 for the 2%, 4%, and 6% WPC levels, respectively, with the highest scores at 4% WPC. Beyond this concentration, the scores declined, with the 6% WPC spread receiving the least favourable score due to a dull appearance, whereas it previously exhibited a creamy white colour. The sensory scores for body and texture were 7.50, 8.40, and 8.00 for 2%, 4%, and 6% WPC, respectively, with 4% WPC achieving the optimal score. The lowest score was at 2% WPC, indicating weaker body characteristics, and the highest score was at 4% WPC, providing optimal thickness without making the spread overly thick or weak. Flavour scores were 7.96, 8.36, and 7.82 for the 2%, 4%, and 6% WPC levels, respectively. The 4% WPC spread received the highest flavour score, while higher concentrations led to a slight acidic taste that masked the creamy flavour. Consequently, overall acceptability was highest for the 4% WPC spread at 8.19, compared to 7.63 and 7.81 for the 2% and 6% WPC levels, respectively, making 4% WPC the optimal concentration.

The present findings align with Patange et al. [17] study on incorporating various levels of WPC (0%, 5%, 10%, 15%, and 20%) into quarg cheese. The colour and appearance scores increased up to 10% incorporation, peaking at 7.5, with the lowest score observed for cheese containing 20% WPC. Similarly, the body and texture scores improved up to 10% WPC (reaching 7.43), then declined, with the lowest score at 20% (5.99). The flavour scores were highest with 5% WPC addition (7.58) and lowest at 20% (6.53). Overall acceptability was highest for quarg cheese with 10% WPC, while the lowest scores were given to samples containing 15% and 20% WPC.

#### 3.1.3 Optimization of salt

Salt was incorporated at levels of 0.5%, 1%, and 1.5%. The mean sensory scores for colour and appearance were 8.38, 8.39, and 8.36, respectively, with no significant difference among the treatments. The spread with 1% salt received the highest score of 8.39. For body and texture, the mean scores were 8.41, 8.43, and 8.40, respectively, again showing no significant difference. The highest flavour score of 8.49 was awarded to the 1% salt level, while the 1.5% salt level received the lowest score of 7.79 due to increased saltiness being unacceptable. The overall acceptability scores were 8.17, 8.35, and 7.50 for the 0.5%, 1%, and 1.5% salt levels, respectively, with the 1% salt level achieving the highest score, thus optimizing the formulation.

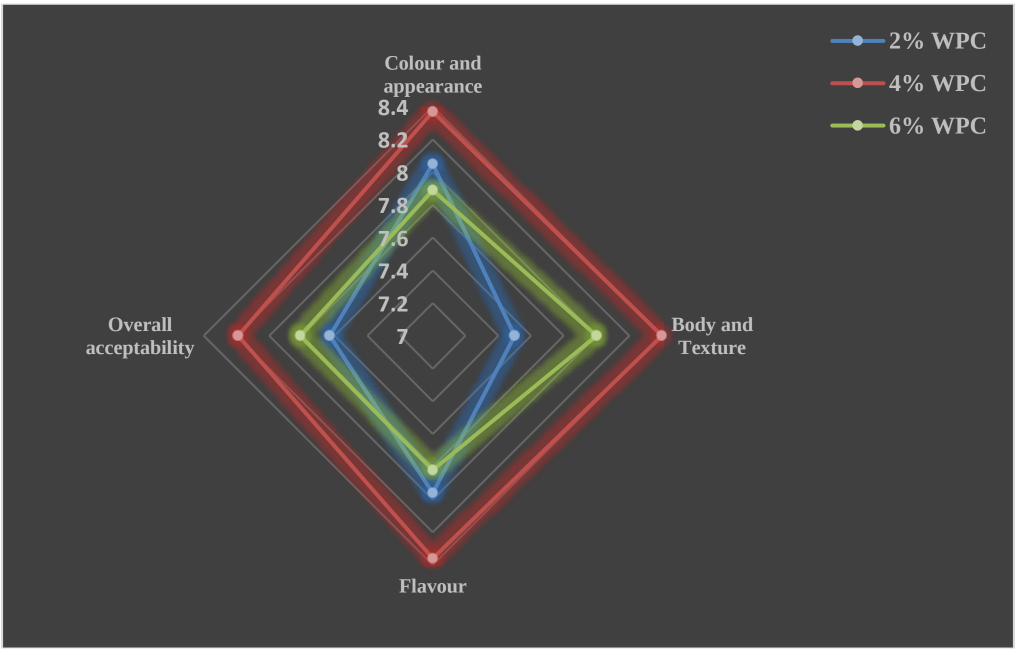


**Fig. 3. Sensory scores for optimization of WPC**

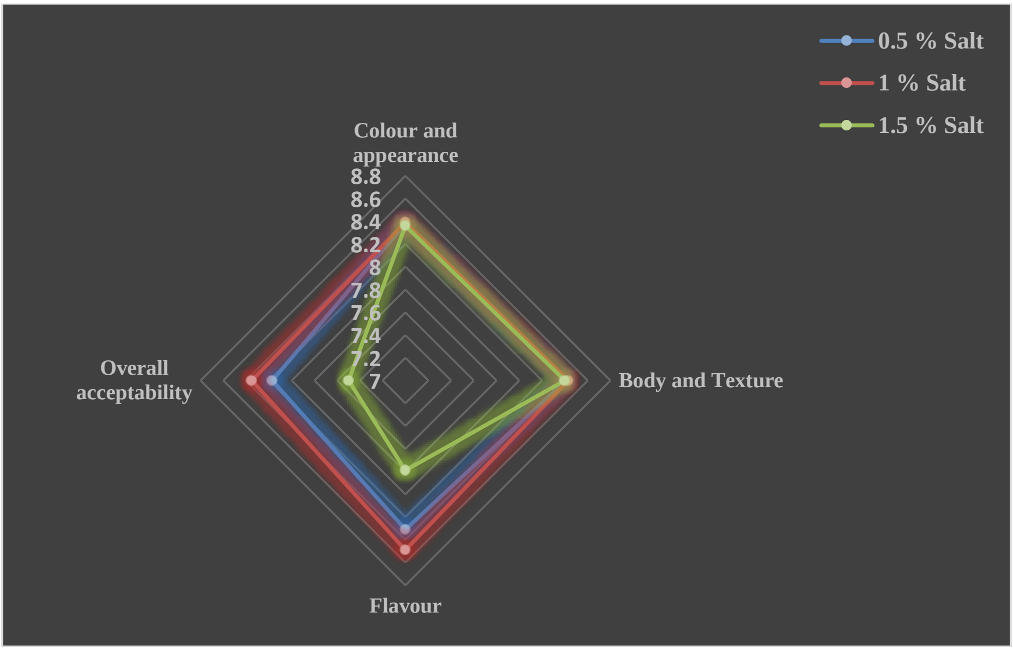


**Fig. 4. Sensory scores for optimization of salt**

The findings of this study are consistent with those of Bhardwaj [16], who investigated cream based spreads with salt levels of 1%, 1.25%, and 1.5%. Bhardwaj found no significant difference in colour and appearance scores among these levels. In study, the 1.25% salt spread received the highest colour and appearance score of 8.02, while the 1.5% salt spread had the lowest score of 7.95. Sensory evaluations further indicated that the 1.25% salt spread achieved the highest acceptability score of 7.87, whereas the 1.5% salt spread received the lowest acceptability score of 6.45 due to its high salt intensity.

### 3.2 Optimization of Spices for the Development of Functional Dairy Spread

Functional dairy spread was prepared by adding ginger, garlic, coriander, and white pepper powder (1:1:1:1) at levels of 1.5%, 2%, and 2.5%. The mean sensory scores for colour and appearance were 8.34 for the control, and 8.35, 8.36, and 8.00 for the 1.5%, 2%, and 2.5% spice blends, respectively. The 2% blend had the highest colour and appearance score of 8.36, while the 2.5% blend scored lowest at 8.00 due to the intensified colour of the spices. Body and texture scores were 8.44 for the control, and 8.46, 8.48, and 8.45 for the 1.5%, 2%, and 2.5% blends, with the 2% blend scoring highest at 8.48. Flavour scores were 8.46 for the control, and 8.57, 8.64, and 7.97 for the 1.5%, 2%, and 2.5% blends, respectively. The 2% blend received the highest flavour score of 8.64, while the 2.5% blend scored the lowest at 7.97 due to its harsh and strong intensity of mixed spices. Overall acceptability scores were 8.30 for the control, and 8.50, 8.61, and 7.99 for the 1.5%, 2%, and 2.5% blends, respectively, with the 2% blend having the highest score, optimizing the formulation at this level.

Similarly, DekulaHimabindu [18] investigated the impact of ginger, garlic, and black pepper powders on the sensory characteristics of cottage cheese at levels of 0.5%, 1%, and 1.5%. The colour and appearance score was highest for the control sample without spices, while the lowest score of 7.56 was given to the cottage cheese with 1.5% spices, as it appeared dull. No significant difference in sensory characteristics was observed between the control and samples with 0.5% and 1% spices. DekulaHimaBindu also reported no significant difference in body and texture scores among the samples, with the control scoring highest at 8.17. The flavour score was highest for the cottage cheese with 1% spices at 8.70, while the 1.5% spiced sample received the lowest score of 7.50 due to its harsh, pungent, and medicinal flavour. Consequently, the cottage cheese with 1% mixed spices had the highest over all acceptability score of 8.50.

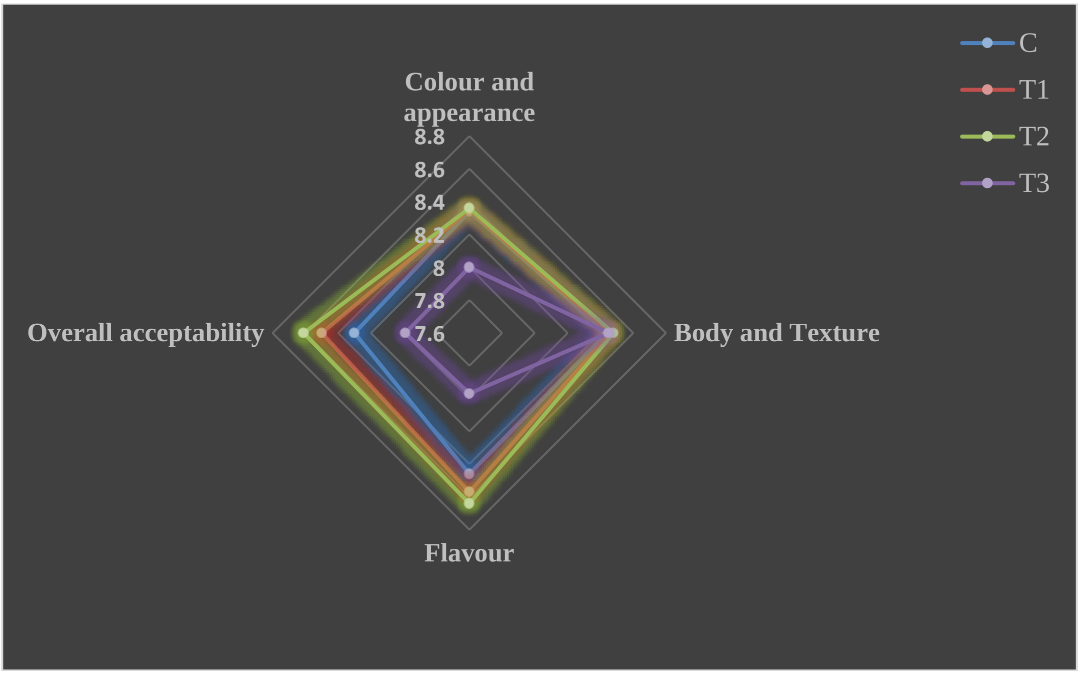


**Fig. 5: Sensory scores for optimization of spices**

** Spices (Mixture of Ginger, Garlic, Coriander paste and white pepper powder at a 1:1:1:1 ratio)*
**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 the control spread at 30.22%, while the lowest was observed in the functional spread at 30.20%. This reduction is attributed to the dilution effect on the spread's fat content, as the added spices are inherently low in fat. These results coincide with the findings of Kaur [19], who prepared paneer spread with the incorporation of dried mint leaves from 0% to 2.5%. The paneer spread with 0% dried mint leaves exhibited the highest fat percentage of 6.9%, while the lowest fat percentage of 6.56% was observed in the spread with 2.5% mint leaves.

### 3.3.2 Protein

The higher protein percentage was found in the functional spread at 7.46% compared to the control at 7.40%. This increase may be attributed to the incorporation of protein content from the added spices. These results align with those found by Kaur [19], who developed paneer spread with the incorporation of dried mint leaves from 0% to 2.5%. The spread with 2.5% mint leaves had the highest protein content at 19.12%, while the lowest protein percentage was recorded for the control at 18.91%.

### 3.3.3 Moisture

The maximum moisture percentage was recorded for the control spread at 54.1%, while the lowest was in the functional spread at 53.2%. This might be due to an 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 the control and functional spreads were 46.8% and 47.6%, respectively. The elevation in the total solids content in the functional spread may be attributed to the incorporation of solids from the spices. These results are in agreement with Patange et al. [17], who prepared spiced quarg cheese with the incorporation of WPC at 10%, ginger at 2%, and cumin at 1%. The spiced quarg cheese had a total solids content of 35.86%, while the control quarg cheese without spices had a total solids content of 36.54%.

**Table 1. Proximate analysis of optimized functional dairy spread**

| 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 $^{a}$ |

**% = Percent; *LA= Lactic acid*

**Same superscripts within the column indicate no significant difference, Different superscripts in the same column indicates significant difference.*

#### 3.3.5 Ash

The maximum ash percentage was recorded for the functional spread (2.57%), while the lowest was observed in the control spread (2.55%). The increase in ash percentage in the functional spread compared to the control could be attributed to the addition of mineral content from the spices. Similar results were confirmed by Nazir et al. [20] in their study on the preparation of yoghurt spread fortified with spirulina powder. They observed that yoghurt spread with 2.5% added spirulina exhibited a higher ash content of 0.69% compared to 0.65% in the yogurt spread without spirulina.

#### 3.3.6 Acidity

The highest acidity percentage was observed in the functional spread (0.42% LA) compared to the control spread (0.34%). This higher acidity in the functional spread could be attributed to the presence of organic acids in the spices. The results are in accordance with the findings by Kaur [19], who developed a paneer spread with dried mint leaves at levels ranging from 0% to 2.5%. The spread with 2.5% dried mint leaves had the highest acidity at 0.5%, while the control had the lowest acidity at 0.45%.

### 3.4 Study on Rheological Parameters of Optimized Functional Dairy Spreads

#### 3.4.1 Viscosity

The highest viscosity was observed in the functional spread at 123 cP, while the lowest was observed in the control spread at 117 cP. This difference 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. Gulzar et al. [21] investigated the preparation of fruited cream cheese spread with 10% apple puree and various hydrocolloids at 2% concentration. Viscosity analysis revealed that the cream cheese spread without hydrocolloid had a viscosity value of 120.61 cP, whereas the combination of gelatin and carrageenan resulted in a higher viscosity of 189.33 cP.

#### 3.4.2 Hardness Index

The highest hardness index was obtained for the functional spread at 0.47 mm, while the lowest was observed in the control spread at 0.46 mm. This 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 in the control spread (0.924) compared to the functional spread (0.932). This may be attributed to the reduced moisture percentage and the higher concentration of added dried spices. Results align with Kaur [19], who developed paneer spread with dried basil leaves ranging from 0 to 2.5%. As basil leaf concentration increased, water activity decreased. The control spread had a water activity of 0.80, while the spread with 2.5% basil leaves showed lower water activity at 0.77.

#### 3.4.4 Spreadability

The higher spreadability observed in the control spread of 1.9 cm/hr compared to the functional spread of 1.6 cm/hr may be attributed to its lower total solids content and higher moisture content. The results align with Kaur [19], 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.

#### 3.4.5 Colour

The L*, a*, and b* values of the control and functional spread were 90.93, -0.88, 16.97, and 87.32, -1.65, 16.05, respectively. This disparity between the control and functional spread can be

**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 $^{b}$ |

**Same superscripts within the column indicate no significant difference, Different superscripts in the same column indicates significant difference.*

**cP= Centi poise; *mm = Millimeter; *Cm/hr = Centimeter per hour*

**** 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.*

attributed to the observed colour variation; the control exhibited a creamish white colour, while the functional spread displayed a slightly darker colour due to the addition of spices, resulting in the control having the highest L*, a*, and b* values. Meena et al. [22] developed omega-3-rich mixed fat table spreads with L*, a*, and b* values of 82.437, 4.353, and 27.87. Additionally, the spread incorporated with 0.25% thyme oil exhibited L*, a*, and b* values of 83.86, 4.53, and 29.49, respectively.

### 3.5 Evaluation of Microbiological Parameters on Optimized Functional Dairy Spreads

The counts recorded for coliforms, yeast and molds, staphylococci, and lipolytic organisms 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. Gaikwad [23] reported that there was no growth observed for coliforms and yeast and molds in fresh flavoured mayonnaise.

## 4. CONCLUSION

The developed dairy spread achieved excellent spreadability at refrigeration temperature (7±1℃) 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.

## ACKNOWLEDGEMENTS

The research work was made possible by the support of the Department of Dairy Technology, Dairy Science College, Hebbal, Bengaluru, Karnataka Animal and Fisheries Sciences University, Bidar, Karnataka, India.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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