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Sensory Analysis of a Greek Yoghurt Spread with Blends of Butter and Salt

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Authors' contributions

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

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ABSTRACT

Aims: To design and evaluate a nutritious Greek yoghurt spread, exploring optimal combinations of butter and salt to elevate sensory satisfaction
Study Design: The study was experimental and laboratory-based, focusing on optimizing the base for low-fat functional Greek yoghurt spread production.
Place and Duration of Study: The study was carried out at the Department of Dairy Technology, Dairy Science College, Hebbal, Bengaluru, Karnataka, India, during the period from January 2024 to October 2024.
Methodology: The Greek yoghurt spread was prepared using standardized cow milk (4% fat), fermented with a mixed starter culture of *Streptococcus thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus*. Initially, the butter content was varied at levels of 30%, 40%, and 50%, followed

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by adjustments to salt concentrations at 0.5%, 1.0%, and 1.5%. Sensory evaluation of the prepared samples was conducted by a trained panel using a 9-point hedonic scale, assessing attributes such as flavour, colour and appearance, body and texture, spreadability, and overall acceptability. Data were statistically analyzed using ANOVA, and significant differences were identified with critical differences (CD) at a 5% significance level.

Results: Increasing butter content significantly enhanced flavour, spreadability, and overall sensory acceptability, with the 40% butter sample achieving the highest scores for all attributes. Similarly, the inclusion of 1% salt improved flavour, texture, and overall acceptability compared to other concentrations. The optimized formulation with 40% butter and 1% salt received the highest sensory ratings, indicating a balance of creaminess, spreadability, and palatability.

Conclusion: The study demonstrated that a butter concentration of 40% and a salt concentration of 1% are optimal for achieving superior sensory quality in low-fat functional Greek yogurt spreads. These optimized formulations provide a nutritious, protein-rich, and lower-fat alternative to traditional high-fat spreads, combining sensory appeal with health benefits. The findings offer valuable insights for developing innovative dairy spreads that cater to health-conscious consumers, delivering a wholesome, flavorful, and versatile product without compromising on taste or nutritional value.

Keywords: Greek yoghurt; spread; sensory attributes; butter; salt.

ABBREVIATIONS

ANOVA : Analysis of Variance
Cagr : Compound Annual Growth Rate
BAHS : Basic Animal Husbandry Statistics
IMARC : International Market Analysis Research and Consulting Group

1. INTRODUCTION

India, the largest milk producer globally, achieved an impressive output of 230.58 million tonnes of milk in the year 2022-23, with a per capita availability of 459 g/day (BAHS, 2023). This substantial milk production has laid the foundation for the growth of the Indian dairy industry, driving innovation and diversification, particularly in the spreads segment. In 2023, the Indian spreads market reached a notable milestone with a market size of US$ 304.1 million. This market is projected to grow significantly, with forecasts predicting expansion to US$ 1,494 million by 2032, driven by a robust compound annual growth rate (CAGR) of 18.77 per cent during the period from 2024 to 2032 (IMARC, 2024). The rapid growth in this sector reflects increasing consumer demand for a variety of innovative and convenient spreadable products, demonstrating the potential for further development in the dairy industry.

Spreads are food products valued for their spreadability at refrigeration temperatures and their ability to maintain consistency under various conditions, exhibiting a unique plastic-like texture for easy application. In India, significant advancements have been made in developing a diverse range of spreads using both dairy and non-dairy ingredients, including cream, vegetable fats, cheese, and traditional products like paneer and ghee. Innovative blends, such as buffalo milk with sunflower oil and buttermilk, have also emerged, driving research into healthier alternatives (Rao & Devaraj, 2021).

Greek yoghurt, also known as strained yoghurt, is a high-protein, low-lactose dairy product characterized by its creamy texture, tangy flavour, and nutritional benefits. It is produced by straining whey from regular yoghurt, resulting in a thicker consistency with higher total solids. Traditionally made from cow's milk and fermented using *Lactobacillus bulgaricus* and *Streptococcus thermophilus*, Greek yoghurt is valued for its sensory attributes, such as smooth spreadability and a mildly tangy taste (Ramakrishnan et al., 2024). With its rich protein content, ranging from 5.6% in cow’s milk-based varieties to 8% in sheep milk, Greek yoghurt has gained immense popularity as a health-promoting food worldwide. Its versatility and adaptability to various formulations make it an excellent base for innovative products like Greek yoghurt spreads. It offers functional and culinary benefits for consumers seeking nutritious and flavourful alternatives (Adekunle et al., 2024).

Butter, a traditional dairy product, is renowned for its rich flavour, culinary versatility, and nutritional benefits. Primarily composed of milk fat, it provides essential fatty acids, vitamins A and D, and contributes a unique texture that enhances various dishes (Cheng et al., 2023). In recent years, innovations such as blending

butter with healthier oils have improved its nutritional value while retaining its spreadability. Additionally, butter contains bioactive compounds like conjugated linoleic acid (CLA), which may offer health-promoting effects. Functional variants, enriched with probiotics or plant extracts, have been developed to support gut health and nutrient absorption (Ziarno et al., 2023). Despite its popularity as a spread, butter faces challenges due to its high fat content and caloric density, making it a costlier option. While cheese spreads provide a nutrient-rich alternative but they have not gained widespread acceptance among Indian consumers due to taste preferences. This has led to a growing demand for more affordable table spreads that are nutritionally balanced, moderately flavoured, and better suited to Indian palates and eating habits (Bose, 2023).

2. MATERIALS AND METHODS

2.1 Materials

Fresh cow milk, with a composition of 4.0% fat, 8.8% solids-not-fat (SNF), acidity of 0.103% lactic acid, and a pH of 6.62, was procured from the Students Experimental Dairy Plant, Dairy Science College, Hebbal, Bengaluru. This milk served as the primary ingredient for preparing the Greek yoghurt spread.

The freeze-dried yoghurt cultures used for fermentation were obtained from Delvo DSL Pvt. Ltd., Netherlands, and stored at -40°C to maintain viability. Before use, the cultures were activated by cultivating them in MRS broth medium at 37°C for 24 hours. The resultant pellets were then reconstituted in a 10% skimmed milk suspension and further incubated at 37–38°C for 18 hours to prepare an active starter culture for Greek yoghurt production.

Unsalted butter, sourced from Amul, Bangalore, was used as the oil phase in the emulsification process of the Greek yoghurt spread. Edible iodized common salt (tata salt, tata chemicals ltd., Mumbai) was purchased locally and incorporated to improve the taste and overall sensory profile of the product.

2.2 Methods

The Greek yoghurt spread was prepared using standardized cow milk. Initially, the milk was added with whey protein concentrate (WPC) and then pasteurized by heating it to 95°C for 5 minutes. Following pasteurization, the milk was rapidly cooled to 45°C. A mixed commercial starter culture containing *Streptococcus thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus* was added at 2% (w/v). The inoculated milk was incubated at 42°C until the pH reached to 4.5, indicating proper fermentation. Once the desired pH was achieved, the resulting coagulum was carefully transferred to a cloth bag to allow the whey to drain naturally. This process was carried out overnight at a controlled temperature of 4±1°C to obtain a thick and concentrated Greek yoghurt. The obtained Greek yoghurt was then used as the base for preparing the Greek yoghurt spread. A detailed process flowchart (Fig. 1) illustrates the production steps and highlights the experimental framework of the study.

2.3 Sensory Evaluation

A sensory evaluation was conducted to assess the study samples' attributes, including color and appearance, body and texture, flavour, and overall acceptability. A panel of highly trained judges, selected for their expertise in sensory analysis, evaluated the samples using a 9-point hedonic scale. Each sample was coded with a random three-digit number to ensure blind testing, and a controlled environment was maintained to minimize external influences. The evaluation process adhered to ethical guidelines for sensory analysis, emphasizing the health and safety of the panelists. The recruitment of trained judges and the implementation of a standardized protocol underscored the scientific rigor and ethical responsibility of the sensory assessment.

2.4 Statistical Analysis

The data were analyzed using R software (version 4.1.2) for statistical computing, with the *dplyr* and *agricolae* packages employed for data organization and processing. Response variables were collected from three replications of the trials, and ANOVA tables were generated to evaluate the effects of the variables on the response measures. When the F value was found to be significant, the critical difference (*P = 0.05*) was calculated using a formula to identify significant differences. The tables highlight significant differences among treatment means by using distinct superscripts.

$$Critical\ difference\ (CD) = \frac{\sqrt{2 \times MSS(E) \times t\alpha}}{r}$$

Where,

MSS (E) = Mean Sum of squares of the error
r = number of replications
tα = table t value of the α level of significance

2.4.1 Flow diagram

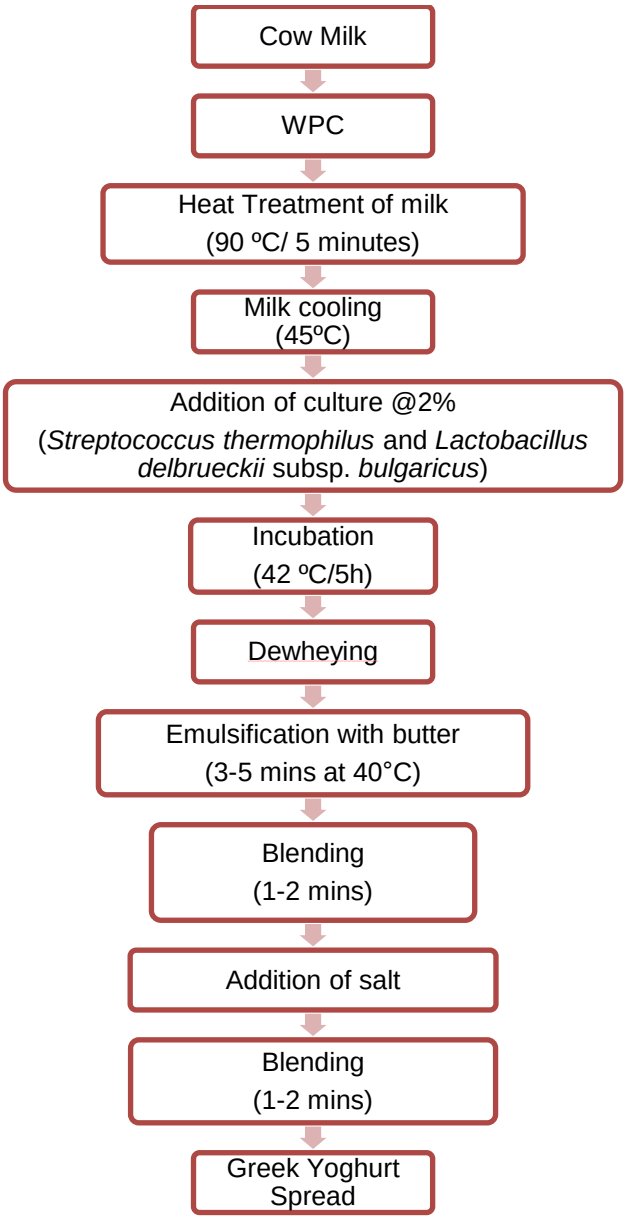

Fig. 1. Process Flow Chart for Production of Greek Yoghurt Spread

3. RESULTS AND DISCUSSION

3.1 Effect of Butter on the Sensory Attributes of Greek Yoghurt Spread

The sensory evaluation of dairy spreads demonstrated that increasing butter content significantly enhanced multiple sensory attributes, particularly flavour, colour, appearance, body, texture, and spreadability. The control sample, with no added butter, consistently received the lowest scores across these categories, with flavour scoring 7.05 and spreadability at 7.09. In contrast, the 40% butter sample achieved the highest ratings, notably an 8.60 for both flavour and texture, and 8.50 for spreadability. These findings align with the research of Kostyra et al. (2007) which exhibited that butter spreads with higher fat content, like 55%, improves sensory qualities by enhancing butter-like notes in both odor and flavour. The addition of butter not only improved flavour but also led to significant enhancements in colour and appearance, as seen by the 40% butter

sample's score of 8.68 in this sensory attribute, with intermediate results from the 30% and 50% butter samples. This trend is supported by Pădureţ (2021), who reported that increased butterfat content correlates with changes in the yellowness (b*) colour parameter, indicating that fat composition plays a critical role in appearance differentiation. Higher butter content also contributed to a firmer texture, with the 40% butter sample outperforming the control (7.12) in body and texture.

The improved spreadability with more butter content mirrors the findings of Tondhoosh et al. (2016), who observed that butter content between 40% and 45% improved spreadability and softened texture, while reducing the melting temperature and trans fatty acid content. Overall acceptability followed this trend, with the 40% butter sample scoring 8.74, significantly higher than the control (7.09), and intermediate scores for the 30, and 50% butter samples, indicating that increasing butter content generally enhances consumer perception of dairy spreads.

3.2 Effect of Salt on the Sensory Attributes of Greek Yoghurt Spread

Greek yoghurt spread was prepared with varying levels of salt to enhance its sensory acceptance and functionality. The sensory scores for colour and appearance, body and texture, flavour, and overall acceptability of the spread with different salt levels were evaluated and recorded (Table 2).

The mean sensory scores for flavour, colour and appearance, body and texture, spreadability, and overall acceptability of the Greek yoghurt spread varied across different salt concentrations. The highest flavour score was achieved by the sample with 1% salt (8.33), significantly outperforming both the control (7.43) and the sample with 1.5% salt (7.47), while 0.5% salt led to a moderate improvement (7.84). Pavithra et al. (2024) reported that increasing the concentration of salt significantly affects the flavour of functional dairy spread.

Table 1. Effect of Butter on the sensory attributes of Greek yoghurt spread

Butter (%)	Flavour	Colour and appearance	Body and Texture	Spreadability	Overall Acceptability
Control	7.05^{c}	7.14^{c}	7.12^{c}	7.09^{b}	7.10^{d}
30	7.25^{c}	7.24^{c}	7.28^{bc}	7.20^{b}	7.56^{c}
40	8.60^{a}	8.68^{a}	8.60^{a}	8.50^{a}	8.74^{a}
50	7.64^{b}	7.71^{b}	7.79^{b}	7.62^{ab}	8.00^{b}
CD (P= 0.05)	**0.34**	**0.86**	**1.11**	**1.25**	**0.67**

Note: The control sample is Greek yoghurt, CD= Critical difference, all the results are average of three trials (n=3), and the same superscript indicates non-significance while different, indicating statistically significant difference at P= .05

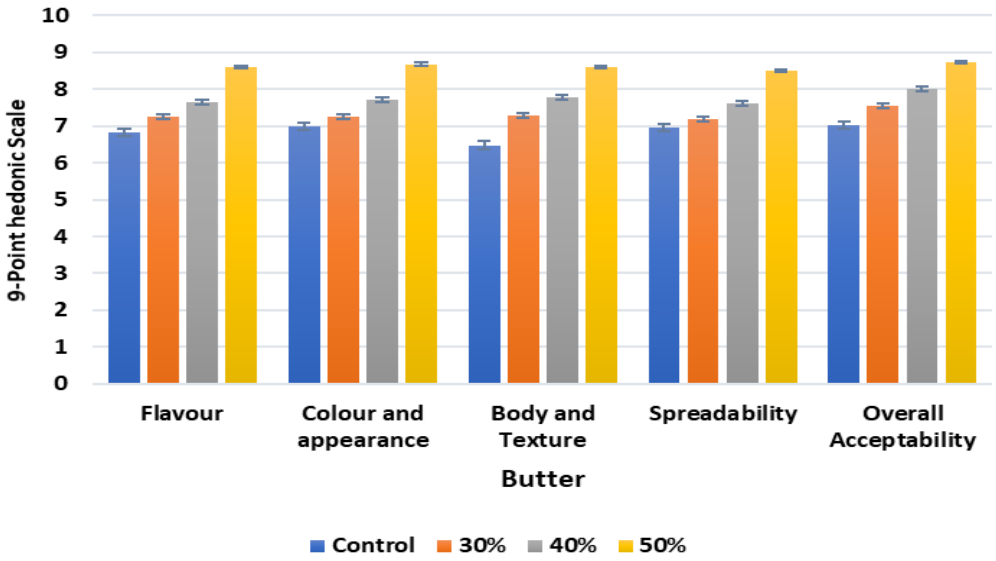

Fig. 2. Effect of Butter on the sensory attributes of Greek yoghurt spread.

Table 2. Effect of Salt on the sensory attributes of Greek yoghurt spread.

Salt (%)	Flavour	Colour and appearance	Body and Texture	Spreadability	Overall Acceptability
Control	7.43^{b}	7.20^{c}	7.13^{b}	7.29^{b}	7.53^{b}
0.5	7.84^{ab}	8.04^{b}	8.04^{a}	8.20^{a}	8.08^{ab}
1.0	8.33^{a}	8.49^{a}	8.25^{a}	8.43^{a}	8.62^{a}
1.5	7.47^{b}	8.19^{ab}	8.13^{a}	8.37^{a}	7.75^{b}
CD (P= 0.05)	**0.53**	**0.28**	**0.37**	**0.39**	**0.42**

Note: The control sample is Greek yoghurt, CD= Critical difference, all the results are average of three trials (n=3), and the same superscript indicates non-significance while different, indicating statistically significant difference at P= .05

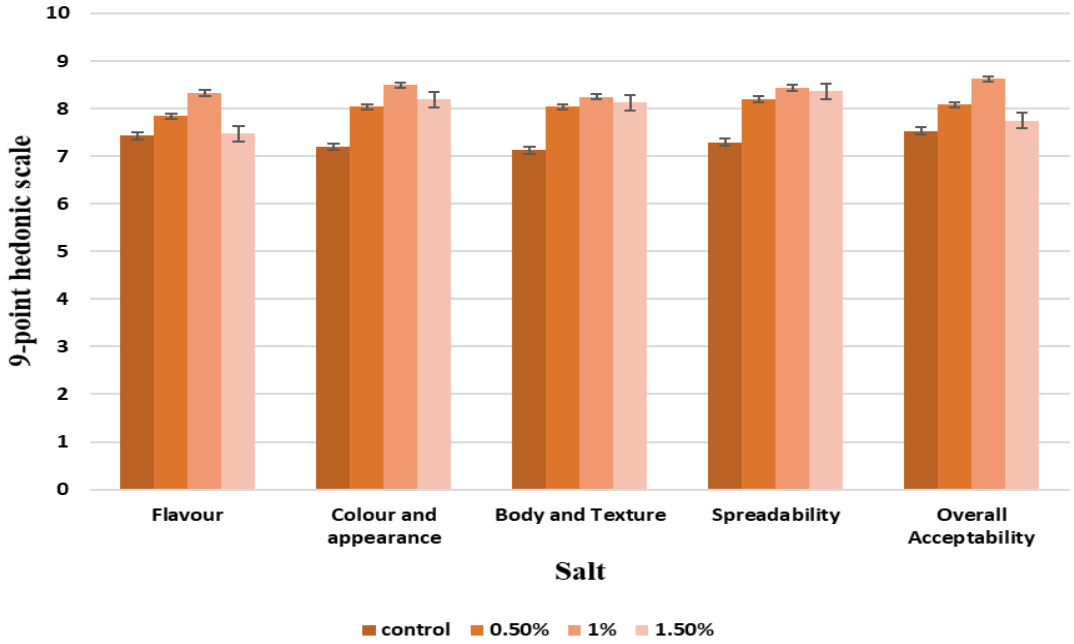

Fig. 3. Effect of Salt on the sensory attributes of Greek yoghurt spread

For colour and appearance, the 1% salt sample scored the highest (8.49), surpassing the control (7.20), with no significant difference between the scores of 0.5% (8.04) and 1.5% salt (8.19). In terms of body and texture, the sample with 1% salt again achieved the highest score (8.25), significantly higher than the control (7.13), while the 0.5% (8.04) and 1.5% salt (8.13) samples showed non-significant improvements. Spreadability followed a similar trend, with the 1% salt sample receiving the highest score (8.43), significantly outperforming the control (7.29), while the 0.5% (8.20) and 1.5% salt (8.37) samples showed no significant differences. These results align with Pavithra et al. (2024), who found no statistical difference in colour and appearance, body and texture among various salt levels (1, 1.25, and 1.5%). However, the spread with 1% salt received the highest score of 8.39, and 8.43 respectively.

Overall acceptability was highest for the 1% salt sample (8.62), significantly surpassing the control (7.53), while the 0.5% salt sample also showed improvement (8.08). Bhardwaj (2017) similarly found that the preparation of cream-based spread with higher salt concentrations negatively impacted overall sensory scores, with 1.5% salt leading to the lowest score (6.74) due to increased salt intensity.

4. CONCLUSION

The study successfully evaluated the sensory attributes of Greek yoghurt spread with varying

concentrations of butter and salt. The results demonstrated that both butter and salt significantly influenced the sensory qualities of the spread, with higher butter content enhancing flavor, texture, color, and overall acceptability. Specifically, the 40% butter sample achieved the highest ratings in flavor, spreadability, and texture, aligning with previous research on the positive impact of higher fat content in spreads. Similarly, the 1% salt concentration improved flavor, appearance, and spreadability, contributing to better consumer acceptability. These findings suggest that optimizing butter and salt levels can significantly enhance the sensory appeal of Greek yoghurt spreads, making them more favorable to consumers. The study highlights the potential of Greek yoghurt as a base for innovative, health-conscious dairy spreads, offering opportunities for further product development in the growing Indian dairy industry.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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