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Effect of Moringa (*Moringa oleifera*) Pulp Incorporation on Sensory Parameters and Textural Qualities of Fresh Shrikhand

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ABSTRACT

The study was conducted at Dept. of Dairy Technology, College of Dairy Science and Food Technology, Raipur, Chhattisgarh, India during March, 2024 to July, 2024 to evaluate the effect of moringa pulp incorporation on sensory parameters and textural qualities of fresh shrikhand. Fermented milk products are an integral part of the human diet in many regions of the world. Shrikhand is one of the important fermented milk products. *Moringa oleifera* commonly known as the drumstick tree. Every part of the Moringa tree, including the fruits or pods, flowers, seeds, stem, and roots, holds significant importance for human health and nutrition. This study was aimed to conduct develop to add value for Shrikhand by blending Moringa pulp and evaluate the sensory and textural qualities of Shrikhand. A control (0%) and 4 lots of Moringa pulp blended Shrikhand samples (5, 10, 15 and 20%) were prepared. The fresh Shrikhand samples were evaluated for its sensorial and textural quality parameters. Moringa pulp blending had significant (p<0.05) effect on sensory attributes of fresh Shrikhand samples, the color and appearance, consistency, flavor and taste, sweetness and overall acceptability scores. However T_0, T_1 and T_3 samples were on par in color and appearance, flavor and taste, sweetness and overall acceptability. Moring pulp blending had significant (p<0.05) effect on the textural qualities of fresh Shrikhand samples. T_0 sample was secured highest values of firmness (12668.57), stickiness (10056.28), spreadability (12706.61) and Adhesiveness (3856.39), whereas T_4 sample was secured lowest values of firmness (6650), stickiness (5409.46), spreadability (7571.64) and Adhesiveness (1317.33) respectively.

KEYWORDS: Moringa pods, shrikhand, sensory parameters, textural qualities

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1. INTRODUCTION

India is the world's largest milk producer, India's milk production surged from 17 mt to over 230.58 mt (Shraddha et al., 2024). There will continue to be a demand for traditional dairy products (Khan et al., 2024). It is estimated that between 50–55% of India's milk production is used to make sweets. A total of 7% of milk produced is used in fermentation, for three primary products, being curd, shrikhand and lassi (Yadav et al., 2024). There are more than 400 types of fermenteddairy products are available in the world (Tamang et al., 2020). Fermented milk products are an integral part of the human diet (Devi et al., 2018). Fermented dairy products contribute to the synthesis of vitamin B complex and helps in prevention of stomachic disorders (Singh et al., 2022). Shrikhand is generally made from lactic fermented whole milk curd and is a semi-solid product (Singh et al., 2022). Shrikhand is one of the important fermented milk products which derive its name from the Sanskrit word "Shikharani" (Mane et al., 2017). Consumption of Shrikhand is reported to be effective in treatment of many diseases like diarrhoea, gastro-intestinal (Naik et al., 2024). Shrikhand is a very refreshing delicacy, particularly in summer months. It is usually flavored with saffron, cardamom, almonds and pistachios (Masih et al., 2020). Shrikhand contains moisture 39% and total solids 61%. It has 10.0% fat, 78.0% carbohydrates, 11.5% proteins, and 0.5% ash calculated on dry matter (Babel et al., 2023). Therapeutic, anticholesterolemic, and anticarcinogenic properties of fermented milk products have long been scientific literature (David, 2015).

Moringa oleifera, commonly known as the drumstick tree or horseradish tree (Rani et al., 2018). It belongs to the Moringaceae family, which comprises 13 species (Padayachee and Baijnath, 2020). Every part of the Moringa tree, including the leaves, fruits or pods, flowers, seeds, stem, and roots, holds significant importance for human health and nutrition (Islam et al., 2021). These parts are rich sources of macro, micro nutrients, bioactive components (Babar et al., 2022). Moringa exhibits diverse bio-functional activities, including anti-inflammatory, and antimicrobial properties (Prajapati et al., 2022). The immature pods of Moringa are highly nutritious, containing essential amino acids, vitamins. Immature pods are rich in fiber (approximately 46.78%) and protein (around 20.66%) (Gopalakrishnan et al., 2016). These pods are also known for their fibrous nature, which makes them valuable for digestive health and the prevention of colon cancer (Shivanna et al., 2024). The seeds are usually used as anticoagulant (Alhassan et al., 2022). The presence of PUFA in the pods can be used in the diet of obese (Athira et al., 2024). WHO has promoted Moringa as an alternative to imported food supplies to treat malnutrition (Tatiya et al., 2024). The nutrient value of 100 gram per moringa pods have Fat 0.1 g, Protein 2.5 g, Carbohydrates 3.7 g, Fiber 4.8 g, Iron 5.3 g, Phosphorus 110 g, Vitamin C 120 g and Calcium 30 g (Kaur, 2021). It has gained attention for its medicinal properties based on local folk knowledge (Matic et al., 2018). India has an annual production of 1.1–1.3 mt of tender pods (Tak and Maurya, 2017). Due to its economic and medicinal properties now, it has been introduced to most parts of the world for cultivation purposes (Patil et al., 2022). The moringa pulp has high nutritive value. So far motinga pulp has successfully utilized for the value addition of milk products like yoghurt (Gupta et al., 2024), lassi (Mistry et al., 2018). Thus, considering the nutritive value of moringa pulp, the present study was aimed to evaluate sensory, textural profile of shrikhand.

2. MATERIALS AND METHODS

2.1. Dairy and non-dairy ingredients

The present study was conducted from March, 2024 to July, 2024, at the College of Dairy Science and Food Technology, Dau Shri Vasudev Chandrakar Kamdhenu Vishwavidyalaya, Raipur, Chhattisgarh, India. Full cream milk (AMUL GOLD) was purchased from Raipur (C.G), which is marked by Gujarat cooperative Milk Marketing Federation, Anand. Starter culture of DVS ST-M6, Thermophilic culture was purchased from Chr. Hansen (India) Pvt. Ltd. (Hyderabad). Good quality commercial grade cane sugar, high quality Cardamom powder and fresh tender Moringa pods, Polystyrene cups of 100 ml capacity with lids were purchased from local shops and vegetable market, Raipur (C.G). The polystyrene cups and lids were soaked in tap water for 30 min and washed under running water. The washed cups were dipped in chlorinated water (200 ppm chlorine) and kept immersed for 15 min. After that the cups were drained and kept in inverted position for drying before they used for packaging of Shrikhand samples.

2.2. Texture analyzer

The Food Texture Analyzer supplied by M/s Stable Micro System, England, as made use to study the rheological properties of the product.

The texture analyzer was used to evaluate the firmness, stickiness, spreadability (work of shear) and adhesiveness (work of adhesion) of Shrikhand. The following steps were undertaken to run the texture analyzer.

Computer was linked to the texture analyzer and texture exponent 32 programmed was marked.

The TTC Spreadability Rig cone probe was fixed to the machine.

Under TA setting command, library option was opened.

Under library, "return to start" was selected which meant

the probe would return to original position after penetrating the sample to the required distance. The following project setting was loaded.

Test mode	:	Compression
Pre-test-speed	:	1.00 mm/sec
Test speed	:	3.00 mm/sec
Post-test-speed	:	10.00 mm/sec
Target mode	:	Distance
Distance	:	23.00 mm
Trigger type	:	Auto (Force)
Trigger force	:	5.0 g
Tare mode	:	Auto
Advanced options	:	On
Break mode	:	Off

The probe height was calibrated to 23 mm

Shrikhand (25±2°C) was filled in female cones without air packets then kept on the platform and probe was positioned centrally and close over the sample surface.

2.3. Procedure for preparation of Moringa pulp

Matured moringa pods were procured from the horticultural college of Danteshwari College of Horticulture, Raipur. Raw pods were thoroughly washed in the running tap water to remove extraneous material, and other surface contaminations. The cutting of moringa pods was carried out using steel knife 64 mm pod length followed by blanching at 95°C for 5 mints to inactivate peroxidase enzyme (Ravani et al., 2020). Cool to room temperature and remove the streamed pods from cooker. Then cut each pods into vertically and remove seeds from pods and scrape the pulp and grinding in a mixer and final sieving the pulp to get smooth homogeneous Moringa pulp as shown in Figure 1.

Figure 1: Preparation of Moringa pulp from pods

2.3. Treatment details and proportions of ingredients

The treatment combinations used for preparation of Moringa pulp blended Shrikhand as detailed in below Table 1 and shown in Figure (2). The Moringa pulp was incorporated at different levels (0%, 5%, 10%, 15%, 20%), sugar incorporated at constant level @ 50% based on Chakka (based on preliminary trials, the amount of Moringa pulp blended was restricted to a maximum of 20% for final.

2.4. Preparation of dahi and chakka

The full cream milk was heated to 90°C for 10 min and cooled to 40±2°C. The milk was inoculated with DVS culture @ 0.2 g l^{-1}. The milk was then incubated at 40±2°C till the desired firmness and acidity of 0.85–0.9% L.A. was obtained. After the desired firmness and acidity of 0.85–0.9% L.A. was obtained, the dahi was hanged for draining of whey to obtain chakka.

2.5. Preparation of Moringa pulp blended Shrikhand and control Shrikhand

The full cream milk was heated to 90°C for 10 min and cooled to 40±2°C. The milk was inoculated with DVS culture @ 0.2 g l^{-1}. The milk was then incubated at 40±2°C till the desired firmness and acidity of 0.85-0.9% L.A.

T_0- Control T_1- 5% T_2- 10% T_3- 15% T_4- 20%

Figure 2: Fresh Shrikhand samples

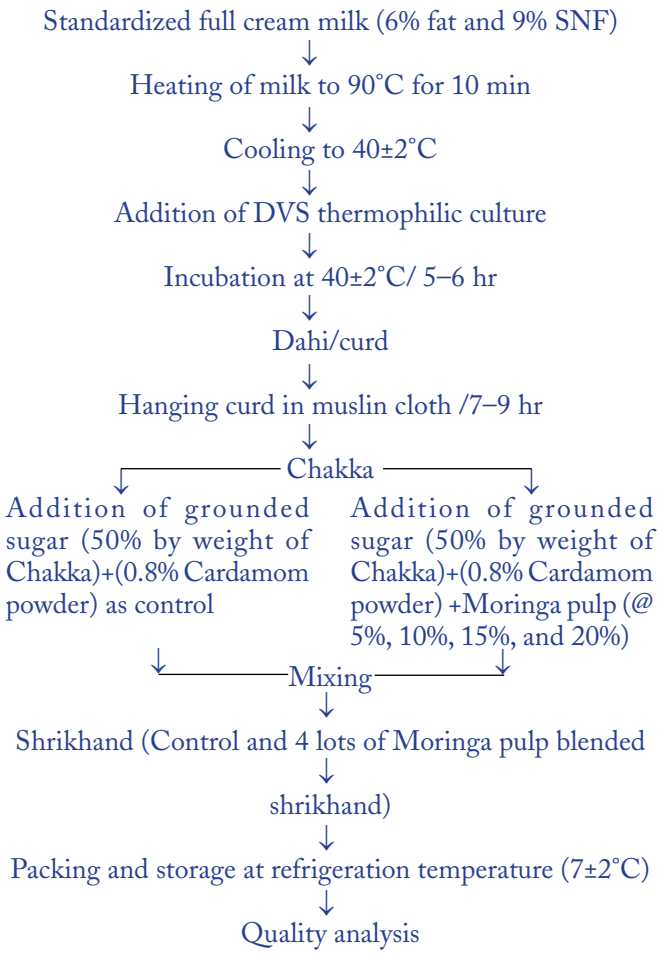

Figure 3: Moringa pulp blended shrikhand and control shrikhand

Table 1: Treatment details and proportions

Treatments/ Ingredients	T_0	T_1	T_2	T_3	T_4
Chakka	66.2	61.2	56.2	51.2	46.2
Moringa pulp	0	5	10	15	20
Sugar	33.0	33.0	33.0	33.0	33.0
Cardamom powder	0.8	0.8	0.8	0.8	0.8
Total	100	100	100	100	100

was obtained. After the desired firmness and acidity of 0.85–0.9% L.A. was obtained, the dahi was hanged for draining of whey to obtain chakka.

2.6. Product development

The present investigation is an attempted to develop Shrikhand with addition of 4 levels of Moringa pulp resulting in five treatments including control (T_0, T_1, T_2, T_3 and T_4). The experiment was replicated 4 times. The control and Moringa blended Shrikhand samples were packed in previously sanitized Polystyrene cup of 100 g capacity. The samples were analyzed for sensory and textural characteristics.

2.7. Sensory evaluation

The sensory characteristic of moringa pulp blended shrikhnad attributes for different treatment samples were evaluated by following the 9-point hedonic scale rating. On this scale, 'like extremely' was given the highest score of '9' and 'dislike extremely' is given the lowest score of '1'. A judgment panel of 20 participants comprised of teaching faculty and postgraduate students of 20–60 age group people those who are expertise in judging and grading of food & dairy products of the College of dairy and food technology Raipur.

3. RESULTS AND DISCUSSION

3.1. Effect of moringa pulp on sensory quality of fresh shrikhand

Shrikhand lots were prepared by blending Moringa pulp (*Moringa oliefera*) (i.e. partially replacing chakka with Moringa pulp) at 5(T_1), 10(T_2), 15(T_3), 20(T_4) per cent and control (T_0) without Moringa pulp and subjected to sensory evaluation on 9 point hedonic scale. The effect of Moringa pulp on color and appearance, consistency, taste and flavor, sweetness and overall acceptability scores of the fresh Shrikhand samples are presented in Table 2.

Table 2: Effect of Moringa pulp on sensory characteristics of fresh shrikhand

Treatments	Color and appearance	Consistency	Flavor	Sweetness	Overall acceptability
T_0	7.43^a	7.83^a	7.83^a	7.68^a	7.73^a
T_1	7.40^a	7.60^{ab}	7.75^a	7.68^a	7.58^a
T_2	7.30^a	7.5^b	7.68^a	7.63^a	7.53a
T_3	7.10^b	7.2^c	7.38^b	7.33^b	7.20^b
T_4	7.03^b	7.0^c	7.05^c	7.13^b	7.03^b
F-Values	9.84	16.34	21.91	7.80	15.56
SEm±	0.06	0.08	0.07	0.09	0.07
CD (p=0.05)	0.18	0.25	0.21	0.27	0.23

3.1.1. Color and appearance

Moringa pulp incorporation influenced the colour and appearance score of Shrikhand. The control (T_0) had the highest colour and appearance score of 7.43, while T_4 (20%) moringa pulp sample had the lowest score of 7.03. Among experimental samples, the T_1 sample was at par with T_0 and T_2 while T_3 and T_4 sample were at par with each other. The lowest colour and appearance score in sample T_4 might be due to presence of more moringa pulp that contributed to slight dullness in colour and appearance as

judged by panels. Similar results reported by Eman et al., 2024 analyzed the Effects of *Moringa oleifera* Leaf and Seed Powder (0.5% and 1%) in Probiotic fermented milk and reported sensory properties for each treatment (C, T_1, T_2, T_3 and T_4). The control samples (C) consistently show the highest scores in all sensory properties tha *Moringa oleifera* Leaf and Seed Powder incorporated experimental samples. Similar results was found in *Moringa oleifera* leaf extract added shrikhnad and found that, highest score for colour and appearance (9.00) was obtained from the treatment T_0 and T_3 followed by T_2 (8.66). The least score (8.33) was obtained in T_1. There were no significant differences found among the treatments with respect to colour and appearance of the samples as reported by Babel et al., 2023. Yadav and Rai (2015) evaluated sensory and textural profile of ashwagandha root extract modulated shrikhand and reported that sensory parameters and textural parameters varies significantly with the manufactured samples. A little bit variation as compared to normal shrikhand may be due to variation in the ingredient (Ashwagandha root extract). Although the ashwagandha root extract modulated shrikhand have less sensory scores.

3.1.2. Consistency

Consistency of shrikhand was significantly (p<0.05) affected by the addition of moringa pulp at different levels. The control (T_0) had higher consistency score of 7.83, while among experimental samples T_4 had lowest consistency score of 7.0. The consistency scores decreased at and above 10 per cent incorporation of Moringa pulp. However, the sample T_3 and T_4 were on par with each other. The experimental samples T_1 (5%) Moringa pulp was on par with control as well as with T_2 (10%). The highest consistency score in control (T_0) sample would be associated with highest firmness value in TPA of 12668.57 g (Table 3).

Table 3: Effect of Moringa pulp on textural qualities of fresh shrikhand

Treatments	Firmness (g)	Stickiness (g)	Spreadability (work of shear) (g. s)	Adhesiveness (work of adhesion) (g. s)
T_0	12668.57^{a}	10056.28^{a}	12706.61^{a}	3856.39^{a}
T_1	12237.0^{ab}	9586.46^{b}	12077.86^{ab}	3587.55^{b}
T_2	11830^{b}	9562.95^{b}	11632.08^{bc}	3486.24^{c}
T_3	11226.24^{c}	8580.14^{c}	11368.47^{c}	3359.43^{d}
T_4	6650.0^{d}	5409.46^{d}	7571.64^{d}	1317.33^{e}
F-Values	21.19	157.10	93.58	1258.03
SEm±	426.60	150.29	208.92	28.90
CD (p=0.05)	435.65	463.12	643.79	89.05

3.1.3. Flavor

Flavor of the fresh shrikhand was very well influenced by the incorporation of Moringa pulp. The control (T_0) sample got the highest score of 7.83 followed by T_1 (7.75), T_2 (7.68). The sample T_4 had the lowest score of 7.05 and it significantly differed from remaining samples. The samples T_1 and T_2 were on par with the control (T_0) in its flavour and taste score. It was also absorbed that there was decreasing trend in scores of flavor and taste of fresh shrikhand samples as the level of Moringa pulp blending increased. This could be due to critical characteristic flavor of Moringa pulp. The decrease in the flavor and taste score in the experimental sample especially when the level of Moringa pulp increased at and above 15%, the judge's perceived little distinct characteristic flavor of Moringa pulp. Fortified with higher levels of *Moringa oleifera* tend to have a pronounced decline in flavor scores, similar to the findings of this study. For example, Saeed et al. (2021) found that while *Moringa oleifera* leaf powder enhanced the nutritional profile of mango-flavored yoghurt.

3.1.4. Sweetness

Sweetness of control (T_0) and 5% (T_1) Moringa pulp blended sample had secured the highest scores of 7.68 followed by T_2 (7.63) and these samples were on par with themselves. In experimental shrikhand samples the sweetness score decreased significantly at and above 15% Moringa pulp incorporation. The T_4 sample secured the lowest score of 7.13; it was similar to T_3 in its sweetness score. It might be due to increased level of incorporation of Moringa pulp.

3.1.5. Overall acceptability

The statistical analysis for the overall acceptability revealed that the control (T_0) sample was awarded the highest score of 7.73, whereas T_4 (20%) sample was awarded the lowest score of 7.03. However T_1 sample was at par with control (T_0) and T_2, while T_3 and T_4 samples were at par with each other. It was noticed that overall acceptability score of fresh shrikhand samples decreased slightly as Moringa pulp incorporation increased. This was found to be significant only at and above 15% of Moringa pulp incorporation. The significant decrease in overall acceptability is attributed to the fact that the experimental samples were adjudged slightly inferior in their colour and appearance, consistency, flavor and taste and sweetness that ultimately reflected in overall acceptability score, when the incorporation of Moringa pulp increased in shrikhand manufacture. Fortification of dairy products with *Moringa oleifera* also influences appearance and overall sensory acceptability. Singh et al. (2022) developed shrikhand incorporated with flaxseed (*Linum usitatissimum* L.) oil microcapsules and reported that sensory

score of all parameters decreased as increase in flaxseed percentage i.e Color and appearance range from 8.58 (T_0) to 7.28 (T_4), Flavor score from 8.65 (T_0) to 6.83 (T_4), Body and texture score from 8.49 (T_0) to 6.57 (T_4), Mouth feel score from 8.78 (T_0) to 5.27 (T_4), Overall acceptability score range from 8.83 (T_0) to 5.29 (T_4). Malla et al. (2021) found that the appearance and overall acceptability scores decreased, especially at higher fortification levels. This is consistent with the observed decline in appearance scores, as well as the overall acceptability of higher *Moringa oleifera* concentrations.

3.2. Effect of moringa pulp blending on the textural quality of fresh shrikhand

The effect of Moringa pulp blending on TPA parameters such as firmness, stickiness, work of shear and adhesiveness values of fresh Shrikhand is represented in Table 3.

3.2.1. Firmness

There is a significant difference (p<0.05) in the firmness value between the control and all experimental samples. The control showed the highest firmness value (12668.57 g), whereas T_4 showed the lowest firmness value (6650.00 g). Among experimental samples, there was a significant decrease in firmness value in shrikhand that contained 15% and above Moringa pulp. The sample T_1 was on par with T_0 and T_2. It was found that addition of Moringa pulp above 10% showed significant difference in firmness when compared to control. The decrease in the firmness in experimental samples might be due to lower TS contents in these samples. Singh et al. (2022) developed shrikhand incorporated with flaxseed (*Linum usitatissimum* L.) oil microcapsules and reported that textural profile of all parameters decreased as increase in flaxseed oil percentage i.e Hardness range from 160.10 (T_0) to 154.67 (T_4), springiness 2.10 (T_0) to 1.03 (T_4). Yadav and Rai (2015) evaluated sensory and textural profile of Ashwagandha Root Extract Modulated Shrikhand and reported that sensory parameters and textural parameters varies significantly with the manufactured samples. A little bit variation as compared to normal shrikhand might be due to variation in the ingredient (Ashwagandha root extract). Although the ashwagandha root extract modulated shrikhand have less textural profile analysis scores but it has many health benefits.

3.2.2. Stickiness

The highest stickiness value was recorded in T_0 (10056.28 g) and the lowest was recorded in T_4 (5409.46 g) shrikhand samples. There was significant difference (p<0.05) between the stickiness values of control and experimental shrikhand samples. The sample T_1 was on par with T_2. In experimental shrikhand samples, at and above 15% moringa pulp blending significantly affected their stickiness values. This decrease in stickiness values could be attributed to the increased level of moringa pulp blending, resulting in reduced total solid content in all experimental shrikhand samples as moringa pulp its-self had lower TS content.

3.2.3. Spredability

The blending of Moringa pulp into Shrikhand significantly (p<0.05) decreased the spredability values. The control sample had highest spredability value of 12706.61 g. s, while moringa pulp containing experimental samples had lowest values ranging from 12077.86 g. s (T_1) to 7571.64 g. s (T_4). It was noticed that blending of moringa pulp at and above 10% showed significant difference in spredability, when compared to control. The highest spreadability values indirectly reflected the resistance offered by the sample to the probe during penetration and indirectly reflected more energy required to perform the shearing process (spreadability). The less work shear force (more spreadability) in experimental samples might be ascribed to higher moisture and lower total solid content. Further T_3 and T_4 experimental samples were evaluated in their consistency during sensory evaluation by judges.

3.2.4. Adhesiveness

Adhesiveness values in Shrikhand samples were T_0 (3856.39 g. s), T_1 (3587.55 g. s), T_2 (3486.24 g. s), T_3 (3359.43 g. s) and T_4 (1317.33 g. s). There was significant difference (p<0.05) in adhesiveness value between the control and experimental shrikhand samples. It was found that adhesiveness decreased in experimental samples as the moringa pulp blending level increased. It could be associated to decrease total solids and increased moisture content in experimental samples. This might also be due to the ratio of total solids to moisture level that determines indirectly the level of adhesiveness. Similar textural scores found in herbal Shrikhand using Catharanthus roseus powder (Singh et al., 2022) i.e the mean obtained for the firmness of the prepared herbal Shrikhand was 64.23 g while for the control it was 66.36 g. The mean obtained for adhesiveness herbal Shrikhand was 35.13 g sec while for the control was 28.23 g sec. Due to an increase in compactness on the microstructure of Herbal Shrikhand produced with Catharanthus roseus powder, the values of the textural parameters like stiffness, gumminess, cohesiveness, and adhesiveness decreased in experimental samples.

4. CONCLUSION

The sensory parameters and textural profile of developed shrikhand were affected by incorporation of moringa pulp with different concentrations. There was a significant difference (p<0.05) in overall acceptability scores observed between all treatment combinations and textural qualities. It was found that overall acceptability score of shrikhand

samples decreased slightly as Moringa pulp incorporation increased. This was found to be significant only at and above 15% of Moringa pulp incorporation.

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