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Impact of plant-derived milks on the physio-chemical properties of shrikhand: A comparative study

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Abstract
The study investigates the effect of peanut milk and soy milk on shrikhand, an Indian fermented dairy product, on its sensory and physicochemical properties. Various treatments involving cow milk, peanut milk, and soy milk in different proportions were prepared. Sensory evaluations indicated differing acceptability among the formulations, with significant variations in attributes such as flavour, texture, and overall acceptability. Physicochemical analyses revealed that treatments with higher peanut milk content exhibited increased moisture and total solids, while fat and acidity levels varied considerably among different formulations. The research highlights the potential of incorporating peanut milk into traditional shrikhand, offering a nutritious alternative that caters to the growing demand for plant-based and lactose-free dairy products. The findings provide valuable insights into product development aimed at enhancing the nutritional profile of shrikhand, making it more appealing to a diverse consumer base.

Keywords: Shrikhand, peanut milk, soya milk chakka

Introduction
Shrikhand is an indigenous, semi-soft, sweet and sour, delicious and healthy whole milk made by lactic acid fermentation, mainly in western India. It is made from chakka (stretched yoghurt/curd) mixed well with sugar and/or flavourings. It is popular due to its unique flavour, palatability, palatability and therapeutic value Fermentation techniques have been used for many years to improve the preservation and quality of food. Lactic acid bacteria (LAB) and other microbial organisms are used to produce various fermented dairy products. Ferment peanuts with *S. Thermophilus* has been reported to be more effective than *Lactobacillus delbrueckii*. Reduction of hexenal content in milk in Bulgaria (Firibu, S.K. 2014) [8].

Peanuts serve as an essential source of dietary fat and protein powder and are highly valued for human and animal nutrition, particularly in developing countries (Elsamania, M.O., & Ahmed, I.A.M., 2014) [5]. Peanut-based milk alternatives are intended for individuals who cannot digest dairy due to lactose intolerance, milk protein allergies, or dietary preferences such as vegetarianism. The growing interest in plant-based milk is driven by concerns over animal fats and proteins, as well as the increasing recognition of the nutritional benefits of plant proteins in low-cholesterol diets (Zaaboul, F., & Raza, 2019) [7].

Soy milk is a plant-based alternative to dairy milk, derived from soaked, ground, and boiled soybeans. It is rich in high-quality proteins, essential amino acids, and bioactive compounds such as isoflavones, which have been linked to various health benefits, including cardiovascular protection and improved bone health (Messina *et al*., 2017) [2]. Due to its nutritional value and lactose-free nature, soy milk serves as a base for various soy-based dairy alternatives, such as soy yogurt, soy cheese, and soy-based desserts. These products provide an excellent source of protein for individuals with lactose intolerance, milk allergies, or those following a plant-based diet (Haug *et al*., 2007) [1]. Moreover, soy milk and its derivatives have gained significant attention due to their potential role in reducing cholesterol levels and lowering the risk of chronic diseases (Tang *et al*., 2020) [3]. The growing consumer demand for sustainable and nutritious dairy alternatives has further fuelled the expansion of soy milk-based products in the global market.

Materials and Methods

Preparation of peanut milk: 250g of peanuts were soaked in water in a ratio of 1:3 (kernel: water) for 18 hours and they were we DE husked. The DE husked kernels were washed with water and ground with hot water in ratio of 1: 6 (kernels to water) in the grinder. The slurry formed was sieved by muslin cloth and peanut milk was produced.

Preparation of peanut milk shrikhand: Fresh standardized milk and peanut used for shrikhand preparation. The good quality peanut was purchased from the local market. It was soaked and ground with hot water. The slurry formed was sieved by muslin cloth and peanut milk was obtained.

Shrikhand was prepared by a method reported in, milk heated to 71º C for 15 seconds, then cooled to 38-40ºC. After cooling the milk, a 2% curd culture was inoculated into the milk, then mixed well and incubated at 40ºC until the curd solidified. When the curd has settled into a good structure, cut it and hang it on a muslin cloth for 8-10 hours. In this process the whey is drained off and the solid mess thus obtained is called Chakka. It is mixed with 25% sugar and kneaded to mix evenly. Now the prepared shrikhand was cooled and stored in the refrigerator.

Preparation of soya milk shrikhand

High-quality, mature, and clean soybeans are selected, soaked in water for 8–12 hours to soften and ease the removal of anti-nutritional factors, then drained and rinsed thoroughly. The soaked soybeans are ground with water in a 1:7 ratios (soybean to water) to extract soy milk, which is then filtered using a muslin cloth to separate the soy pulp (okara) from the milk. The extracted soy milk is boiled for 10–15 minutes to eliminate the beany flavor and anti-nutritional components. Once boiled, the soy milk is cooled to approximately 42°C before adding a probiotic (2%). The inoculated milk is incubated at 42°C for 6–8 hours until it ferments and thickens into soy curd. The curdled soy curd is then strained through a muslin cloth for 6–8 hours under refrigeration to remove excess whey and obtain thick soy chakka. This soy chakka is blended with sugar (25 % w/w) to achieve a smooth, creamy consistency. Finally, the soy shrikhand is packed in airtight containers and stored at a refrigerated temperature of 4°C to maintain freshness and prevent microbial spoilage.

Treatments details

The Cow milk, peanut milk and soya milk were used (w/w) to prepare shrikhand in the following proportions.

Table 1: Treatment details for shrikhnd production

Treatments	
T_1	100% Cow Milk
T_2	100% Peanut Milk
T_3	100% Soy Milk

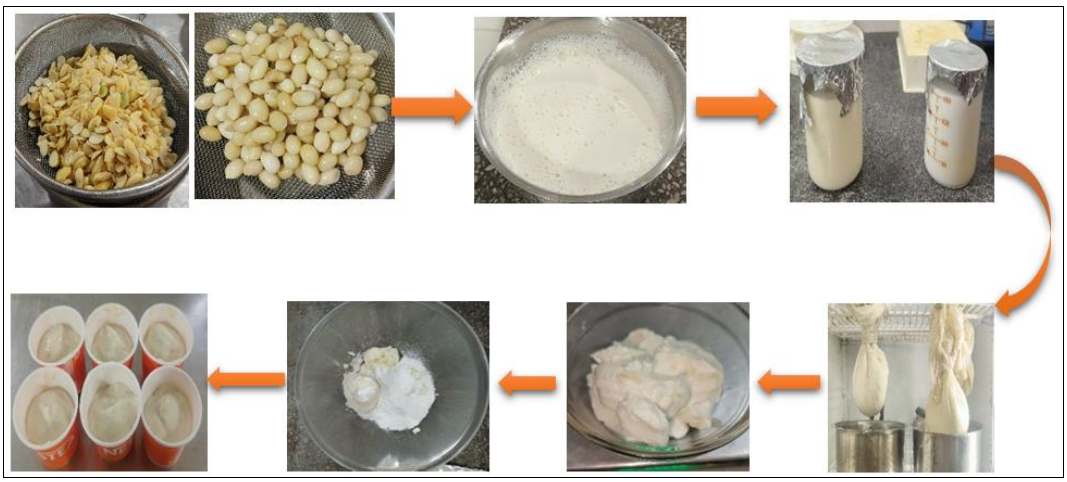


Fig 1: Process to Prepartion of shrikhand different plant sources

Cow milk/ Peanut Milk/ Soy Milk
↓
Heating (15c /15 sec)
↓
Cooling to 40 ºc -42ºc
↓
Addition of 2% starter culture
↓
Incubation (40ºc, 8 hours)
↓
Curd formation
↓
Hanging curd in muslin cloth for 8 hrs.
↓
Chakka
↓
Adding sugar (25%by weight of chakka)
↓

Mixing/whipping
↓
Shrikhand

Flow diagram1- illustrating the preparation of shrikhand.

Fig 2: Prepared shrikhand by T1-cow milk, T2- peanut milk, T3-soy milk

Overall acceptability – Sensory evaluation of finished products

The acceptability of the final products was measured in terms of sensory attributes such as color and appearance, body texture, flavor and taste, and overall taste acceptability using a 9-point hedonic scale with different individuals. The sample of shrikhand were subjected to the organoleptic evaluation by a panel of five of five semi trained judges. Evaluation was done on a 9-points hedonic scale (IS: 6273-2, 1971). Sensory evaluation of shrikhand formulated with peanut milk and mixed milk was performed using a 9-point hedonic scale (A. B., & Firibu, S. K, 2014) [8]. Sensory properties judging the sensory properties of milk samples were determined by panel of judges who were familiar with the product using the hedonic scale. The sensory scores included; Like extremely 9, Like very much 8, Like moderately 7, Like slightly 6, Neither like nor dislike 5, Dislike slightly 4, Dislike moderately 3, Dislike very much 2, Dislike extremely 1. The panellists were also asked to make some comments/recommendations about the sensory texture/mouth feel and flavour of the samples.

Physiochemical Analysis

- **Ph:** pH values were obtained using Orion star series SN B21899 digital pH meter.
- **Titratable Acidity:** Titratable acidity determined by titration of the sample with 0.1 NAOH and phenolphthalein end point comparing by colour. (IS 1166-1973)
- **Protein:** The protein content is determined from the organic nitrogen content by Kjeldahl method. (as per DGSH 2005).
- **Fat**- Determination of Fat by Acid Digestion Method (IS 2785-1979).
- **Total solids:** Determination of total solids by Gravimetric method.
- **Moisture content:** The moisture content of sample is the loss in mass, expressed as a percentage by mass when the product is heated in hot air oven 102ºc to constant mass (IS:2785:1979; Reffirmed 1995).

Results & discussion

Sensory evaluation: In terms of colour and appearance, all treatments of shrikhand showed the same score of 7.5, indicating no significant differences across the treatments. For body and texture, the highest mean score (8.2) was achieved by treatment T2, followed closely by T3 with a score of 8.1, and T1 with a score of 8.0. Treatment T1 had the lowest score for body and texture, and significant differences were observed among the treatments.

Table 2: Sensory evaluations of shrikhand prepared by cow milk, soy milk and peanut milk

Sample	Colour & Appearance	Body & Texture	Flavor & Taste	Overall acceptability
T_1	7.87±0.73	8.0±0.81	7.4±0.66	8.0±0.73
T_2	7.79±0.78	8.2±0.83	8.2±0.68	8.5±0.73
T_3	7.79±1.13	8.1±0.94	7.1±0.68	7.8±0.47

Regarding flavour and taste, treatment T2 again had the highest mean score of 8.2, followed by T1 with 7.4 and T3 with the lowest score of 7.1. Significant differences were noted among the treatments in terms of flavour and taste. For overall acceptability, treatment T2 achieved the highest mean score of 8.5, followed by T1 at 8.0, and T3 at 7.8. The minimum score of 7.8 was recorded for both T0 and T3, with significant differences found between the treatments.

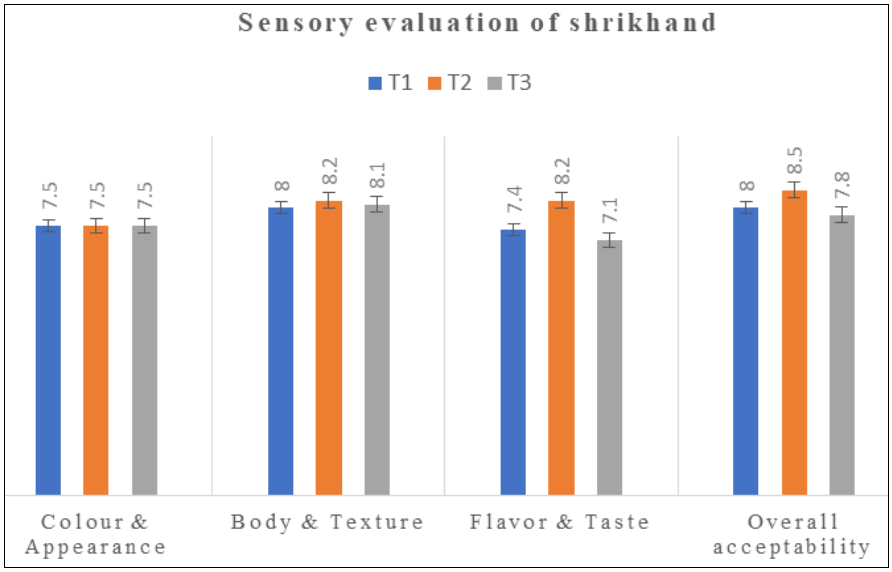


Fig 2: Sensory evaluations of all shrikhand samples T1-Cow milk, T2-peanut milk and T3-soy milk.

Table 3: Physiochemical parameters all shrikhand samples

Sample	Protein	Fat	Moisture	Total solids	PH	Acidity
T_1	8.21±0.598	8.3±0.296	61.2±0.715	38.8±0.715	5.3±0.192	0.926±0.029
T_2	8.5±0.551	9.8±0.443	51.26±0.926	48.74±0.924	5.6±0.122	0.693±0.054
T_3	7.14±0.319	10.4±0.394	48.09±0.640	51.91±0.640	5.8±0.187	0.664±0.034

Physiochemical parameters

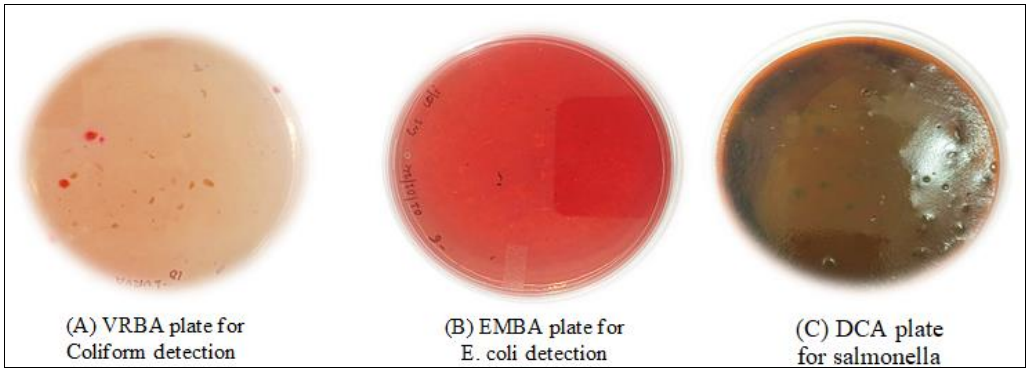
In terms of fat percentage, the highest mean value (8.3) was observed in treatment T1, followed by T1 again with 8.3, and T2 with 6.2. The lowest score (1.7) was recorded in treatment T3, with significant differences found among the treatments. Regarding moisture percentage, treatment T1 showed the highest mean value of 61.2, followed by T2 with 51.26, and T3 with 48.09, which was the minimum score. Significant differences were observed among the treatments in moisture content as well. For total solids percentage, the highest mean value (51.91) was found in treatment T3, followed by T2 (48.74) and T1 (38.8), with the minimum score being 38.8 in T1 (control). There were significant differences among the treatments for total solids content. Regarding pH, the highest mean value (5.8) was observed in treatment T3, followed by T1 at 5.1 and T2 at 4.9. The lowest pH score of 4.7 was found in T3, with significant differences noted among the treatments. For lactic acid percentage, the highest mean value (0.926) was recorded in treatment T1, followed by T2 at 0.693 and T3 at 0.364, which was the minimum score. Significant differences were found among the treatments in terms of lactic acid content as well.

Microbial analysis

Microbial analysis data for three samples labeled T1, T2, and T3, focusing on specific parameters related to water quality. The coliform enumeration reveals that T1 has 7 x 10^1 cfu/ml, T2 has 4 x 10^1 cfu/ml, and T3 has a higher count of 2 x 10^2 cfu/ml, indicating varying levels of bacterial contamination, with T3 exhibiting the highest count. Notably, all three samples report E. Coli as absent, suggesting no fecal contamination in any of the samples. Additionally, Salmonella is absent in all three samples, indicating the lack of this harmful pathogen. Overall, while the coliform counts differ among the samples, the absence of both E. Coli and Salmonella indicates that the water is free from certain harmful microorganisms that typically serve as indicators of contamination.

Table 4: Microbial Analysis of all the samples

SR. No.	Parameter	T1	T2	T3
1.	Coliform (cfu/ml)	7×10^1	4×10^1	2×10^2
2.	E.Coli	Absent	Absent	Absent
3.	Sallmonella	Absent	Absent	Absent



(A) VRBA plate for Coliform detection

(B) EMBA plate for E. coli detection

(C) DCA plate for salmonella

Conclusion

In conclusion, the addition of peanut milk to mixed milk shrikhand significantly influences its sensory and physicochemical characteristics, enhancing its appeal as a nutritious dairy alternative. The study demonstrates that formulations high in peanut milk not only contribute to improved moisture content and total solids but also positively impact the overall acceptability of the product among consumers. The findings advocate for the innovation of traditional dairy products by integrating plant-based ingredients, thereby expanding market opportunities and catering to the increasing demand for health-conscious and lactose-free options. Future research can explore further fortification and processing methods to optimize the health benefits and sensory attributes of shrikhand, ensuring its relevance in contemporary dietary practices.

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