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Research Article

A Comparative Study on Milk Obtained from Various Sources

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A B S T R A C T

Introduction: Milk is classified as a complete food that contains essential vitamins and minerals as well as complete proteins, fats, and carbohydrates that are crucial for supporting life and promoting good health. Therefore, the main objectives of the study are to determine consumer preferences for milk and milk products, develop milk and curd from alternate sources, and assess their efficacy.

Materials and Methods: We investigated milk-oriented topics and the responders stated that indigenous milk had a high protein content, calcium content, and other advantages. Even though milk is known for its nutritional value, advantages, and cost-effectiveness, some individuals avoid it due to lactose intolerance, and hence it is important to develop lactose-free milk. We used indigenous cow milk, cross-breed milk, buffalo milk, soy milk, and coconut milk. All milk and curds underwent sensory analysis.

Results and Discussion: Indigenous cow milk scored high (24.84), followed by coconut milk (24.32), according to the data. Buffalo curd (23.44) scored higher than standard curd (23.32). Protein and calcium contents of standard and best-acceptable milk and curd were determined. There is a strong desire to develop lactose-free milk and milk products. 100 mL of coconut milk has 1.1 g of protein in it. The curd obtained from cross-breed and buffaloes contains nearly the same amount of nutrients, and the chosen products were also economical.

Conclusion: It was suggested that more plant-based milk alternatives should be developed for lactose-intolerant people.

Keywords: Coconut Milk, Flavour, Lactose, Protein, Sensory Characteristics

Introduction

India has such a long tradition of livestock husbandry and dairying that it has become an integral part of its cultural habits. In general, the dairy industry has witnessed considerable growth from 1970 onwards after the inception of the operation flood programme launched by the National Dairy Development Board. World milk production had been estimated at 557 million metric tonnes in 1998 in which the share of buffalo milk was above 59 tonnes. Cows are major contributors at about 85% of milk production followed by buffaloes at 11% and goats and sheep at 2% each. India is the largest milk-producing country in the world with a production of 71 million tonnes in 1999.[1]India ranks first in global milk production contributing 20.17% (2019-2020). With a daily output of 206 lakh litres, Tamil Nadu is one of the top ten milk-producing states in the country. In 2021, India consumed the maximum cow's milk in the world. This number represents about 83 million tonnes. The annual global consumption of liquid cow's milk in 2021 was 1,000 tonnes per country.[2]

Dairy was only very recently included in the human diet, at a time when it seemed to be advantageous to its consumers. Calcium, in particular, and other vitamins and minerals are abundant in milk. It is crucial for maintaining strong bones. Insulin resistance does not develop as a result of calcium.[3] About 87% of cow's milk is water. All the vital vitamins and minerals are present in the remaining 13%. The following nutrients may be found in 100 cc of milk: calories: 63 kcal; carbohydrates: 4.6 g; protein: 3.2 g; fat: 3.0 g; minerals: calcium: 125 mg; sodium: 50 mg; magnesium: 10 mg; potassium: 150 mg; phosphate: 210 mg; citrate: 200 mg; chloride: 100 mg; bicarbonate: 10 mg; and so on. A variety of macro and micro constituents, including nutrients, organic and inorganic chemicals, enzymes, and colours, are dispersed colloidal in milk, which is a complex combination of emulsified fat.[4]

Milk is considered a complete food because it is rich in proteins (casein, albumin, and globulins), lipids, carbohydrates, all known vitamins, and various minerals needed to sustain life and maintain good health.[5] A value of 3.5% protein is often considered an average for milk. It has been divided into two classes - casein and whey protein.[6] Natural sugar is the main carbohydrate in milk that tastes sweet, even when consumed whole, in the form of lactose. Lactose in milk often causes symptoms such as bloating, gas, or nausea after eating dairy products. This is called lactose intolerance.[7] In India, according to the 2022 census, about 1,417,173,173 people are affected by lactose intolerance. In some cases, switching to lactose-free alternatives can help alleviate these side effects.[8]

Lactose-free milk has the same nutritional profile as regular milk. Today, there are many dairy-free alternatives in the market. Non-dairy milk, including oat, coconut, rice and soy milk, contains other simple sugars, such as fructose (fruit sugar), galactose, glucose, sucrose, and maltose.[9] Therefore, the main objective of the study was to determine customer preferences for milk and dairy products, to develop milk and curd from various sources, and simultaneously evaluate the effectiveness of milk and curd for sensory characteristics and nutritional content.

Materials And Method

We selected our sample by suggesting sampling methods. We selected students and staff from our institute as panellists for our sensory assessment. A total of 25 members were selected as panellists for sensory evaluation and 90 people were selected as consumers to analyse the perception of milk.[10] The study was carried out from April 2022 to June 2022 for a period of 3 months. The adult age group was included who have good sensory skills.

Analysis of Consumer Perception of Milk

We conducted a consumer survey on milk products through online mode. The survey was about milk consumption, monthly expenditure on milk, types of milk, nutrition and milk consumption, by-products of milk, and so on. We used Google Forms to formulate the questionnaire which contained 18 questions. It was shared on social media applications like WhatsApp, mail, etc. The responses were recorded. This was performed to elicit beliefs regarding preferences for milk consumption among the consumers.

This survey facilitated us to develop milk and curd from different sources.

Sensory Evaluation

Cross-breed milk of Sindhu cow was purchased from a local farmers' dairy unit. From the 2 litres of milk, 1 litre was boiled and sugar of 100 g was added. The milk was analysed for sensory characteristics. The remaining 1 litre of milk was cultured for curd at optimum temperature. Once the curd was set, it was analysed for sensory characteristics.

The same procedure was performed for indigenous and buffalo milk also and the sensory scores were recorded.

Soya milk was prepared from soya beans which were purchased from the local market. Washing and cleaning were done and they were soaked in water overnight (Figure 1). The peel was removed to reduce the beany flavour and toxicity. It was ground to a paste consistency with the addition of water. Then the soya bean paste was diluted with water to extract the milk with the help of a muslin cloth filtrate (Figure 2). Once the milk was strained, it was boiled.

The thick layer of solids formed on the top was removed. After completing the boiling process, it was mixed with cross-breed cow's milk in a ratio of 50:50 i.e. one litre of

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soya milk with one litre of cow's milk. After that, 1 litre was added with 100 g of sugar and sensory evaluation was performed. The remaining one litre was cultured for curd and it was also analysed for sensory characteristics.

Coconut milk was prepared from the extraction of coconuts. Coconuts were purchased from local markets. They were sliced and rinsed to remove any dirt and dust present in them. The coconut pieces were blended with the use of a mixer/ blender into a thin paste consistency by adding the water. Then the milk extract was obtained from the coconut using a muslin cloth. It was repeated 3 times to obtain the complete extraction. The milk was double-boiled to avoid curdling which happens in the direct boiling method. For sensory evaluation of milk, sugar was added to one litre of the milk. The remaining one litre of coconut milk was cultured with cows using curd as a medium at optimum temperature and sensory evaluation was performed.

We had taken cross-breed milk as standard and four variations of milk considered were indigenous cow milk, buffalo milk, soya milk, and coconut milk, which were named V1, V2, V3, and V4 respectively. A total of 25 panellists analysed the sensory characteristics of prepared milk and curd. It was analysed with a 5-point hedonic rating scale. The sensory evaluation room was set up in a clean and neat environment without any interruptions. The interpretation of scores of the five-point hedonic rating scale is as follows:

5 - Very Good, 4 - Good, 3 - Fairly Good, 2 - Fair, 1 - Poor

The hedonic rating scale relates to pleasurable or unpleasurable experiences. This test is used to measure the consumer's acceptability of food products.[11] When more than three samples need to be evaluated and accuracy is desired, then a scorecard is developed with all the attributes. The sample is developed and marked against all the attributes in the scorecard. A number of samples of each food are presented to the evaluator and scored. The one which receives the highest score from the panellists is taken as the most acceptable one.[12]

Figure 1.Soaking of Soya Bean

Figure 2.Extracting Milk from Soya Bean

Table 1.Nutrient Composition in Milk

	Energy (kcal)	Protein (g)	Fat (g)	Carbohydrate (g)	Calcium (mg)	Iron (mg)
Cow's milk	67	3.2	4.1	4.4	120	0.2
Buffalo's milk	117	4.3	6.5	5.0	210	0.2

Nutrient Analysis

The standard nutritional value of cow's milk and buffalo's milk has been represented in Table 1 as given by the ICMR.[13]

The best acceptable milk and curd were chosen based on the sensory evaluation scores. The standard milk (cow milk) along with the best acceptable milk (buffalo milk) were analysed for the protein and calcium content present in them. These two components were chosen because the respondents recorded in the consumer survey that the milk was rich in calcium and protein. The protein content is determined from the organic nitrogen content by the Kjeldahl method.[14] FSSAI manual of methods for milk products/ AOAC 18th edition is used to analyse the calcium present in the selected products.[15]

Cost Calculation

The cost was also calculated for all kinds of milk. It included the cost of the milk source, labour cost, fuel and manufacturing, and so on. The cost was calculated for one litre of milk.

Data Interpretation

The SPSS software was used to compare and analyse the data. This was used to identify the difference among sensory characteristics of milk and curd among various sources. The significance of nutrients was also analysed.

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Results and Discussion

The results of the consumer survey, sensory attributes, nutrient analysis, and cost calculation were discussed in this topic.

Consumer Survey on Milk

The consumer survey results have been discussed below as per the responses of 90 people.

All the respondents belonged to the adolescent (43.3%) or adult (56.7%) age groups. Among 90 respondents, 77 were female and 13 were from the male category.

Regarding the milk sources, 43.3% of them obtained milk from the cooperative society - milk booth and only 3.3% preferred to buy milk from the local milk vendors (Figure 3).

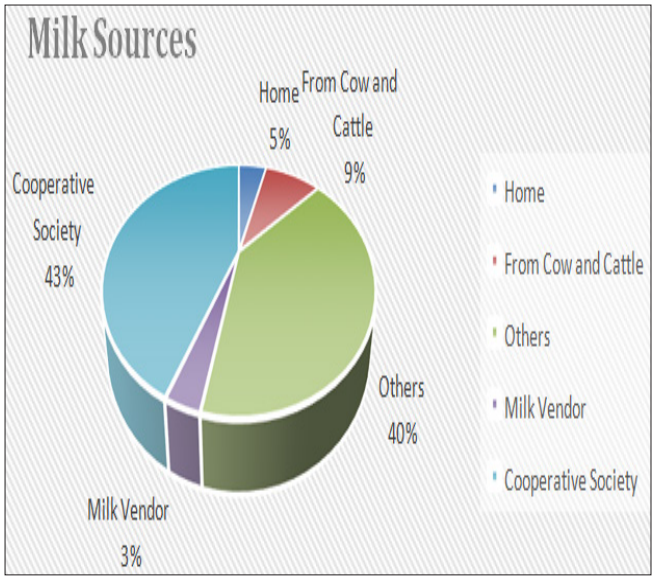

Figure 3.Various Sources of Milk

Regarding milk consumption in a day, 34 participants consumed ¼ litre of milk, 17 did not prefer to take milk at all, 7 consumed ½ litre of milk, and 32 consumed 1 litre of milk per day. So, on average, ₹ 600 was spent on milk per month by the respondents.

Seven members out of 90 had lactose intolerance.

A research study was conducted at a multicentre in India to determine the incidence of lactose intolerance in healthy volunteers from different parts of the country. It concluded that the incidence was 66.6% in the subjects from two South Indian centres in Trivandrum and Pondicherry.[16] So it was clear that many people suffer from lactose intolerance in our country.

The milk products preferred by the respondents were curd, cheese, ghee, palkoa, butter, buttermilk, ice cream, desserts, etc.

When they were asked to give milk preferences, i.e. the animal/ plant sources of milk, 65% chose cow's milk for the protein and calcium content and some other health benefits present in it. Goat milk was also preferred by some of the respondents.

The following benefits of cow's milk were listed by the respondents:

- Contains a good amount of calcium and protein
- Strengthens the body
- Reduces the risk of osteoporosis
- Essential in day-to-day life

Beyond the above-mentioned benefits, some other benefits are listed below:

- Acts as probiotics
- Maintains gut health
- Provides good quality protein for vegetarian people[17]

Among the four variations of milk chosen by us - indigenous cow milk, buffalo milk, soya milk, and coconut milk, 65.9% of people liked to consume coconut milk and among these, 41.1% of them had tasted coconut milk already. 64.7% of respondents liked to consume buffalo's milk but only 12.2% had tasted it. 61.2% of people showed interest in tasting indigenous cow milk and 30% had already consumed it. The least preference was for soya milk where only 31.5% of participants showed interest in consumption and 15.5% had already tasted/ consumed it.

When they were asked about nutritious milk, 36.6% of people rated indigenous milk as the most nutritious one and the least scored was cross-breed milk with 5.6% (Figure 4).

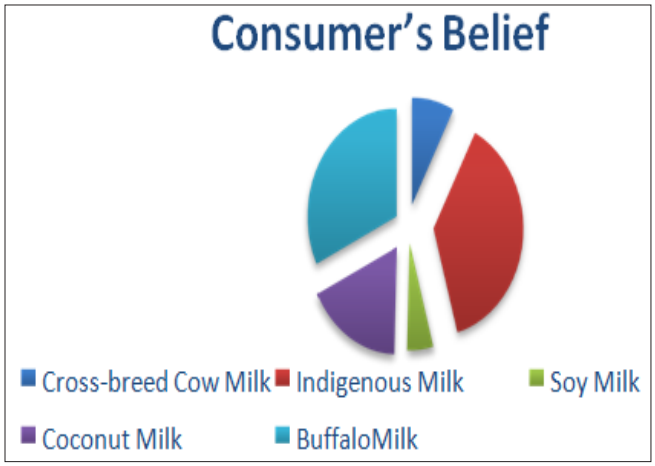

Figure 4.Consumer's Belief in Nutrition of Various Types of Milk

The respondents recorded that 400 ml of milk along with 1 cup of curd is recommended for a daily diet.

During the first two or three days after delivery, thick and yellowish fluid is secreted from the mammary gland. This differs from regular milk and is called colostrum.[18]

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All the respondents had knowledge about colostrum and its health benefits. Even though they knew that it is beneficial to health, only 58% of them prefer it.

A research study on colostrum stated that the concentration of many nutrients and biologically active substances (immunoglobulin, enzymes, hormones, growth factors, etc.) are many times higher in colostrum than in milk.[19]

Raw milk consumption was preferred only by 56% of people and the remaining regretted consuming milk in raw form. Research findings concluded that raw milk does not meet the microbial safety and quality aspects and hence it may act as a carrier for milk-borne diseases and illnesses.[20]

So from the above findings, it was concluded that all consumers expect safe, hygienic, and nutritious milk for consumption and lactose intolerant people expect it from a plant source.

Sensory Scores for Milk and Curd

Standard milk (cross-breed milk) along with four variations (indigenous milk-1, buffalo milk-2, soya milk-3, and coconut milk-4) were evaluated for sensory scores. About 25 products were evaluated and the average scores have been given in Table 2.

Similarly, a study performed on the sensory characteristics of yoghurt was done and tabulated to find the differences among variations at 5% level. Sensory analysis of the tests indicated that the use of carbohydrate-based fat substitutes could successfully resemble full-fat products.[21]

In the same way, Table 3 showsan analysisofcurd. When the results were compared, coconut milk was determined to be the most suitable option for lactose-intolerant people.[22]

Here the buffalo curd scored high in overall sensory attributes.

The quantity of buffalo milk production in the world had increased from 5.4% in 1961 to 15.7% in 2018.[23]

Nutrient Analysis of Milk and Curd

The nutritional content of the best-scored milk and curd was analysed along with the standard. The protein and calcium contents were analysed because the consumer survey clearly explained that all of them consumed milk because of its protein and calcium content. The results have been shown in Table 4.

There is a strong desire to develop lactose-free milk and milk products, but it is not possible to meet the nutritional aspects too. However, the dietary recommendation for Indians is 1 g of protein per kg of body weight, and hence it is sufficient that 100 ml of coconut milk provides 1.1 g of protein.[24]

Table 5, shows the nutrient analysis of curd.The curd obtained from cross-breed cows and buffaloes contains more or less similar nutrient contents.

Cost Calculation

The cost differences between the best-scored and standard curd and milk have been listed in Table 6.

So the chosen products were acceptable in economic aspects also.

Table 2.Sensory Scores for Milk

Choices of Milk	Appearance	Colour	Flavour	Texture	Taste	Overall
Standard*	4.88	4.8	4.8	4.64	4.68	23.84
Variation 1**	5	5	4.92	4.96	4.96	24.84
Variation 2*	4.64	4.4	4.84	4.72	4.6	23.24
Variation 3*	4.64	4.44	3.9	4.08	4.04	21.3
Variation 4*	4.92	4.88	4.88	4.86	4.8	24.32

*p < 0.10. The result is significant at 10% level.
**p > 0.10. The result is not significant at 10% level.

Table 3.Sensory Scores for Curd

Choices of Milk	Appearance	Colour	Flavour	Texture	Taste	Overall
Standard*	4.68	4.72	4.52	4.88	4.48	23.32
Variation 1**	4.68	4.64	4.68	4.68	4.56	23.2
Variation 2**	4.84	4.52	4.72	4.72	4.64	23.44
Variation 3*	4.24	3.84	3.92	3.96	3.92	20.48
Variation 4*	4.56	4.36	4.28	4.16	4.12	21.48

*p < 0.10. The result is significant at 10% level.
**p > 0.10. The result is not significant at 10% level.

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Table 4.Nutrient Analysis of Milk

Per 100 ml	Standard*	Variation 4*
Protein (g)	3.2 g	1.1 g
Calcium (mg)	115 mg	18 mg

*p > 0.05. The result is significant at 5% level.

Table 5.Nutrient Analysis of Curd

Per 100 ml	Standard*	Variation 2*
Protein (g)	10.6 g	11.2 g
Calcium (mg)	128 mg	135 mg

*p < 0.05. The result is not significant at 5% level.

Table 6.Cost Calculation

Per 1 Litre	Standard Milk	Variation 4 Milk	Standard Curd	Variation 2 Curd
Cost (₹)	50	40	60	50

Conclusion

Milk is a nutrient-rich liquid food produced by animal mammary glands. A comparative study of indigenous cow milk, cross-breeds of cow milk, buffalo milk, soy milk, and coconut milk was conducted. Although many people enjoy milk, they do not enjoy drinking it in its raw form, and it must be processed into another form or an alternate product. Despite being aware of the nutritional value, benefits, and cost-effectiveness of milk, some people avoid it due to the colour, taste, and flavour of cow's milk. The sensory evaluation revealed that indigenous cow milk scored the highest among milk, followed by coconut milk. When compared to standards, the majority of people preferred buffalo curd (cross-bred curd). When the results were compared, coconut milk was determined to be the most suitable option for lactose-intolerant people. The nutrient analysis showed that coconut milk had scored low when compared with cow milk but economically coconut milk was a better option. In curd, buffalo curd was cheaper than cow milk curd with increased nutrient content. Further studies suggest that using colon bacteria that help break down lactose effectively can reduce the risk of lactose intolerance symptoms. From the above findings, we are suggesting that everyone should:

- Include milk in their diet.
- Try to include lactose-free milk in case of lactose intolerant people.
- Find other alternatives for milk and milk products.
- Promote plant-based milk sources instead of animal sources.
- Try to develop more products from milk which do not reveal its original sensory characteristics.

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