Consumption Pattern of A2 Milk in Bengaluru City of Karnataka of India

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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

The dairy sector in India, often referred to as the "milk bowl of the world," is a cornerstone of the nation's agricultural economy. A2 milk, derived from native Indian cow breeds, is gaining popularity due to its perceived health benefits over conventional milk. The research aims to provide a complete understanding of factors that influence A2 milk consumption in Bengaluru, addressing both consumer behaviour and market dynamics. The study used a mixed-method approach,

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combining quantitative analysis through surveys and factor analysis. Data were collected from 80 respondents across Bengaluru city of Karnataka. Garrett ranking was utilised to identify key constraints faced by consumers, while the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's test were applied to ensure data adequacy for factor analysis. Results indicate that 82.50% of respondents are aware that A2 milk is a good source of lactose, but awareness drops significantly for other nutritional benefits, with only 19.16% aware of its omega-3 fatty acid content. The general awareness of A2 milk's health benefits of the A2 milk is moderate, with 57.5% of respondents exhibiting a medium level of awareness. Factor analysis revealed that product quality and market considerations significantly influence purchasing decisions, while high cost and lack of awareness are major constraints. The high price is attributed to lower yield per cow and higher maintenance costs. Furthermore, 90.50% of respondents highly accepted the taste of A2 milk, indicating a strong sensory appeal. In conclusion, the study highlights the need for targeted awareness campaigns and pricing interventions to enhance consumer education and engagement. Addressing these constraints could improve market penetration and maintain consumer interest in A2 milk, promoting its health benefits, and ensuring its competitive edge in the dairy market. The findings provide valuable information for producers and marketers aiming to expand the A2 milk market in Bengaluru and similar urban areas.

1. INTRODUCTION

The dairy sector plays a crucial role in India's agro-economic landscape by contributing significantly to the country's rural economy, employment generation, and nutritional security. Dairy accounts for five per cent of the country's agricultural Gross Domestic Product (GDP) and directly supports more than 8 crore farmers [1,2]. India is the top milk producer in the world, accounting for 23 per cent of all milk produced worldwide [3]. From 146.31 MT in 2014–15, milk output in the nation increased at a Compound Annual Growth Rate (CAGR) of roughly 5.85 per cent to reach 230.58 MT in 2022–23 [4]. In the context of Karnataka, the state significantly contributes to India's overall milk production. Karnataka produced 12.503 MT of milk in 2022-23 [5]. This substantial contribution from Karnataka highlights the state's essential role in supporting the national dairy sector and its integral role in ensuring the country's dairy self-sufficiency and economic prosperity.

Milk is the primary product of the dairy sector which is widely known for its nutritional richness, containing high-quality proteins, essential vitamins (A, D, B12), minerals (calcium, phosphorus) and fats [6-8]. Casein, the main component of milk proteins, consists of approximately 30-35% β-casein, with variants A1 and A2 differing at 67th amino acid position. Cows producing A1 milk are exotic breeds such as Holstein, Friesian and Ayrshire, while indigenous cows such as Gir, Red Sindhi, and Sahiwal produce A2 milk [9-12]. In recent years, the dairy sector in India has seen increasing interest in A2 milk, which was a new dimension to the nutritional landscape [13]. A2 milk suggest that this protein variant may be easier to digest for individuals who experience discomfort or digestive issues after consuming conventional milk containing A1 β-casein. A2 milk claim various health benefits including improved digestion, reduced risk of lactose intolerance and potential alleviation of symptoms associated with conditions such as irritable bowel syndrome (IBS) and autism [14-16]. The emergence of A2 milk has sparked a significant market trend, with dairy companies and farmers increasingly focusing on promoting indigenous cattle breeds and producing A2 milk products. This trend aligns with the broader movement towards traditional and natural food products, driven by consumer preferences for healthier and more sustainable options. The emergence of A2 milk represents a significant development in India's dairy sector, reflecting evolving consumer preferences and nutritional trends [17-21].

The market for A2 milk is rapidly expanding due to the increasing consumer demand for its perceived health benefits. Several dairy units in India have started offering A2 milk at premium prices to consumers. The Karnataka boasts a rich agricultural heritage, with dairy farming being a vital part of traditional livelihoods. In recent years, there have been around ten A2 milk farms in Bengaluru in the last five years. Several studies have explored the factors that influence A2 milk consumption and its health benefits.

Table 1. Population status of indigenous cattle in Karnataka

Breed	Population			% Share in total indigenous cattle of Karnataka
	Pure	Graded	Total	
Amritmahal	105330	123617	228947	3.47
Deoni	49114	62080	111194	1.68
Hallikar	1148876	550559	1699435	25.73
Khillar	225207	495153	720360	10.91
Krishna Valley	3462	10919	14381	0.22
Malnad Gidda	897888	147448	1045336	15.83

Source: 20th livestock census 2018-19

This holistic approach aims to provide valuable information on the intricate relationship between milk production and consumption, shedding light on the broader implications for the dairy industry in the Bengaluru district of Karnataka, India. The findings of this study aim to contribute to informed decision-making among policymakers, stakeholders in the dairy industry, and farmers. It also seeks to investigate the factors driving consumer preferences for A2 milk in the city of Karnataka. In addition to economic considerations, sociocultural aspects will be examined to understand how A2 milk aligns with the dietary patterns and traditions of the local population.

Karnataka state is developing the cattle and buffalo breeding infrastructure under National Project for Cattle and Buffalo Breeding. There is about 88 million livestock population in Karnataka such as cattle, buffalo, sheep, goats and pigs. The indigenous breeds of Karnataka are Hallikar, Amrithmahal in the southern part and Khillar, Krishna valley and Deoni in the northern part (Table 1). All are draught purpose breeds. Malnad Gidda is a dwarf variety of cattle found in the Malnad regions of the State. Germplasm of these breeds are conserved. The breeds of desi cows are Gir, Sahiwal, Ongole, Kankrej, Tharparkar, Rathi, Haryanvi and Gangatiri, Amritmahal *etc.*

2. METHODOLOGY

The study uses both primary and secondary data. Secondary data was obtained from co-operative Milk Producers Federation Limited (KMF) and from private A2 milk dairies in Bengaluru. The state federation, KMF, which is the apex body for the dairy co-operative movement in the state, has 15 milk unions across Karnataka covering 32 districts. Which procure milk from Primary Dairy Cooperative Societies (DCS) and distribute milk to the consumers in various Towns/Cities/Rural markets in Karnataka. KMF sells varieties of dairy products such as milk, milk powder, ghee, butter, curd, and other fermented products, milk sweets, UHT milk, chocolate, ice-cream desserts, A2 milk through its outlets [22]. While collecting primary data, the present study is confined to Bengaluru city only. For the study, data were obtained from 80 consumers and five retailers drawn purportedly from the city. The required data were collected from the respondents by personal interview method with the help of a pre-tested structured schedule by snowball sampling and also through Google forms. Here we have used snowball sampling as the consumers of A2 milk are widely spread across the city. The sample respondents were interviewed in modern retail formats of A2 milk, college campuses, and at homes.

2.1 Factor Analysis

Factor analysis is a class of procedures that is primarily used for data reduction and summarization. It is a statistical method used to describe variability among observed, correlated variables in terms of a potentially lower number of unobserved variables, called factors. Factor analysis is a good way to identify latent or underlying factors from a collection of seemingly important variables. The observed variables are modelled as linear combinations of potential factors, plus "error" terms. The information gained about the interdependencies between the observed variables can be used later to reduce the set of variables in a dataset.

The factor analysis was performed to analyse the factor that influences the purchase of A2 milk by consumers. Factors such as age, chemical-free milk, freshness, nutritive value, thickness, colours, brand image, easy availability, health benefits, reasonable price, taste and flavour, lactose intolerance, and immunity booster. Factor analysis model is given by Kline in [23].

$$X_i = A_{i1}F_1 + A_{i2}F_2 + A_{i3}F_3 + \cdots + A_{im}F_m + V_iU_i$$

Where,

X_i = ith standardized variable
A_{ij} = standardized multiple regression coefficient of the variable on the common factor j
F = common factor
V_i = standardized regression coefficient of variable i on unique factor
U_i = Unique factor for variable i
m = number of common factors
The unique factors are uncorrelated with each other and with the common factors.
The common factors themselves can be a linear combination of the observed variables.

$$F_i = W_{i1}X_1 + W_{i2}X_2 + W_{i3}X_3 + \cdots + W_{ik}X_k$$

where

F_i = estimate of ith factor
W_i = weight or factor score co-efficient
K = number of variables;

It is possible to select weights or factor score coefficient so that the first factor explains the largest portion of the total variance. Then the second set of weights can be selected so that the second factor accounts for most of the residual variance, subject to being uncorrelated with the first factor. The same principle can be applied to the selection of additional weights for the additional factors.

2.2 Bartlett's Test of Sphericity

It is a statistic test for examining the hypothesis for showing that the variables are uncorrelated in the population i.e., the population correlation matrix is an identity matrix. Bartlett's test of sphericity tests the hypothesis that a correlation matrix is an identity matrix, which would indicate that the variables are unrelated and, therefore, unsuitable for structure detection. Each variable correlate perfectly with itself (r=1) but has no correlationwith the other variables (r=0) [24].

2.3 Garrett's Ranking Technique

Garrett's ranking technique was used to analyse the consumer preference for A2 milk over conventional milk and the constraints faced by respondents while buying A2 milk in the Bengaluru city of Karnataka. The order of merit given by the consumers was changed into ranks

by using the formula: the procedure given by Henry Garrett and Woodworth R S [25].

Per cent position = $\frac{R_{ij}-0.5}{N_j} \times 100$

Where,

R_{ij} = Rank given for ith item by jth individual
N_j = Number of items ranked by jth individual

The per cent position of each rank was converted into scores by referring to the Garrett table. The scores of individual respondents were then summed up and divided by the total number of respondents for whom the scores were gathered. The mean scores for all the factors were ranked; the factors having the highest mean value is considered to be the most important factor and ranked accordingly [26].

3. RESULTS AND DISCUSSION

3.1 Level of Awareness of A2 Milk among Consumers in Bengaluru City

The awareness levels among consumers regarding the nutritional benefits of A2 milk are presented in Table 2. It was observed that 82.50% of respondents are aware that A2 milk is a good source of lactose, while 17.50% are unaware of this fact. Additionally, 49.17% of the respondents are aware of the presence of vitamins A, D, and B12 in A2 milk, compared to 50.83% who are not. Regarding the hormone- and antibiotic-free nature of the A2 milk, only 25% of respondents were aware, while 75% were not. Furthermore, 75% of the respondents recognised that A2 milk is rich in calcium, which is beneficial for bone health, while 25% were unaware. Awareness of the significant amount of omega-3 fatty acids in A2 milk, which reduce the risk of heart disease or stroke, was low, with only 19.16% of respondents acknowledging this benefit and 80.84% unaware. Similarly, only 22.50% of respondents were aware that A2 milk can help prevent and treat osteoporosis, leaving 77.50% unaware. Finally, only 27.50% of respondents knew that A2 milk contains potassium, which aids in maintaining blood pressure, while 72.50% were not aware.

These findings indicate that for five of the seven indicators assessed, the majority of consumers in the city of Bangalore do not know about the health benefits of A2 milk. This suggests a pressing need for producers and marketers of A2

milk to implement awareness campaigns. Such initiatives could not only attract new customers but also help retain the existing customer base by enhancing their understanding of the product's health benefits.

Table 3 reveals the general extent of awareness of A2 milk among consumers in Bengaluru. The findings indicate that more than one-third (57.5%) of respondents exhibit a medium level of awareness regarding the health benefits of A2 milk. This is followed by 22.5% of respondents who have a low level of awareness and 20% who possess a high level of awareness.

3.2 Factors Influencing the Purchase of A2 Milk by Consumers

The attributes influencing the purchase decision for A2 milk were analysed using factor analysis. The initial step involved evaluating the suitability of the data for factor analysis using the Kaiser-Meyer-Olkin (KMO) measure and the Bartlett test, as presented in Table 4.

The KMO score of 0.882 indicated adequate sampling adequacy, and the significance level for the Bartlett test being below 0.01 suggested a strong correlation within the data. Therefore, we proceeded with factor analysis to identify the determinants of consumer purchase decisions.

Product quality, which includes qualities like freshness, nutritional value, thickness, color, health advantages, and lack of adulterants, with eigenvalue greater than 1, indicating the influence on A2 milk purchase behavior. Market factors, which included medical recommendations, taste and flavour, trendiness/fashionability, simple availability, fair pricing, and compatibility with lactose sensitivity,

Table 2. Extent of awareness of A2 milk consumers

S.No.	Awareness Level	Aware		Not Aware	
		Frequency	Percent	Frequency	Percent
1.	Good source of lactose	99	82.50	21	17.50
2.	It contains vitamin A, D and B12	59	49.17	61	50.83
3.	Free of hormones and antibiotics	30	25.00	90	75.00
4.	It contains an abundance of calcium which strengthen the bones	90	75.00	30	25.00
5.	It contains a significant amount of omega-3 fatty acids that reduce the risk of heart disease or stroke	23	19.16	97	80.84
6.	It helps to prevent and treat osteoporosis, or weakening of bones	27	22.50	93	77.50
7.	The potassium present in A2 milk benefits your blood pressure	33	27.50	87	72.50

Source: Authors' computations based on primary survey

Table 3. Overall extent of awareness of A2 milk by consumers

Category	Respondents (n=120)	
	Frequency	Percent
Low	27	22.50
Medium	69	57.50
High	24	20.00

Source: Authors' computations based on primary survey

Table 4. KMO and Bartlett's test for variance among variables

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.882
Bartlett's Test of Sphericity	Approx. Chi-Square	1598.055
	Degrees of freedom	171
	Significance	0.000

Source: Authors' computations based on primary survey

Table 5. Factors influencing the consumer purchase decision of A2 milk

Factor	Product quality	Market Factors	Household characteristic
Age	0.072	0.114	**0.819**
Chemical free milk	**0.895**	0.226	0.004
Freshness of milk	**0.912**	0.158	0.088
Nutritive value of milk	**0.932**	0.177	0.023
Thickness of milk	**0.915**	0.252	0.072
Colour of milk	**0.805**	0.414	0.113
Brand image	0.478	**0.68**	-0.017
Easy availability	0.268	**0.637**	-0.262
Health benefits	**0.823**	0.408	0.014
Reasonable price	0.109	**0.841**	-0.054
No adulterants	**0.746**	0.509	0.05
Trendy/Fashionable	0.195	**0.829**	0.088
Lactose intolerance	0.574	**0.625**	0.093
Immunity booster	0.622	0.579	0.05
Taste and flavour	0.622	**0.631**	0.19
Doctor recommendation	0.558	**0.608**	-0.009
Proportion of consumption/Income	-0.075	0.151	**-0.786**

Source: Authors' computations based on primary survey

were the second important element. All of these elements together have an impact on customers' choices to buy A2 milk. Family characteristics, including age and the ratio of family consumption to household income, were shown to be the third factor that influenced consumer purchasing behaviour (Table 5).

These results are consistent with those of Srivastava [27], who investigated consumer variables influencing the purchasing decisions for Fast-Moving Consumer Goods (FMCG) in unauthorised colonies. The results are backed up by Srivastava's study, which examined socioeconomic characteristics, product preferences among generic and branded categories, explanations for such preferences, and the general factors influencing purchase behaviour.

3.3 Constraints Faced by Consumers while Buying A2 Milk

The constraints faced by consumers while purchasing A2 milk in Bengaluru city were analyzed using Garrett ranking, and the results are presented in Table 6. According to the majority of respondents, the primary constraint is the high cost of A2 milk, which has a mean score of 62.53. This is followed by consumer ignorance of A2 milk, with a mean score of 59.87, and the lack of online access to certain brands such as Gatti Gaushala and Pyramid

Organic, which has a mean score of 57.59. Additionally, the limited availability of organic stores selling A2 milk (mean score of 52.91) and the lack of advertising programs for A2 milk (mean score of 47.97) were also significant constraints.

The higher price of A2 milk compared to conventional milk can be attributed to several factors. The yield of A2 milk per cow is lower, and maintaining native Indian breed cows incurs substantial costs, requiring high-quality care and advanced infrastructure. These cows need a rich in nutrients, including plant mixes, wheat bran, and crushed soybeans. Furthermore, marketing costs are elevated due to the perishable nature of the product and exclusive supply chain models used for transporting and selling of A2 milk. Consequently, these factors contribute to the higher price of A2 milk.

The second major constraint is the lack of awareness among consumers regarding the health benefits of A2 milk, largely due to insufficient advertising programs. This lack of awareness hampers consumer education and engagement, thus affecting the overall market penetration of A2 milk. These findings underscore the need for targeted strategies to address these constraints, including pricing interventions, improving accessibility, and increasing consumer awareness through effective advertising campaigns.

Table 6. Constraints faced by consumers while buying A2 milk

S. No.	Constraints	Garrett's Values	
		Mean Score	Rank
1.	The high price of A2 milk	62.53	I
2.	Lack of awareness of the health benefits ofA2 milk	59.87	II
3.	Lack of online access of some of thebrand	57.59	III
4.	Availability of a smaller number oforganic stores for A2 milk	52.91	IV
5.	Lack of Advertisement programs	47.97	V

Source: Authors' computations based on primary survey

3.4 Preference for A2 Milk over Conventional Milk

Table 7 presents the preference for A2 milk over conventional milk by consumers in Bengaluru city of Karnataka. The majority of the respondents prefer A2 milk due to its nutritive value (mean score of 84) when compared to conventional milk because A2 milk contains an abundance of calcium, which helps the body grow and repair bones. It also helps prevent and treat osteoporosis, or the weakening of bones followed by brand image (mean score of 62.50) because for consumers brand is very crucial.

It creates an impression and it enables consumers to make an easier, faster buying decision and most of the consumers prefer because A2 milk is organic by nature (mean score of 60.50) out of regard for consumer needs such nutritional value, flavor, freshness, and appearance, as well as safety, human health, and environmental concerns, followed by attractive packaging(mean score of 54.75) of A2 milk is an important consideration for respondents, which could be one of the reasons for preference of A2 milk, consumers believe that attractive packaging deliver a sense of quality while also reflecting the product's brand image and the rest of the respondents prefer A2 milk because they do not care about the price of the milk(mean score of 42.75) even if the price is high they will still prefer A2 milk because of its nutritional value.

3.5 Acceptance of A2 Milk among Consumers

Table 8 presents the acceptance of A2 milk among Bengaluru consumers. The taste of A2 milk is highly accepted by respondents (90.50%) because consumers feel that A2 milk tastes just like milk that contains the A1 protein, making it possible to enjoy consumers' favorite milk-laden treats without risking digestive discomfort or compromising on the taste of

Table 7. Preference for A2 milk over conventional milk

S. No.	Particulars	Garrett's Values	
		Mean Score	Rank
1.	Milk A2 is more nutritious than commercial milk.	84.00	I
2.	I prefer A2 milk for its nutritious value	76.75	II
3.	The brand image is most important while buying	62.50	III
4.	I prefer organic to inorganic	60.50	IV
5.	Attractive packaging is the most important consideration while buying A2 milk	54.75	V
6.	I don't care about the price of milk	42.75	VI

Source: Authors' computations based on primary survey

Table 8. Acceptance of A2 milk among consumers

S. No.	Particulars	Total score	Average score	Per cent
1.	Appearance	351	4.39	87.75
2.	Aroma	354	4.43	88.50
3.	Taste	362	4.53	90.50
4.	Colour	345	4.31	86.25
5.	Thickness	348	4.35	87.00
6.	Odor	343	4.29	85.75

Source: Authors' computations based on primary survey

consumers. Followed by aroma (88.50%), appearance (87.75%), thickness (87%), colour (86.25%) and odor (85.75%). These were the sensory attributes of A2 milk that are accepted and well-liked by the respondents. The acceptance of A2 milk is high among respondents due to its health benefits.

4. CONCLUSION

This study provides a comprehensive analysis of the consumption patterns of A2 milk in Bengaluru city, Karnataka. The findings reveal a significant awareness gap among consumers on the nutritional benefits of A2 milk. While a majority of respondents (82.50%) are aware of its lactose content, awareness of other health benefits such as the presence of vitamins A, D, and B12, hormone and antibiotic-free nature, omega-3 fatty acids, and potassium remains low. This lack of awareness underscores the need for targeted awareness campaigns to educate consumers about the health benefits of A2 milk, which could enhance market penetration and consumer retention. The study also identifies key factors that influence consumer purchase decisions through factor analysis. Product quality, including freshness, nutritional value, and the absence of adulterants, emerged as the most significant factor. Market considerations such as brand image, availability, price, and medical recommendations also play crucial roles. Household characteristics, including age and income, further influence purchasing behavior, aligning with previous research by Srivastava [27]. Constraints faced by consumers, analyzed using Garrett ranking, highlight high costs and lack of awareness as primary barriers. The higher price of A2 milk is attributed to lower cow yield, substantial maintenance costs, and exclusive supply chain models. Insufficient advertising exacerbates the consumer's ignorance about A2 milk's benefits. Addressing these constraints through pricing interventions, improving accessibility, and improving consumer education via effective advertising is imperative for market expansion. Consumer preferences indicate a strong inclination towards A2 milk due to its nutritive value, brand image, organic nature, and attractive packaging. Despite higher costs, consumers prioritise health benefits, indicating a willingness to pay a premium for quality. The sensory attributes of A2 milk, such as taste, aroma, appearance, thickness, color, and odor, are highly accepted, reinforcing its market potential.

In conclusion, while A2 milk is favoured for its health benefits and sensory attributes, overcoming price and awareness barriers is crucial. Strategic initiatives focused on education, pricing, and accessibility can promote greater acceptance and consumption of A2 milk in Bengaluru, ultimately promoting healthier dietary choices among consumers.

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 writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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