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RESEARCH ARTICLE

Sprouted finger millet as a functional food: Assessing urban consumption patterns and nutritional potential in Coimbatore district

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Abstract

The study examined consumer awareness and purchasing behaviour toward sprouted ragi flour in Coimbatore, Tamil Nadu, India. Through a survey of 200 respondents using convenience sampling, the research revealed significant consumer preference for sprouted ragi flour due to its superior nutritional benefits. The findings indicate that 60 % of surveyed consumers were aware of sprouted ragi flour, with 100 % expressing to pay premium prices (approximately 60 % higher than regular ragi flour). Key findings showed that nutritional benefits (42 %) were the primary driver for consumer adoption, followed by digestibility (32 %). The study identified limited availability as the major constraint (rank I), followed by short shelf life (rank II). Factor analysis revealed three key dimensions influencing purchase decisions: market factors (price, promotions, shelf life, availability), product attributes (health benefits, quality, taste) and brand attributes (reputation, recipes, packaging). The research contributes to understanding consumer behaviour in the health food sector and provides strategic recommendations for manufacturers and retailers in the expanding millet market.

Keywords: consumer behaviour; finger millet; health foods; nutritional awareness; purchasing decisions; sprouted ragi flour

Introduction

The global shift toward health-conscious eating has renewed interest in traditional grains, particularly millets, which are experiencing a remarkable renaissance in modern diets (1). Millets, ancient grains cultivated in arid and semiarid regions, are rich in essential minerals and vitamins, earning them the classification of “nutri-cereals” (2). Among various millet varieties, finger millet (*Eleusine coracana*), commonly known as ragi, stands out for its exceptional nutritional profile and versatility (3).

Sprouted ragi flour represents an evolution in traditional grain processing, where ragi grains undergo controlled germination before being dried, roasted and ground into flour. The germination process typically lasts 24 to 48 hr, during which enzymes activate, enhancing the grain's nutritional value and digestibility (4). This sprouting process significantly enhances the nutritional bioavailability while reducing anti-nutritional factors like phytates, making the flour more digestible and nutrient-rich than its conventional counterpart (5). Traditional grains are making a strong comeback as people seek healthier food choices (6).

The nutritional superiority of sprouted ragi flour is well-documented, offering high calcium content (crucial for bone health), significant iron levels (essential for preventing anaemia), substantial plant-based protein, high dietary fibre and a low glycaemic index suitable for diabetic management (7). Additionally, its naturally gluten-free nature makes it an ideal alternative for individuals with celiac disease or gluten intolerance. Sprouted ragi flour shows improved nutritional and functional properties compared to regular ragi flour. Protein digestibility increases from 72 % to 84 % calcium arises from 225 to 280 mg/100 g and vitamin C nearly doubles. Anti-nutrients like phytates and tannins reduce significantly. While sugars and glycemic index increase due to starch breakdown during germination (8).

Recent research indicates that awareness and availability of good nutritious options can enhance their consumption, suggesting that consumer education and market accessibility are critical factors in adopting nutritious alternatives like sprouted ragi flour (9). Understanding consumer behaviour toward such health-focused products becomes essential for stakeholders in the food industry, particularly in urban markets where health awareness is increasing (10).

The study aims to fill the research gap by providing empirical insights into consumer awareness, preferences and purchasing behaviour toward sprouted ragi flour in Coimbatore, an emerging urban centre in Tamil Nadu, India.

Nutritional benefits of sprouted ragi flour

The sprouting process fundamentally transforms the nutritional profile of ragi grains. Research demonstrates that sprouting increases the bioavailability of essential nutrients while breaking down anti-nutritional compounds (11). The process enhances calcium content significantly, with sprouted ragi containing higher levels compared to regular ragi flour. Iron content also increases substantially, making it particularly beneficial for addressing iron deficiency anaemia, especially among women and children (12).

The presence of phytochemicals in millet grains benefits human health by reducing cholesterol and phytates in the body (13). The sprouting process enhances these benefits by increasing enzyme activity such as amylase, protease, peroxidase, alkaline phosphatases, ATPase and nitrate reductase and making proteins and carbohydrates more digestible (7,14).

Consumer behaviour in health food markets

Consumer behaviour toward health foods is influenced by multiple factors, including awareness, perceived benefits, taste preferences and availability (15). Health problems, weight loss and sensory attributes such as taste were major motivations for millet consumption, with demographic factors such as age, qualification and income having a significant influence (16). Studies on millet consumption patterns reveal that urban consumers are increasingly adopting millets due to growing health consciousness. Attention is growing among governments and industry with the role played by millets to help build resilience for farmers, indicating institutional support for millet promotion (17).

Materials and Methods

The study employed a descriptive research design using primary data collection through structured questionnaires. The research methodology comprised:

Sampling method and size

A convenience sampling method was used to select participants for the study. The sample consisted of 200 respondents (out of 200, 137 were female respondents and 63 were male respondents).

Data collection

Data was collected through scheduled interviews using a well-structured questionnaire (consisting of closed-ended questions). The questionnaire was designed to gather information on respondent's demographic profiles, usage patterns, preferences between platforms and factors influencing their choices.

Analysis tools

Percentage analysis

The study used percentage analysis and averages within descriptive statistics to analyse and summarize various characteristics. Demographic details viz., age, gender, monthly family income, educational status and awareness level-were analysed by the above statistical tools (18).

$$Percentage\ analysis = \frac{Number\ of\ samples\ taken}{Total\ no\ of\ samples} \times 100 \quad \text{(Eqn. 1)}$$

Factor analysis

Factor analysis is a multivariate statistical technique widely used to explore the underlying structure of a large set of observed variables. It is particularly useful when the research involves multiple interrelated variables (19).

Garrett ranking method

Garrett's ranking technique was used to rank each of the factors and those ranks were converted into percent values using the formula given below.

$$Percent\ position = 100 \times \frac{\sum(Rij - 0.5)}{Nj} \quad \text{(Eqn. 2)}$$

Where,

R_{ij} = rank given for the i^{th} factor by the j^{th} individual

N_j = number of factors ranked by the j^{th} individual

Using Garrett's table, the estimated percentage was converted into a score. Then, for each factor, the total of the scores obtained and the average value were calculated (20).

Results and Discussion

Consumer awareness and demographic

The study revealed that 60 % of respondents (120 out of 200) knew about sprouted ragi flour, indicating moderate awareness levels in the urban Coimbatore market. Among aware consumers, 77 % women (92 respondents) compared to 23 % men (28 respondents), suggesting higher health consciousness among female consumers (Fig. 1).

The age distribution showed that the 31-40 age group represented the largest segment (54 %) of aware consumers, followed by the 21-30 age group (33 %). This pattern aligned with life-stage health awareness, where individuals in their thirties typically become more health-conscious due to family responsibilities and emerging health concerns (Fig. 2).

Educational qualification analysis revealed that graduates (42 %) and individuals with secondary education (38 %) formed most aware consumers, indicating that education levels positively correlate with health food awareness. The occupational distribution showed private sector employees (40 %) as the largest segment, followed by public sector employees (23 %) and business owners (23 %). The distribution highlights a possible gap in awareness or participation among government workers, which could be due to less exposure or limited promotional efforts in that segment (Fig. 3).

Consumer preferences

The study found out that the primary reasons for switching to sprouted ragi flour was that most consumers, about 42 %, preferred the product because of its nutritional benefits. Around 32 % of them choose it for easy digestion. Traditional reasons influenced 13 % of the consumers, while another 13 % said they were influenced by recommendations from friends or family.

This pattern confirmed that health consciousness is the primary driver for adopting sprouting ragi flour, aligning with global trends towards functional foods. Similar findings have been observed in other urban Indian studies, where increasing awareness of lifestyle-related health issues has led to a rise in millet consumption among middle-income and educated consumers.

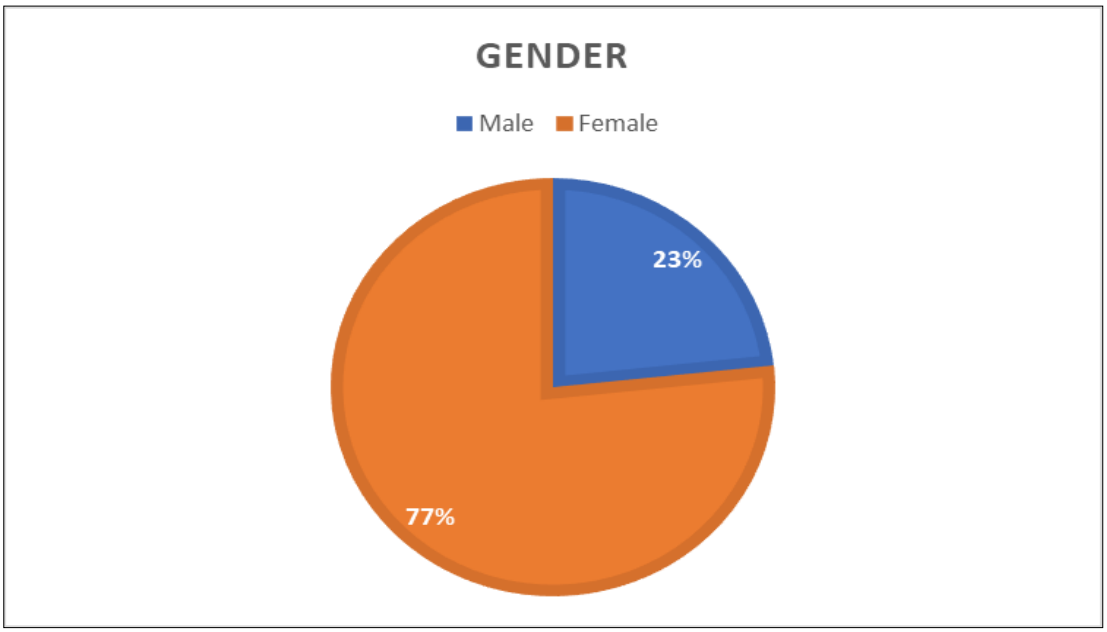

Fig. 1. Gender profile of the sample respondents.

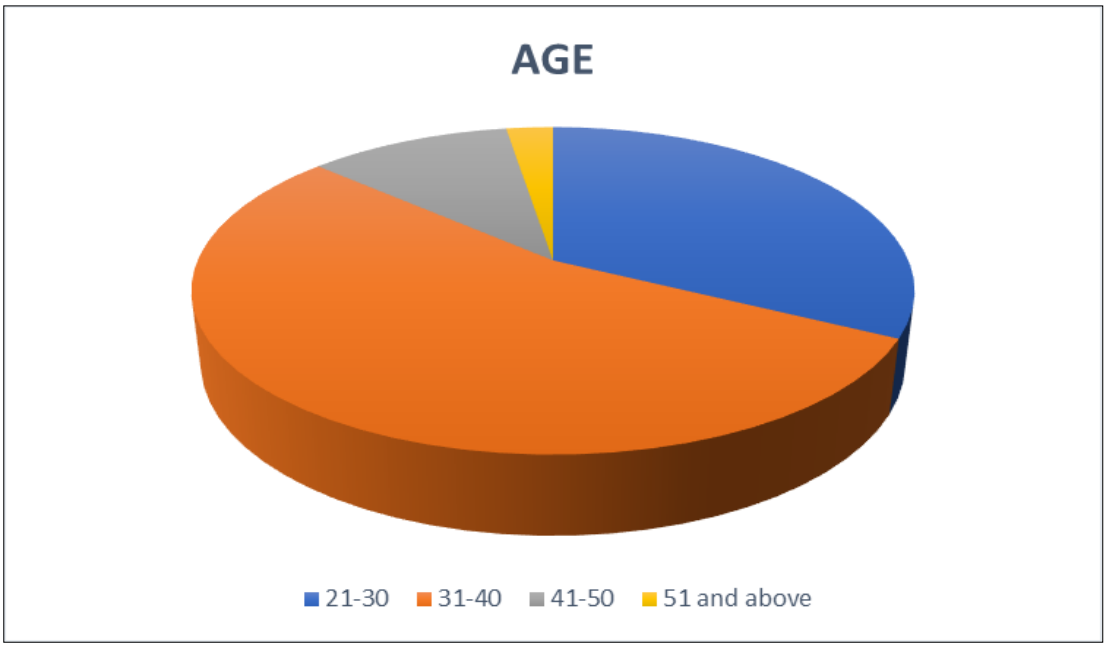

Fig. 2. Age of the sample respondents.

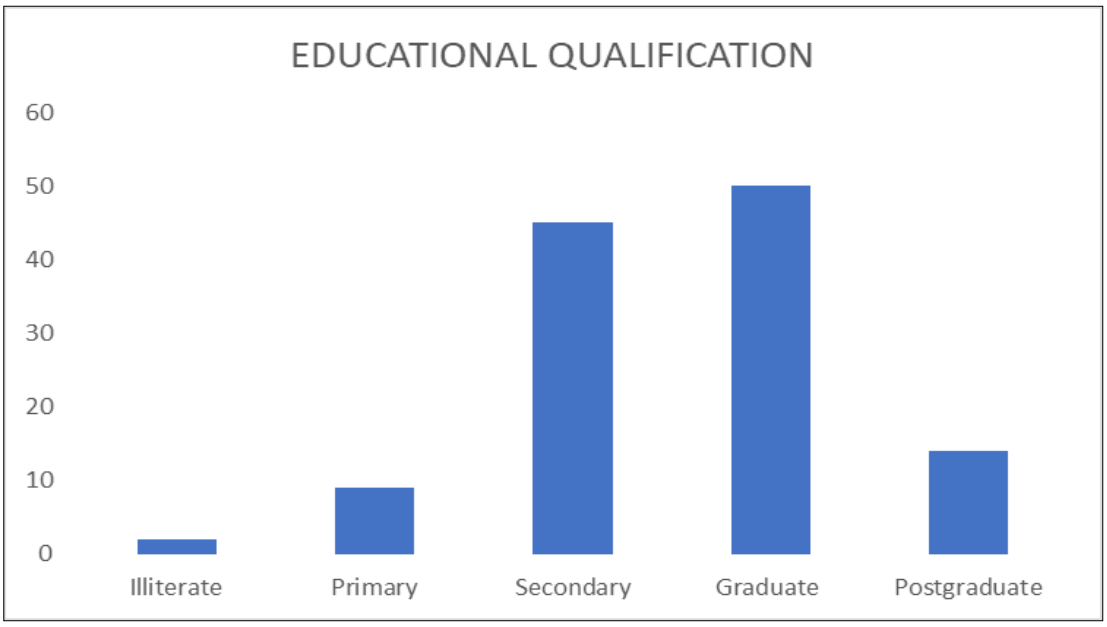

Fig. 3. Educational qualification of the sample respondents.

Information sources and purchase behaviour

Online sources (32 %) emerge as the most important information channel, followed by health professionals (27 %) and friends (25 %). This digital-first approach to health information reflects modern consumer behaviour patterns, particularly among educated urban consumers.

Primary usage patterns showed: The survey found that 33 % of consumers use the product mainly for preparing *puttu*, showing its popularity in traditional dishes. About 30 % prefer it for making *dosa*, while 28 % use it for porridge due to its health benefits. Only 7 % use it for *laddu*, indicating it's less common for sweets. These preferences reflect the product's versatility in daily cooking.

Monthly purchase frequency dominated (58 %), with weekly purchases at 20 % and occasional purchases at 22 %. This suggests regular integration into household cooking routines.

Supermarkets (42 %) are the preferred purchase location, followed by online platforms (33 %) and local grocery stores (21 %). This preference pattern indicates the importance of organized retail channels for health food distribution.

Consumption and pricing analysis

Average monthly consumption analysis revealed: 500 g packages (61 % preference), 250 g packages (22 % preference) and 1 kg packages (15 % preference).

Price analysis shows that 48 % of consumers pay ₹101-120 for 500 g packages, while 27 % pay ₹81-100. Remarkably, all aware consumers express willingness to pay the premium price of approximately ₹115 for 500 g of sprouted ragi flour compared to ₹46 for regular ragi flour, representing a 150 % price premium.

Factor analysis of purchase influencers

The Kaiser-Meyer-Olkin (KMO) measure of 0.775 indicates good sampling adequacy for factor analysis. The analysis reveals three significant factors explaining 78.39 % of total variance (Table 1).

The factors were grouped in to three categories based on the eigenvalues, which are greater than 1.

Category 1: Market factors (45.15 % variance), which comprises price (0.870 loading), promotions (0.866 loading), shelf life (0.774 loading) and availability (0.762 loading).

Table 1. KMO and Bartlett's test for the factors that influence customers to purchase sprouted ragi flour

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.775
Bartlett's Test of Sphericity	Approx. Chi-Square	856.201
	df	45
	Sig.	0.000

Category 2: Product attributes (22.70 % variance), which comprises health benefits (0.910 loading), quality (0.891 loading) and taste (0.688 loading).

Category 3: Brand attributes (10.55 % variance), which comprises brand reputation (0.870 loading), recipes (0.797 loading) and packaging (0.701 loading)

These factors contributed to the total variance explained and were categorized based on the eigenvalues greater than 1 (Table 2 & 3).

Table 3. Factors are classified into three categories based on the eigenvalue greater than 1

Rotated component matrix			
Factors	Component		
	1	2	3
Price	.870		
Promotions	.866		
Shelf Life	.774		
Availability	.762		
Health benefits		.910	
Quality		.891	
Taste		.688	
Brand reputation			.870
Recipes			.797
Packaging			.701

Consumer constraints analysis

Garrett ranking analysis identifies key constraints faced by customers, shown in Table 4. The major barrier faced by consumers was limited availability of the product, with the highest mean score of 68.83, making it the most significant constraint. The second major issue was the short shelf life (mean score: 63.2), highlighting challenges in product preservation. Taste preferences ranked third with a mean score of 58.41, indicating concerns with sensory acceptance. Lack of proper labelling was also noted (mean score: 43.89), showing that consumers face difficulty in understanding product information. Lastly, limited cooking knowledge or recipes (mean score: 49.5) pointed to a gap in awareness about how to use the product effectively.

Table 4. Constraints faced by the customers are ranked using the Garrett ranking

Sl. No.	Factors	Mean value	Rank
1	Limited availability	68.83	I
2	Short self-life	63.2	II
3	Taste preferences	58.41	III
4	Cooking knowledge (recipes)	49.5	VI
5	Insufficient labelling	43.89	V

Table 2. Principal component analysis: total variance explained by extracted factors

Total variance explained									
Component	Initial eigenvalues			Extraction sums of squared loadings			Rotation sums of squared loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6.848	52.729	52.729	4.514	45.145	45.145	3.044	30.437	30.437
2	2.489	19.165	71.894	2.270	22.700	67.845	2.541	25.412	55.849
3	1.334	10.271	82.165	1.054	10.545	78.390	2.254	22.541	78.390
4	.596	4.591	86.756						
5	.523	4.026	90.782						
6	.394	3.034	93.816						
7	.253	1.949	95.765						
8	.235	1.812	97.576						
9	.172	1.325	98.902						
10	.143	1.098	100.000						

Strategic implications and recommendations

Market development strategies

Distribution channel expansion: The identification of limited availability as the primary constraint suggested the need for aggressive distribution network expansion.

Manufacturers should focus on increasing the brand's presence in supermarkets and hypermarkets to reach more customers. They should focus on strengthening partnerships with online platforms to boost digital sales. At the same time, efforts should be made to develop specialized health food retail networks. Additionally, building strong supply chain connections between rural producers and urban markets is a key part of the strategy.

Product innovation and shelf-life enhancement: To address the second-ranked constraint of short shelf life, the research laboratory is focusing on enhancing packaging technologies aimed at preserving product freshness and extending shelf life. It is developing special packaging with controlled air to keep food from spoiling quickly. The lab is also exploring natural ways to preserve food instead of using chemicals. Smaller pack sizes are being designed to boost faster sales and reduce waste. These efforts aim to improve product quality and meet consumer needs.

Consumer education and awareness

Digital marketing focus : Given the prominence of online sources (32 %) for information gathering, digital marketing strategies should include creating SEO-optimized content highlighting sprouted ragi's health benefits. Social media campaigns can be designed to connect with health-conscious audiences. Collaborations with influencers, such as nutritionists and health experts, will help build trust and reach a wider audience.

Professional healthcare channel development: With health professionals ranked as the second most important source of information (27%), outreach initiatives should include educational programs for medical practitioners to enhance their awareness of the product's health benefits. Partnerships with nutritionists should also be developed to support product recommendations. Clinical studies can be conducted, published and widely shared to build scientific credibility. Additionally, participation in professional conferences will help connect with experts and promote the product within the healthcare community.

Market placement and price planning of the product

Validating the product's premium market position: The 100 % willingness to pay premium prices validates a premium positioning strategy. However, companies should support premium pricing, it is important to clearly explain the health benefits of the product to the consumers. Highlight its high nutritional value and why it is better than regular options. Use simple messages that show how it helps with immunity, digestion or good for diabetic people. Share quality assurance details like clean sourcing, safe processing and certifications. Customer reviews and expert support can increase trust. In addition, different price options, like small packs for new users and premium ones for regular buyers. This helps reach more people based on their budget and needs.

Market segmentation strategy : Based on demographic analysis, targeted approaches should focus on urban females aged 31-40 years, with graduate-level education and belonging to middle-income households. The secondary target should include health-conscious males who fall within similar demographic characteristics. Additionally, the tertiary target comprises young professionals aged 21-30 years who are actively seeking preventive health solutions.

Product development recommendations

Recipe development and cooking support: To address constraints related to cooking knowledge, manufacturers should develop simple and practical recipe booklets that promote healthy cooking habits and are easy for consumers to follow at home. A user-friendly mobile app can also be developed to suggest recipes based on individual tastes and dietary needs. Organizing live cooking demos will help people learn how to make nutritious meals step by step. They can also team up with culinary schools to develop and refine tasty, Health-focused recipes that suit modern lifestyles.

Product line extensions: Based on usage patterns and consumer preferences, there is strong potential for product line extensions utilizing sprouted ragi. These include ready-to-cook sprouted ragi mixes, which save time and effort in the kitchen. Instant sprouted ragi porridge variants can also attract health-conscious consumers looking for quick and nutritious options. In addition, sprouted ragi-based snack products can serve as healthy alternatives to regular snacks. Combination flour blends that mix sprouted ragi with other millets can offer both taste and added health benefits

Conclusion

The study shows that 60 % of consumers in Coimbatore are aware of sprouted ragi flour and all of them are willing to pay extra for its health benefits. However, availability, taste and shelf life remain key challenges. Research confirms that germination improves nutrition and shelf life without affecting taste. Market factors like price, promotion and access influence purchase decisions more than branding. Studies also show that millet-based products are well accepted when properly processed and marketed. Online platforms and organized retail play a big role in reaching health-conscious buyers. To succeed, companies must improve supply, product quality and clear health messaging.

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Authors' contributions

MM was responsible for writing the entire manuscript. MCK and DM provided technical guidance and support in structuring the manuscript. EP and GV offered guidance on formatting the manuscript appropriately. All authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest: The authors do not have any conflict of interest to declare.

Ethical issues: None

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