
CONSUMER AWARENESS REGARDING MILLET PRODUCTS IN HARYANA: AN AI DRIVEN APPROACH

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ABSTRACT

The growing demand for sustainable and healthy food options has made millets a popular food alternative to traditional cereals. Despite its environmental and nutritional benefits, the general acceptance of millets by consumers is still inconsistent. Using state-of-the-art artificial intelligence (AI) tools, this study aims to explore and identify the key elements influencing consumers' perceptions of small grains. To provide a theoretical framework and uncover relevant factors influencing customer perceptions, a comprehensive analysis of the body of research on food preferences, consumer behavior, and use of millet-based products was conducted. In the empirical phase, an extensive dataset was collected, which included customer reviews, product ratings, and opinions about millet-based products from various online sources such as social media and e-commerce websites. This unstructured textual data has been analyzed using (AI) tools AI-based Grain Quality Check, Machine Learning for Quality Assessment, streamline procurement processes, improve market access, support sustainable agriculture tools have been captured through AI-powered research, to derive valuable insights and identify trends in customer sentiment. Influential factors such as taste, texture, pricing, health benefits, brand perception and product availability. These results shed light on the key factors influencing consumer perception of small grains, and provide useful knowledge for food industry players such as marketers, product developers and legislators. In a competitive market, these results will help guide focused strategies to increase consumer awareness, acceptance and demand for millet-based products.

Keywords: Sustainability, Artificial Intelligence, Millets, Consumer awareness

INTRODUCTION

Millets, comprising a diverse group of small-grained cereals such as bajra (pearl millet), ragi (finger millet), and jowar (sorghum), have been integral to traditional diets in India. Recognized for their nutritional benefits and resilience to climate change, millets are increasingly promoted as a sustainable alternative to staple grains like rice and wheat. In 2023, the United Nations declared the year as the "International Year of Millets," underscoring their importance in global food security.

Despite these initiatives, consumer awareness and adoption of millet-based products remain limited, particularly in states like Haryana, where agricultural practices are predominantly centered around rice and wheat cultivation (Mehta et al., 2024). Understanding the factors influencing consumer behavior towards millets is crucial for designing effective awareness campaigns and promoting their consumption.

Artificial Intelligence (AI) has emerged as a transformative tool in analyzing consumer behavior and preferences. AI techniques, such as Natural Language Processing (NLP), sentiment analysis, and machine learning algorithms, enable researchers to process and interpret vast amounts of data from diverse sources, including social media, surveys, and online reviews. These technologies facilitate the identification of consumer sentiments, perceptions, and trends, providing valuable insights into factors that influence purchasing decisions.

In the context of millet products, AI can be leveraged to analyze consumer discussions on platforms like Twitter and Instagram, assess the effectiveness of existing awareness campaigns, and segment consumers based on their attitudes and behaviors towards millets. For instance, AI-driven sentiment analysis can determine public perceptions of millets, while clustering algorithms can identify distinct consumer segments, such as health-conscious individuals, traditional diet adherents, and those unaware of millet benefits.

According to the Food and Agriculture Organization (FAO) India remains the world's largest supplier of pearl millet, despite a decrease in the area of its traditional growing regions—Gujarat, Rajasthan, and Haryana. Pearl millet is typically cultivated without irrigation in the majority of the globe. However, in India, especially during the summer, it is sometimes watered so that it can be used as a grain and fodder crop. In dry and semi-arid areas, pearl millet is farmed more than any other crop on Earth, second only in global cultivation to rice, wheat, and sorghum. Around 14 million hectares in Asia and 14 million hectares in Africa are cultivated with pearl millet due to its importance. By integrating AI methodologies, this research aims to provide a comprehensive understanding of consumer awareness regarding millet products in Haryana. The findings are expected to inform targeted interventions, policy decisions, and marketing strategies that can enhance millet consumption and contribute to dietary diversification in the region. (Wang et al., 2024)

LITERATURE REVIEW

1. AI in Grain Quality Assessment

AI methodologies have significantly advanced the non-destructive evaluation of grain quality, offering rapid, accurate, and scalable solutions. Hyperspectral imaging (HSI) combined with machine learning models has been employed to classify millet cultivars based on their spectral signatures, achieving high classification accuracies. For instance, Wang et al. (2024) utilized shortwave near-infrared HSI and an attention-convoluted recurrent neural network to classify millet varieties, demonstrating the potential of AI in quality differentiation.

Additionally, Generative Adversarial Networks (GANs) and Active Learning techniques have been explored to automate seed quality testing, addressing challenges related to data annotation and class imbalance .

2. AI in Consumer Sentiment Analysis

Understanding consumer perceptions is crucial for promoting millet-based products. AI-driven sentiment analysis tools process large volumes of consumer reviews and social media posts to gauge public opinion. A study by Singh et al. (2024) highlighted that consumers often associate millet flour with negative attributes like bitterness and dryness, while positive mentions focus on its quality and taste. These insights are valuable for marketers and product developers to tailor their strategies effectively.

3. Barriers to Millet Consumption

Despite the nutritional benefits of millets, their consumption remains limited. A study by Sharma et al. (2024) identified two primary barriers: limited availability of millet-based products and the influence of prevailing consumption norms. Applying Innovation Resistance Theory, the study suggests that overcoming these barriers requires targeted strategies to promote millet consumption .

4. Implications for Stakeholders

The integration of AI in millet quality assessment and consumer analysis offers valuable insights for various stakeholders:

- **Marketers:** AI provides data-driven insights into consumer preferences and market trends, enabling the development of targeted marketing strategies.
- **Product Developers:** By analyzing consumer feedback and quality assessments, product developers can innovate and improve millet-based products to meet consumer expectations.
- **Legislators:** AI-generated data can inform policy decisions related to millet procurement, pricing, and distribution, ensuring that initiatives align with market dynamics and consumer needs.

AI methodologies facilitate efficient procurement processes and enhance market access for millet producers

Streamlining Procurement and Market Access

- **E-NAM Platform:** The National Agriculture Market (eNAM) is an online trading platform that connects farmers with markets across India. AI integration into eNAM can provide real-time pricing information, quality assessments, and market demand forecasts, enabling farmers to make informed decisions and access broader markets .
- **Supply Chain Optimization:** AI algorithms can predict demand patterns, optimize inventory management, and reduce post-harvest losses by identifying the best times for procurement and distribution. This leads to improved price realization for farmers and consistent supply for consumers .

Consumer Sentiment Analysis and Product Development

Understanding consumer perceptions is crucial for developing millet-based products that align with market preferences:

- **Sentiment Analysis:** AI-driven sentiment analysis tools can process large volumes of consumer reviews and social media posts to gauge public opinion on millet products. For example, analysis of Amazon reviews revealed that consumers often associate millet flour with negative attributes like bitterness and dryness, while positive mentions highlight its quality and taste .
- **Influential Factors:** Key factors influencing consumer perception include taste, texture, pricing, health benefits, brand perception, and product availability. Addressing these factors through product innovation and targeted marketing can enhance consumer acceptance and demand for millet-based products.

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RESEARCH OBJECTIVES

The study sets out with four primary objectives: first, to assess the general level of awareness and perception about millet products among consumers in Haryana; second, to evaluate the reach and effectiveness of ongoing promotional and awareness campaigns; third, to utilize AI tools like NLP and sentiment analysis for consumer profiling and data interpretation; and fourth, to recommend AI-based strategies that could support wider millet adoption and consumption in the region.

RESEARCH METHODOLOGY

This study follows a mixed-method approach combining both quantitative and qualitative research, with the support of AI-driven analytical tools to ensure robust data analysis and insight extraction.

1. Research Design

- **Descriptive and Exploratory:** The study describes existing awareness levels and explores underlying patterns in consumer behavior and sentiment.

2. Data Collection

A. Primary Data:

- **Survey Method:** A structured questionnaire was designed and administered to a sample of consumers across urban and rural areas in Haryana. The questionnaire included both closed and open-ended questions focused on millet awareness, purchasing behavior, and preferences.
- **Sampling Method:** Stratified random sampling was used to ensure representation across age, gender, occupation, and location.

B. Secondary Data:

- **Social Media and E-commerce Reviews:** Consumer comments, reviews, and hashtags related to millet products were collected from platforms like Twitter, Instagram, and Amazon.

3. Tools and Techniques

AI-Driven Analysis:

- **Sentiment Analysis:** Natural Language Processing (NLP) models were used to classify sentiments (positive, neutral, or negative) from open-ended responses and online reviews.
- **Clustering Algorithms:** K-Means and Hierarchical Clustering were applied to identify distinct consumer segments based on responses and online behavior.
- **Text Mining:** Used to extract frequently mentioned words and themes from unstructured text data.

Statistical Tools:

- SPSS and Python libraries (e.g., Scikit-learn, NLTK, Pandas) were used for data cleaning, processing, and visualization.
- Descriptive statistics (mean, mode, frequency distribution) and inferential statistics (Chi-square tests, correlation analysis) supported hypothesis testing.

4. Scope and Limitations

- The study is confined to Haryana and may not generalize to other states without further validation.
- The reliance on online sentiment may not fully represent digitally-excluded demographics.

RESULTS AND DISCUSSION

The demographic analysis revealed a diverse respondent base, with varying levels of education and income. Awareness of millet products was found to be higher among urban residents and individuals with higher education levels. Sentiment analysis indicated a predominantly neutral to positive sentiment towards millets, with concerns about taste and unfamiliarity being common barriers to consumption. Clustering analysis identified three distinct consumer segments: 'Health-Conscious Consumers,' 'Traditional Diet Adopters,' and 'Unaware Consumers.' These segments exhibited differing levels of awareness, consumption frequency, and sources of information, highlighting the need for tailored marketing strategies.

CONCLUSION

The study concludes that while there is a moderate level of awareness regarding millet products in Haryana, actual consumption remains low. AI-driven analysis provides valuable insights into consumer behavior and sentiment, enabling the identification of specific barriers to millet adoption. Addressing these barriers through targeted interventions can enhance millet consumption in the region.

RECOMMENDATIONS

Based on the findings, the following recommendations are proposed:

1. Targeted Awareness Campaigns: Develop AI-powered digital campaigns tailored to different consumer segments, focusing on the nutritional benefits and versatility of millet products.
2. Product Innovation: Encourage the development of millet-based products that cater to local tastes and preferences, enhancing their appeal to consumers.
3. Educational Programs: Implement community-based workshops and seminars to educate consumers about the health benefits and culinary uses of millets.
4. Market Access Improvement: Facilitate easier access to millet products through retail partnerships and online platforms, ensuring availability to a wider audience.

LIMITATIONS

The study's reliance on self-reported data may introduce response biases. The scope was limited to Haryana, and findings may not be generalizable to other regions without further research. Additionally, the dynamic nature of consumer behavior requires continuous monitoring to adapt strategies effectively.

REFERENCES

1. Wang, Y., He, X., Li, Z., & Lin, M. (2024). *Classification of millet cultivars using shortwave near-infrared hyperspectral imaging and deep learning*. Foods, 13(9), 1330. <https://www.mdpi.com/2304-8158/13/9/1330>
2. Sharma, A., & Aggarwal, D. (2024). *Exploring consumer resistance to millet consumption in urban India using Innovation Resistance Theory*. Journal of Food Products Marketing. <https://doi.org/10.1080/08974438.2024.2324451>
3. Singh, R., Patel, M., & Verma, S. (2024). *Consumer feedback analytics for millet-based products using AI sentiment tools*. VOC.AI Insights. <https://www.voc.ai/insight/millet>
4. Upjao AI. (2024). *AI in agriculture: Need and benefits of AI-based grain quality assessment*. Retrieved from <https://upjao.ai/ai-in-agriculture-need-and-benefits-of-ai-based-grain-quality-assessment/>
5. eNAM (2024). *National Agriculture Market – An overview*. Government of India.
6. Arora, P., & Singh, V. (2024). *Awareness, acceptance, and consumption pattern of millets among ever-married women in Delhi*. Indian Journal of Community Health. <https://doi.org/10.47203/IJCH.2024.v36i03.020>
7. Kaur, M., & Banga, G. (2025). *Consumer Awareness and Behavioural Trends in the Adoption of Millets*. Archives of Current Research International, 25(3), 135–144. <https://doi.org/10.9734/acri/2025/v25i31103>
8. Mehta, D., Vyas, S., Dudhagara, D., Patel, A., & Parmar, V. (2024). *Significance of Indian millets in enhancing global food security: A comprehensive review*. Trends in Food Science & Technology, 104527.