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Sivasankar S

Research Scholar, School of Agriculture, University of Technology, Jaipur, Rajasthan, India

Dr. GP Meena

Professor & Dean, School of Agriculture, University of Technology, Jaipur, Rajasthan, India

Divyangi Samuchia

Assistant Professor, School of Agriculture, University of Technology, Jaipur, Rajasthan, India

Impact on market potential of sugar-free bakery products in Kerala: A perspective study

Sivasankar S¹, Dr. GP Meena², Divyangi Samuchia³

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ABSTRACT

The study was carried out in randomly selected Bakeries in the Kerala state. The study increasing prevalence of obesity, type 2 diabetes mellitus, cardiovascular diseases and other lifestyle-related disorders has increased consumer demand for healthier food alternatives. Bakery products such as bread, cakes, biscuits, cookies, muffins and pastries are widely consumed but conventional formulations generally contain significant amounts of sucrose. Sugar-free bakery products developed using alternative sweeteners provide an opportunity to reduce added sugar while maintaining desirable sensory and technological characteristics. The present study focused on the manufacture, quality evaluation, consumer acceptance, sales growth and market potential of sugar-free bakery products in Kerala. The study considered the use of steviol glycosides, sucralose, erythritol, xylitol and maltitol as sugar replacers. Product development involved ingredient selection, formulation, baking, cooling, packaging and storage, followed by sensory, physicochemical, nutritional and shelf-life evaluation. A questionnaire-based consumer survey was also undertaken to assess purchasing behaviour and acceptance. Consumer responses indicated that weight control and diabetes management were important reasons for choosing sugar-free bakery products. Bread/rusk and biscuits/cookies were the preferred categories. Sixty-seven percent of respondents indicated that they would recommend sugar-free bakery products, while 29% would probably recommend them. Product variety, taste, price and availability were identified as important areas for improvement. The industrial observation at Delicia Food Industries, Kottayam, further indicated increasing demand for healthier bakery products in Kerala. The study concludes that sugar-free bakery products have promising market potential, provided that manufacturers optimize sweetness, texture, nutritional quality, affordability and product variety.

Keywords: Sugar reduction, Sugar substitutes, Sucrose, Polyols, *Stevia*, Dietary fibre, Aftertaste, Glycaemic response

Introduction

Bakery products are among the most widely consumed processed foods because of their convenience, affordability, availability, long shelf life and sensory appeal. Bread, cakes, biscuits, cookies, muffins and pastries form important components of the bakery sector. Conventional bakery products commonly contain wheat flour, sucrose and fat and may therefore contribute considerable amounts of added sugar and dietary energy. The report identifies increasing concern regarding obesity, type 2 diabetes, cardiovascular disease and other lifestyle-related disorders as important reasons for developing reduced-sugar food alternatives.

Sucrose performs several technological functions in bakery products in addition to providing sweetness. It contributes to moisture retention, tenderness, browning, flavour development, volume and shelf-life characteristics. Consequently, complete replacement of sucrose is technologically challenging. High-intensity sweeteners provide sweetness at low concentrations but generally cannot provide the same bulk and structural functions as sucrose. Sugar replacement therefore requires suitable combinations of sweeteners and functional ingredients such as polyols, dietary fibre and hydrocolloids.

The increasing availability of alternative sweeteners has provided opportunities for the development of sugar-free bakery products. Steviol glycosides, sucralose, erythritol, xylitol and maltitol are among the sweeteners considered in the attached study. These ingredients differ in sweetness intensity, bulking ability, moisture retention and technological performance.

The nutritional benefits of sugar reduction are also an important consideration. Sugar-free bakery products may provide lower added sugar and energy content and may contribute to a lower glycaemic response when appropriately formulated. However, sugar reduction alone does not automatically make a product nutritionally healthy. The nutritional quality also depends on flour, fat, protein, fibre and other ingredients used in formulation.

Consumer acceptance is a major factor determining the commercial success of sugar-free bakery products. Taste, texture, colour, aroma, freshness, price, availability and confidence in the safety and natural origin of

Corresponding Author:

Sivasankar S

Research Scholar, School of Agriculture, University of Technology, Jaipur, Rajasthan, India

sweeteners influence consumer purchasing behavior. Keeping in view of that the study was conducted in the Kerala state to find out the Market Potential of Sugar-Free Bakery Products.

Review of Literature

Excessive consumption of added sugars has been associated with several adverse health outcomes. Malik *et al.* (2010) reported associations between high consumption of sugar-rich foods and increased risk of weight gain, obesity, insulin resistance and type 2 diabetes. Te Morenga *et al.* (2013) [1], through a systematic review and meta-analysis, reported that reduction in dietary sugar intake was associated with a reduction in body weight. Johnson *et al.* (2009) further highlighted associations between excessive added-sugar consumption and obesity, hypertension, dyslipidaemia and cardiovascular disease. Hu (2013) [2] also emphasized the relationship between diets high in refined carbohydrates and added sugars and metabolic disorders. In addition, Moynihan *et al.* (2014) [3] reported a strong association between free-sugar consumption and dental caries. These findings provide an important nutritional basis for the development of reduced-sugar bakery products.

Struck *et al.* (2014) [4] reported that replacing sucrose can adversely affect product volume, colour, flavour, texture and overall acceptability. Sugar interacts with water, proteins and starch during processing and contributes to the structural and sensory characteristics of baked products. Sahin *et al.* (2019) [5] similarly reported that sugar influences dough rheology, crumb structure, browning and flavour formation. Ghosh *et al.* (2012) [6] reviewed the use of polyols such as erythritol, xylitol, sorbitol and maltitol and reported their potential to provide sweetness with lower energy contribution than sucrose, while also contributing to bulk and moisture retention. The nutritional potential of sugar-free bakery products extends beyond simple sugar reduction. Toews *et al.* (2019) [7] reported that replacing sugar with non-sugar sweeteners may reduce energy intake and body weight in short-term studies, although evidence concerning long-term health effects remains limited. The thesis also identifies dietary fibre, resistant starch, whole grains, protein-rich ingredients and other functional ingredients as approaches for improving the nutritional profile of reduced-sugar bakery products. Such ingredients may contribute to satiety, improved texture and enhanced nutritional value.

Sheereen *et al.* (2012) [8] reported that convenience, quality, freshness, taste, hygiene and nutritional value influenced consumers' purchasing decisions for bakery products in Kerala. Their findings also indicated that increasing health awareness was influencing consumer preferences towards healthier bakery alternatives. In a subsequent study, Sheereen and Zakkariya (2014) reported that hygiene, product quality, product variety and health-related concerns influenced the selection of bakery outlets. These findings suggest that health-oriented bakery products may provide opportunities for improving customer satisfaction and competitiveness in the Kerala market.

Although considerable research has examined the health implications of added sugar and the technological development of reduced-sugar bakery products, comparatively limited information is presented in the reviewed literature regarding the specific market potential, purchasing behaviour and consumer acceptance of sugar-free bakery products in Kerala. The existing Kerala-based studies primarily address general bakery-product purchasing behaviour rather than focusing specifically on sugar-free products. Therefore, further investigation of consumer awareness, preferred product categories, purchasing frequency, reasons for purchase, satisfaction, price perception, recommendation behaviour and expectations for product improvement is justified. This provides the basis for the present study on the market potential of sugar-free bakery products in Kerala.

Materials and Methods

The study consisted of product development, quality evaluation, literature-based nutritional assessment, sensory evaluation, consumer acceptance analysis and industrial observation. The methodology involved ingredient selection, formulation, product preparation, quality

evaluation and graphical analysis of consumer responses. An industrial visit was conducted at Delicia Food Industries, Kottayam, Kerala, to understand bakery production practices, market trends and demand for sugar-free and reduced-sugar products.

Selection of ingredients

The basic ingredients considered included:

- Wheat/refined wheat flour or whole wheat flour
- Egg or egg substitutes
- Milk/milk powder
- Vegetable oil or butter
- Baking powder
- Baking soda
- Salt
- Flavouring agents such as vanilla, cocoa and spices

The sugar replacers considered were:

- Steviol glycosides (stevia)
- Sucralose
- Erythritol
- Xylitol
- Maltitol

Sweeteners were selected based on sweetness intensity, safety, functional characteristics and suitability for bakery applications.

Sugar-free formulations were developed by replacing sucrose with selected sugar substitutes at different levels. Preliminary trials were used to optimize formulations for desirable sensory characteristics. The general preparation procedure consisted of:

Ingredient weighing → Dry and wet ingredient mixing → Sweetener incorporation → Batter/dough preparation → Baking → Cooling → Packaging → Storage

A conventional sugar-containing product was used as a control for comparison.

Specific manufacturing processes considered in the report included:

Sugar-free bread: Ingredient mixing → Dough preparation → Fermentation → Dividing → Proofing → Baking → Cooling → Packaging.

Sugar-free cake: Ingredient weighing → Batter mixing → Depositing → Baking → Cooling → Decoration → Packaging.

Sugar-free cookies: Ingredient mixing → Dough formation → Moulding → Baking → Cooling → Packaging.

Sugar-free rusk: Ingredient weighing → Mixing → Dough formation → Fermentation → Moulding → Proofing → First baking → Cooling → Slicing → Second baking/toasting → Final cooling → Quality inspection → Packaging → Storage.

Sensory evaluation

Sensory evaluation was conducted using a blind taste-test approach to assess consumer acceptability. Important sensory characteristics included sweetness, aftertaste, aroma, colour, texture and overall acceptability.

Nutritional analysis

The nutritional assessment considered the following proximate parameters:

- Moisture
- Ash
- Protein
- Fat
- Carbohydrates
- Energy value

The report also considered the nutritional advantages of sugar replacement based on existing scientific literature.

Physicochemical evaluation

The prepared products were evaluated for:

- Weight
- Volume
- Hardness
- Softness
- Chewiness

These parameters were used to understand the influence of sugar replacement on product structure and texture.

Shelf-life evaluation

The products were stored under suitable conditions and periodically assessed for:

- Sensory quality
- Moisture
- Texture
- Microbial stability

These parameters were considered to determine the effect of sugar replacement on product quality and shelf life.

Consumer acceptance survey

A questionnaire-based survey was conducted to determine consumer awareness and acceptance. The questionnaire considered demographic characteristics, awareness of sugar-free products, reasons for purchase, health concerns, preference for natural or artificial sweeteners and willingness to purchase sugar-free bakery products.

The survey results were presented using bar graphs and pie charts. Participation was voluntary and confidentiality of participant information was maintained.

Results and discussion

Sales growth of sugar-free bakery products

The report showed a continuous increase in sales of sugar-free bakery products between 2021 and 2025.

Year	Sales (₹ lakh)
2021	5
2022	7
2023	10
2024	12
2025	14

Sales increased from ₹5 lakh in 2021 to ₹14 lakh in 2025, representing a substantial increase over the five-year period. The report associates this growth with increasing awareness of diabetes, obesity and healthy eating, together with the introduction of new product varieties and improved marketing strategies.

Growth of the bakery sector

The report also presented an increase in the estimated number of bakery industries in India and Kerala.

Year	India	Kerala
2021	320,000	26,500
2022	345,000	28,400
2023	372,000	30,600
2024	398,000	32,100
2025	426,140	33,314

The data presented in the report indicates a steady expansion of the bakery sector in both India and Kerala, alongside increasing interest

in health-oriented bakery products.

Consumer preference for product categories

The consumer survey showed the highest preference for bread/rusk and biscuits/cookies, with both categories reported at 100% in the study's response summary. Cakes were preferred by 33%, pastries by 29% and muffins by 10%.

Frequency of purchase

Weekly purchase was the most reported frequency at 43%, followed by monthly purchase at 33%, daily purchase at 14% and occasional purchase at 5%.

Reasons for choosing sugar-free bakery products

The main reason reported for choosing sugar-free bakery products was weight-control management (43%). Diabetes control accounted for 33%, while 19% selected fitness lifestyle as the reason.

Consumer satisfaction

The study indicated a moderate level of consumer satisfaction. 36% of consumers were reported as satisfied and another 36% responded neutrally, while 10% were highly satisfied.

Perception of price

Approximately 76% of respondents considered the price of sugar-free bakery products reasonable, whereas 19% did not agree.

Recommendation intention

The survey showed a positive recommendation tendency. 67% of consumers indicated that they would recommend sugar-free bakery products, while 29% indicated that they would probably recommend them. No negative response was reported in the study.

Consumer expectations for improvement

Product variety was the most frequently reported desired improvement (38%), followed by better taste (29%), lower price (24%) and greater availability (5%).

The results indicate that sugar-free bakery products have considerable potential as an emerging segment of the bakery industry in Kerala. The increase in reported sales from ₹5 lakh in 2021 to ₹14 lakh in 2025 demonstrates a positive sales trend. This increase is consistent with the report's observation that health awareness, concerns regarding diabetes and obesity, product innovation and improved marketing are contributing to increased demand.

The development of sugar-free bakery products, however, presents significant technological challenges. Sucrose is not merely a sweetening ingredient; it influences moisture retention, browning, tenderness, flavour, volume and structural properties. Replacing it with a high-intensity sweetener alone can therefore result in undesirable changes in texture and product structure.

The use of polyols such as erythritol, xylitol and maltitol can provide sweetness and some of the bulk that is lost when sucrose is removed. Dietary fibres, hydrocolloids and other functional ingredients can further assist in maintaining texture and moisture. The report highlights the importance of optimizing sweetener concentration and combining sweeteners with appropriate functional ingredients.

Sensory quality remains a critical determinant of market success. Although health benefits can encourage consumers to try sugar-free products, consumers continue to expect acceptable taste, texture, aroma and appearance. High-intensity sweeteners such as stevia may produce characteristic aftertastes when used alone. Combining sweeteners or using appropriate bulking agents can help produce a sensory profile closer to conventional bakery products.

The consumer survey supports this observation. Although recommendation intention was positive, consumer satisfaction was only moderate, and 29% of respondents identified better taste as an important, desired improvement. The demand for greater product variety was even higher at 38%. This suggests that future product development should focus not only on sugar reduction but also on improving sensory characteristics and expanding the product portfolio.

Weight management was the leading reported reason for choosing sugar-free bakery products, followed by diabetes control and fitness lifestyle. These findings indicate that consumers associate sugar reduction with broader health and lifestyle objectives. The literature reviewed in the report similarly identifies health awareness, weight management and diabetes-related concerns as important drivers of demand.

Price was not identified as a major barrier by most respondents, with 76% considering the price reasonable. Nevertheless, 24% of consumers expected lower prices, suggesting that affordability remains relevant for wider market penetration. Sugar-free bakery products can be more expensive because alternative sweeteners and specialized formulation processes may increase production costs.

The nutritional advantages of sugar-free bakery products should also be interpreted carefully. Replacing sucrose can reduce added sugar and potentially lower energy density, but the overall nutritional value depends on the complete formulation. Products containing high levels of fat or refined starch should not automatically be considered healthy simply because they are labelled sugar-free. Incorporating dietary fibre, whole grains, resistant starch and protein-rich ingredients can further improve nutritional quality.

The industrial observation at Delicia Food Industries, Kottayam, supports the consumer survey findings. The report noted increasing demand for healthier bakery products and identified growing awareness of diabetes, obesity and healthy eating as factors influencing consumer purchasing behaviour. The industry was also reported to be responding through product innovation and the introduction of health-oriented products.

Overall, the findings suggest that the Kerala market is favourable for sugar-free bakery products, but sustained growth will depend on manufacturers' ability to combine health benefits with acceptable taste, texture, variety, affordability and availability.

Conclusion

The present study demonstrates that sugar-free bakery products represent a promising area of food product development and have significant potential in the Kerala market. The reported sales data showed continuous growth from ₹5 lakh in 2021 to ₹14 lakh in 2025, indicating increasing commercial interest in this product category. *Stevia*, sucralose, erythritol, xylitol and maltitol provide potential alternatives to sucrose. However, successful sugar replacement requires careful formulation because sucrose performs several technological functions beyond sweetness. The use of appropriate sweetener combinations, polyols, dietary fibre, hydrocolloids and other functional ingredients can help compensate for the technological limitations of sucrose replacement. Consumer acceptance was generally favourable, with bread/rusk and biscuits/cookies being the preferred products and 67% of respondents indicating that they would recommend sugar-free bakery products. Weight management was the principal reported reason for purchase. However, consumers identified greater product variety and improved taste as important areas for development.

The study also concludes that the future growth of sugar-free bakery products in Kerala depends on the development of products that are not only low in added sugar but also nutritionally balanced, sensorially acceptable, affordable, widely available and clearly labelled. Further research should focus on optimizing sweetener combinations, improving texture and flavour, establishing scientifically supported shelf-life data and conducting larger consumer studies.

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