

Process Innovation and Industrial Insights in India's Biscuit Sector

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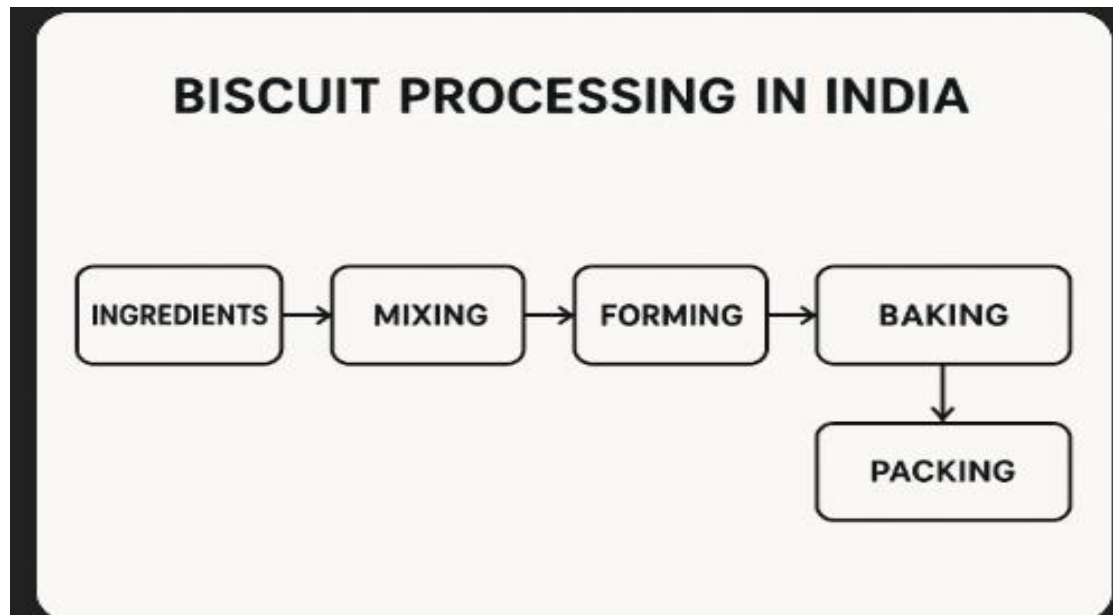
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Abstract: The Indian biscuit industry, one of the fastest-growing segments in the processed food sector, has undergone significant transformation in recent decades. From traditional glucose biscuits to premium and functional baked goods, this evolution has been fueled by technological advancements, shifting consumer preferences, and innovations in process optimization. This article provides a historical overview of biscuit manufacturing in India, analyses current market trends, and explores the factors contributing to the industry's growth, including new product development and diversification into health-oriented and indulgent segments. Special attention is given to industrial observations made during hands-on training, with a focus on the analysis of process parameters such as dough consistency, baking conditions, and filling control in high-efficiency production lines. The integration of automation, quality assurance systems, and ingredient innovation is also discussed as key drivers of modern biscuit production. This study concludes that aligning consumer demands with technological upgrades is essential for sustained competitiveness and future innovation in India's biscuit sector.

KEYWORDS: Biscuit industry, Process innovation, Product development, Core-filling technology, Indian food sector, Quality assurance, Consumer trends, Functional biscuits, baking parameters, Industrial processing



Introduction

Around the world, bakery goods are a significant component of the diet. They are consumed as a staple in the form of bread, as well as for breakfast and as snacks. A biscuit is the most widely consumed baked goods by almost everyone. This is mostly because they are readily consumable, have high nutritional value, come in a wide range of flavors, and are reasonably priced. The United States, China, and India are the top three biscuit-producing countries, according to production figures. Biscuits are a healthy convenience food with a long shelf life, and one of its main draws is the large number of varieties that are possible. In Britain and many other nations, the word "biscuit" is a general noun. It includes goods also referred to as crackers (a word from the United States for thin, non-sweet products that crackled as they broke), hard sweet, or cookies (a term derived from the Dutch word "koekje," which means "small cake"), semi-sweet biscuits, and wafers made from a fluid batter and baked between heated plates. In North America, the term "cookie" was used because it can be confused with tiny breads or muffins made with soda. The term "cookie" is primarily used in other countries to refer to wire-cut, sometimes rough-shaped products that frequently contain huge bits of chocolate and nuts, among other ingredients [1]. The Latin term *panis biscotus*, which means twice-cooked bread, is the root of the English word biscuit [2]. The term "biscuits," which originated in Britain, refers to small, often flat baked goods made with wheat flour and varying amounts of fat, including sugar. Because wafer biscuits are made between two hot plates rather than on a baking band or wire like most other kinds, they are a unique kind of baked good. Today, biscuits are used as snacks, upscale presents, dietary supplements, and baby food. They also contain a number of pricey components like cream and chocolate. Biscuits are

generally understood to be cereal-based goods baked to a moisture content of less than 5%. Sugar and fat are the two main elements that are added in different ways to the cereal component [3]. A main definition of "a kind of hard dry bread, made to be carried to sea" and a secondary definition of "a composition of fine flour, almonds, and sugar, made by the confectioners" are provided by Dr. Samuel Johnson in his 1755 dictionary. Ship cookies are also mentioned by William Shakespeare in his 1600s play *As You Like It*. The first biscuits were made in large quantities and were unsweetened, more like crackers in contemporary usage.

2. Historical background of Biscuits

India's biscuit industry began in the early 1900s when local bakeries were established to serve the British populace and urban elites [4]. The biscuit sector had a significant surge in expansion during World War II when it became clear that biscuits were a high-energy, practical food option for both soldiers and civilians [5]. Small-scale bakeries gradually gave way to

organized biscuit production facilities in India after independence, with well-known brands like Britannia and Parle becoming household names [6]. The sector grew quickly in the 1970s and 1980s as a result of rising demand for inexpensive, packaged snacks. The sector's scalability was further enhanced by the implementation of automated production lines, enhanced packaging technologies, quality control systems, and nationwide distribution networks [7]. The market saw diversification into premium categories, health-conscious varieties, and decadent offers like cream-filled and chocolate-centered biscuits, signaling the start of a new age in biscuit innovation in the twenty-first century [8]. India is currently one of the world's biggest manufacturers and consumers of biscuits, and both domestic and foreign companies make significant investments in consumer-centric development, process optimization, and new product development [6,4]. The earliest biscuits originated as dried rusks, valued for their long shelf life during sea voyages. However, early bakers experimenting with fat and sugar in their recipes would have noticed that small pieces of dough, when baked in a typical hot oven and removed once they achieved a desirable color and stable structure, were not fully dry or crisp. To enhance both texture and shelf life, these partially baked goods were returned to a slightly cooler oven for further drying. Alternatively, baking them from the beginning in a cooler oven over a longer time could achieve thorough drying, though this method led to less color development and a weaker structure. Over time, consistent advancements have been made to enhance productivity by minimizing labor requirements and accelerating production processes. Initially, workforce reduction was seen in the mixing and dough-handling stages. However, it is only within the past four to five decades that significant reductions in labor have been achieved in the packaging section, bringing the number of workers down substantially.

3. Market Position and Growth of Biscuits

As of 2025, India's biscuit industry remains a vital pillar of the country's processed food sector, contributing significantly to the bakery market, which is projected to reach a valuation of INR 5,500 billion by the end of this year [6]. The segment has shown an impressive compound annual growth rate (CAGR) of 12.8% over the past five years, driven by rapid urbanization, rising disposable incomes, increasing health awareness, and an expanding base of young consumers [8]. According to recent market research, India's per capita biscuit consumption has reached approximately 2.8 kg in 2025, showing gradual yet consistent growth compared to previous years [7]. Despite this, there remains a significant gap when compared with countries such as the UK (10.5 kg) and Japan (7.2 kg), indicating room for

further penetration and market development [9].

The Indian biscuit industry currently produces over 3.8 million metric tonnes annually, with the organised sector accounting for 72% of this output, up from 65% in 2019. Brands like Britannia, Parle, ITC, Unibic, and Patanjali have strengthened their foothold through strategic investments in automation, digital marketing, and health-focused product lines [6]. The export segment has also expanded, with sweet biscuit exports now valued at INR 480 crore, a 42% increase from 2020 figures, supported by growing demand in markets such as the Middle East, Africa, and Southeast Asia [8].

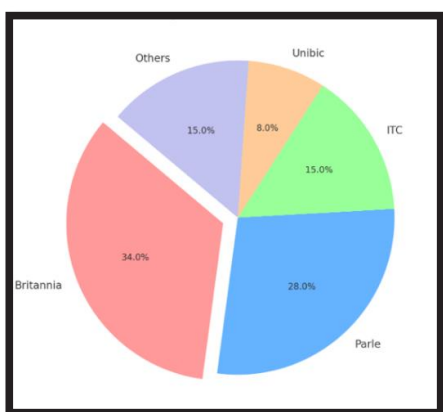


Fig. 1 Market Share of Major Biscuit Brands in India.

Significantly, premium and health-oriented biscuits now account for nearly 34% of the organised market share, growing at a CAGR of 18.5%, outpacing the 6.2% growth of the conventional glucose and milk biscuit segment [4]. These include functional offerings enriched with proteins, multigrains, vitamins, and prebiotics, aligning with consumer demand for wellness-focused snacking options [6].

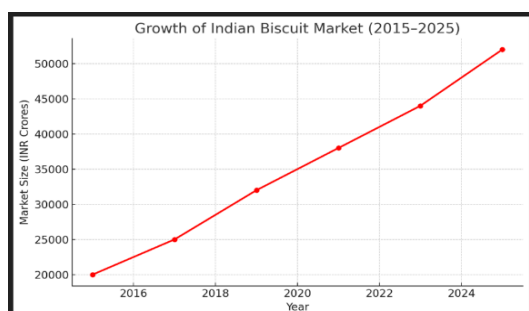


Fig. 2 Growth of the Indian Biscuit Market (2015-2025)

The unorganised sector, while still holding 28% of the total volume, is gradually shrinking due to increasing consumer preference for branded products that ensure quality, hygiene, and nutritional transparency [10]. This transition is also being facilitated by government-led initiatives supporting food safety compliance [11]. Overall, India's biscuit sector in 2025 is characterized by diversification,

digitization, and disruption—with brands leveraging e-commerce, sustainability initiatives, and regional flavour innovations to stay competitive in both domestic and international markets.

4. Biscuit Manufacturing Process

Ingredient Preparation

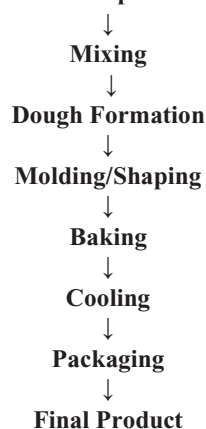


Fig. 3. Biscuit Manufacturing Process Flowchart

4.1 Ingredient Mixing: The process begins by accurately measuring and combining basic ingredients like flour, sugar, fat, and water. The mixture is blended in a mixer to ensure uniformity. This step is crucial for developing the dough consistency that affects texture and taste.

4.2 Dough Sheeting: The mixed dough is then rolled and flattened into sheets. Sheeting is controlled by rollers to achieve a consistent thickness, ensuring uniform baking. This process influences the final product's crispness and evenness.

4.3 Cutting/Shaping: The dough sheets are cut into biscuit shapes using molds or cutters. The design and shape of the biscuits contribute to both their aesthetic appeal and baking efficiency. This step can also involve shaping for specific textures like crackers or cookies.

4.4 Baking: The formed dough pieces are baked at regulated temperatures in an oven that has been preheated. The expansion of the dough brought on by the heat gives the biscuit its structure and adds to its distinctive crunch.

4.5 Cooling: The biscuits are transferred to a cooling conveyor after baking. In order to prevent the biscuits from becoming soggy during packaging, this procedure is crucial for stabilising the product's texture and lowering its moisture level.

4.6 Packaging: Once cooled, the biscuits are packaged in moisture-proof materials to maintain freshness and quality. Packaging is done in automated lines, with careful sealing to prevent contamination or degradation, ensuring a long shelf life.

4.7 Quality Control and Inspection: Quality control inspections are performed on the finished biscuits. This includes visual inspections, size consistency, taste testing, and physical tests like crunchiness. It ensures that each batch meets the required standards before being shipped.

5. Technological Innovations in Biscuit Manufacturing

The biscuit manufacturing industry has seen remarkable transformations over the years, driven by technological advancements that improve efficiency, product quality, and sustainability. Innovations in this domain not only boost production capabilities but also enhance the consumer experience. Several key technological advancements have shaped the industry, including high-speed baking ovens, core-filling and layering technologies, AI/ML in quality control, and modern packaging solutions.

5.1 High-Speed Baking Ovens

High-speed baking ovens are pivotal in modern biscuit manufacturing, significantly enhancing production efficiency. These ovens employ advanced heating technologies that reduce baking time while maintaining uniform heat distribution. This results in consistent product quality, enabling manufacturers to meet the growing demand for biscuits with greater speed and precision. With the ability to bake at higher temperatures for shorter periods, these ovens optimize energy use, ensuring cost-effectiveness in the production process [12].

5.2 Core-Filling and Layering Technology

The introduction of core-filling and layering technology has revolutionized biscuit production, particularly in the development of filled and layered biscuit products. This technology involves the precise injection of filling materials, such as creams or jams, into the biscuit dough, allowing for a variety of innovative product types. The technology ensures even distribution of filling, enhancing the flavor profile and visual appeal of the biscuits. Moreover, it enables manufacturers to create multilayered products with intricate textures, catering to evolving consumer preferences for more indulgent snacks [13].

5.3 Role of AI and Machine Learning in Quality Control

In modern biscuit manufacturing, AI-powered systems can monitor critical parameters such as dough consistency, baking time, and oven temperature in real time. These systems analyze large datasets to predict and detect quality issues before they arise, enabling manufacturers to adjust production processes proactively. Machine learning algorithms also help in refining the production process by identifying patterns and trends that might not be apparent to human operators, leading to continuous improvements in product consistency.

5.4 Modern Packaging Solutions

Packaging innovations have been another key area of development in the biscuit manufacturing sector. Modern packaging solutions, such as nitrogen flushing and eco-friendly packaging materials, play a crucial role in enhancing product shelf life and sustainability. Nitrogen flushing replaces oxygen in the packaging with nitrogen, which preserves the freshness and crispness of biscuits by preventing oxidation. Eco-friendly packaging options, such as biodegradable wrappers and recyclable materials, are increasingly adopted in response to growing consumer demand for sustainable practices in food production. These packaging solutions not only maintain the product's quality but also reduce the environmental impact of biscuit manufacturing.

6. Advanced Ingredient Technology:

- **Functional Ingredients for Health and Wellness:** Consumers today are becoming more conscious of the connection between nutrition and well-being. As a result, a range of food products now contain functional ingredients like dietary fibres, plant proteins, phytochemicals, probiotics, and prebiotics. For instance, resistant starch is being utilised to lower the glycaemic index of meals, making them appropriate for diabetic consumers, in addition to improving intestinal health.
- **Encapsulation and Delivery System:** Advanced microencapsulation techniques are used to protect delicate bioactive substances such as vitamins, omega-3 fatty acids, and antioxidants. These methods allow for regulated release in the digestive system, increase bioavailability, and improve component stability. Because it can effectively supply nutrients without changing the flavour or texture of food, nanoencapsulation is becoming more and more popular .
- **Alternative Proteins and Clean Label Ingredients:** The development of new protein sources like pea, rice, mycoprotein has been fuelled by the global move towards plant-based diets. In order to replicate the mouthfeel and texture of animal products, these ingredients are being enhanced utilising methods like fermentation and high-moisture extrusion. Furthermore, natural stabilisers and emulsifiers such as citrus fibre, guar gum, and sunflower lecithin are now used in place of synthetic ingredients due to clean label requirements.

5.4 Food Structuring and Enzyme Technology

For example, amylases are employed to alter starch in baking applications, while transglutaminase enhances protein gelation in dairy and meat products. Without sacrificing product quality, these enzymes aid in the creation of novel textures, extended shelf life, and increased nutritional value [14].

5.5 Intelligent Sweeteners and Fat Substitutes

Steviol glycosides, allulose, and monk fruit extract are examples of novel substances being used to substitute sugar without compromising sweetness in response to the global obesity issue. The development of low-fat goods with appealing textures is also being aided by fat substitutes such oleogels and microparticulate proteins [15].

6. Conclusion

The Indian biscuit industry has witnessed a transformative journey, evolving from basic bakery goods to advanced, consumer-responsive products that blend indulgence with nutrition. This evolution has been made possible through significant advancements in production technologies, the incorporation of health-focused ingredients, and the growing emphasis on product diversification and innovation. Industrial observations reveal that the optimization of process parameters—such as dough consistency, core-filling accuracy, and thermal controls—plays a pivotal role in

maintaining product quality and consistency on modern production lines. Furthermore, the integration of automated systems and quality control frameworks ensures higher efficiency, food safety, and compliance with regulatory standards. As consumer demands continue to shift toward personalized, functional, and premium offerings, the biscuit sector must continue investing in both technological innovation and product development. The future growth of India's biscuit industry will depend on its ability to align evolving consumer expectations with sustainable manufacturing practices and cutting-edge processing techniques.

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