

Biodegradable Packaging – Solution to Environmental Pollution

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Introduction

The use of plastics has increased environmental pollution, as its non-degradable nature has led to waste accumulation. As per the sources, every year, worldwide, the municipal solid waste generated is more than 2 billion and is expected to rise to 70% by 2050. About 5 trillion pieces of plastic contaminate the oceans, out of which a meagre 9% is recycled effectively, leaving the rest 91% in landfills or environment space (Jafarzadeh *et al*, 2020; George and George, 2023). This leads to soil and water pollution, while, plastics incineration process releases toxic pollutants, that badly affects air quality.

Biodegradable packaging is a promising innovation in sustainable packaging solutions, offering an alternative to single-use plastics. Biodegradable materials are degraded by biological agents, mainly bacteria and fungi, into carbon dioxide, water and biomass under suitable environmental conditions. Modern biodegradable packaging materials, such as polylactic acid (PLA), polyhydroxy alkanooates (PHA), thermoplastic starch, cellulose films and mycelium composites, have different mechanical, barrier characteristics and environmental challenges. Biodegradable packaging is obtained from plant-based materials, animal based, microorganism derived, agricultural waste etc. The eco-friendly (biodegradable packaging) food packaging market which had a CAGR of 7.63% in 2024 is expected to reach \$505 billion by 2034 (Wandhekar *et al*, 2026) Furthermore, the innovative technologies (nanocomposites, fillers and bio-coatings), aids in improvising the performance and cost-efficiency of sustainable packaging that also aids in extending food shelf life and even biodegradability.

The key manufacturing processes include extrusion (films and sheets), injection moulding (containers), spraying and coating (edible films), pulp moulding and compression moulding (trays). As the production rates increase the industries can achieve cost savings through reduction in requirements of waste management and lowering the prices of material. Industries that adopt sustainable packaging solutions will build their brand image and consumer loyalty, thereby, increasing their market share and profitability. It can be concluded that the businesses that adopt sustainable environmentally friendly principles early will be able to strengthen their market and attract customers who are aware about environmental conditions, that can lead to better future collaborations with other sustainability-oriented enterprises.

Global Vs India Biodegradable Packaging Market Overview

The biodegradable packaging market is boosting in some countries as consumers are becoming more aware of their environmental impact and also governments are supporting their production through new economic policies and tax incentives. However, the emerging economies have a long way to go. This current scenario presents a platform where biodegradable materials can replace conventional materials that have very low degradability. The growth of the eco-friendly food packaging industry is attributed to the enforcement of strict plastic regulations in major markets, the increased adoption of recyclable and compostable packaging solutions by FMCG players, the rapid growth of e-commerce food delivery services, and the continuous development of bio-based packaging solutions.

The growth of the eco-friendly food packaging market is mainly driven by the implementation of stringent single-use plastic regulations in Europe, India, and North America. Governments are taking stronger measures to implement these plastic bans to decrease plastic waste. For example, in July 2025, the Indian government introduced the use of barcode and QR code marking on plastic packaging under the revised Plastic Waste Management Rules to increase compliance and accountability. Furthermore, the European Commission reiterated the objectives of the Single-Use Plastics Directive, which requires that all PET bottles contain at least 25% recycled plastic by 2025, increasing to 30% by 2030 (European commission on single use plastics, 2025) Such regulations are compelling many companies to change their packaging solutions to more sustainable options, thereby increasing the growth of the market.

Additionally, the market is further driven by the adoption of recyclable and compostable packaging targets by FMCG companies. Leading brands are establishing partnerships with circular economy objectives to develop solutions that can be recycled.

The market experienced steady growth from USD 178.4 billion in 2022 to USD 199.7 billion in 2024 because of increase in regulatory enforcement against single-use plastics and increase in consumer demand for sustainable packaging solutions. The market expanded during this period owing to the increased investments of businesses in biodegradable materials along with global brands building their sustainable packaging portfolios and quick-service restaurants as well as retail food chains adopting eco-friendly packaging solutions.

According to KEN Research Analysis report 2024, the Indian Biodegradable packaging market valued to USD 3.09 billion, this surge in growth was driven by increased environmental awareness in consumers and businesses and also stringent rules and regulations of government against single use plastics, secondly the growing waste management issue (62 million tons of waste generated every year out of this only 20% is treated) which has forced government to implement strict packaging regulations and adopt recyclable packaging's. The food and beverage sector showed highest demand seeking ecofriendly alternatives. The market demand is dominated by metropolitan cities like Mumbai, Bangalore and Delhi. These cities lead due to more consumer awareness, stringent government rules and regulations and thriving e-commerce sector. Under the Swachh Bharat Mission 2.0 the government focussed attention on promoting biodegradable packaging. The Indian government has allocated INR 2500 crores for R&D in biobased material through DBT which will encourage local raw material production.

Conclusion

The major market challenges of biodegradable packaging material are limited due to availability of raw materials like corn starch, sugarcane bagasse etc, as their use in other sectors like biofuel production is also high. Due to

lack of standardization and certification many industries wrongly declare their products as biodegradable which misleads the end users. Till now, only a few companies have acquired proper BIS certifications. In future the increased adoption by e-commerce platforms will lead to the growth of biodegradable packaging market in India along with more research and developments leading to innovations in biodegradable packaging materials.

References

- Jafarzadeh S, Jafari SM. Impact of metal nanoparticles on the mechanical, barrier, optical and thermal properties of biodegradable food packaging materials. *Critical reviews in food science and nutrition*. 2021 Sep 8;61(16):2640-58.
- George AS, George AH. Biodegradable ecofriendly sustainable tableware and packaging: A comprehensive review of materials, manufacturing, and applications. *Partners Universal International Research Journal*. 2023 Jun 20;2(2):202-28.
- Wandhekar S, Kshirsagar RB, Shaikh AM, Patil BM, Shinde ST, Agarkar BS, Kovacs B. The futuristic trend of edible and biodegradable food packaging, its impact and need: a review. *Discover Food*. 2026 Mar 3;6(1):169.
