

Design a framework and development of biocomposites for sustainable packaging application

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Abstract

Conventional packaging materials, such as synthetic plastics, metal, and glass, have a significant negative environmental impact. These materials contribute to environmental unsustainability throughout their lifecycle, from manufacturing to disposal. Therefore, there is an urgent need to create a sustainable system for packaging materials. This challenge can be addressed by replacing fossil fuel-based materials with eco-friendly alternatives. The use of biobased materials, such as natural fiber-reinforced biocomposites, in the packaging sector is still in its early stages. Consequently, there is a need for a guiding and sustainability assessment framework for industry, companies, researchers, and designers to facilitate the selection of biobased packaging for specific applications. Existing frameworks and tools have some limitations, such as considering few aspects of sustainability or having assessment parameters related to conventional materials. In this work, a sustainability assessment framework has been designed by considering various aspects of sustainability and the complete lifecycle phases of packaging materials. Furthermore, the relative weightage of parameters has been determined using the Analytical Hierarchy Process (AHP) methodology. The proposed framework provides a normalized sustainability score ranging from 0 to 1. Additionally, novel natural fibre-reinforced biocomposites have been developed for sustainable packaging. These natural fibres are extracted from agricultural waste such as rice husk, sugarcane bagasse, etc. The properties of the developed biocomposites were optimized by varying materials and process parameters. The resulting biocomposites are biodegradable and capable of enhancing the shelf life of packaged food. The developed active biocomposite packaging shows potential applications not only in food packaging but also in domains such as cosmetics, pharmaceuticals, and other sectors where product shelf life is a critical concern. Consumer acceptability of developed biocomposite based packaging was also evaluated based on various sensory criteria using the Multi-Criteria Decision Analysis (MCDA) technique. The sustainability score of the developed biocomposite packaging materials was compared with that of conventional packaging using the designed framework. The framework was validated by industry experts and through comparisons with existing frameworks.