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Packaging Systems Using Agricultural Product in World

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Abstract

Packaging is essential for the preservation of food for longer period by extending the shelf life of food. Conventionally plastic, cardboard and pepper were used for food packaging but there were some limitations that plastic is a non-degradable material and it could be dangerous for food items and also polluted the environment. On the other hand cardboard and peppers are biodegradable but they don't have good barrier ability for moisture and gas which is crucial factor in food preservation. Therefore this article focused on bioactive packaging which could be obtained from agricultural residues during farming and food processing. These Agricultural residues could be obtained from fruits, vegetables and other plant wastes including rice husks, maize comb etc. These residues have rich content of cellulose, lignin and pectin which are important material for food packaging films and coatings. These contents have good ability of moisture and gas barriers, also have flexibility and tensile strength. These agricultural sources also have antioxidant and antimicrobial properties which are important factors in food packaging for preserving food from oxidation and microbial spoilage. So it is concluded from this review that agricultural residues are best source of food packaging and also ecofriendly because of their biodegradable ability.

Keywords: *Agricultural residue, Bioactive packaging, Biodegradable, Antimicrobial, Antioxidant*

Introduction

Packaging is essential in order to preserve food's sensory and nutritional characteristics until it is consumed (Acharyya et al., 2024). This emphasizes how crucial it is to provide innovative packaging options that meet consumer needs and handle the escalating environmental issues. In the past, food packaging has mostly been made of cardboard, paper, and plastic. Paper and cardboard may be recycled, however they have problems with moisture and gas barriers, which are crucial for keeping a variety of foods. Conversely, plastic is the conventional material of choice for a variety of packaging applications due to its adaptable qualities, which include lightness, strength, and flexibility. However these materials' exceptional stability also makes them resistant to natural deterioration, which causes them to build up and create environmental issues (Acharyya et al., 2024). Food packaging may protect products from mechanical impacts and microbiological contamination, as well as provide a prolonged shelf life by acting as barriers against light, moisture, and oxygen (Bian et al., 2024). Producing packaging that is effective and eco-friendly is crucial in this situation (Doğan, 2023; Yu et al., 2021).

Bioactive packaging represents a significant advancement in both food packaging and environmental conservation (Cruz et al., 2022). According to Gupta et al. (2024), bioactive compounds are designed to extend the shelf life of food products, inhibit microbial development, and even improve their nutritional content. These are the leftovers from farming and food production, such wheat straws, rice husks, maize cobs, fruit peels, and vegetable stalks. This is due to the fact that the usage of bioactive packaging improves food safety, food waste reduction, and sustainable food packaging in the food industry (Rai et al., 2021; Ranganathan et al., 2020). Although these materials are typically disregarded as waste, they can be a rich source for the production of bioactive packaging materials. The purpose of this article is to talk about the possibilities of agricultural leftovers that include a lot of organic compounds and fibers and may have natural antioxidant and antibacterial qualities for making high-value packaging goods.

Properties of Agricultural resources

The agricultural leftovers have bioactive qualities in their original state is one benefit of using them in bioactive packaging. According to some recent studies, these residues are also rich in substances that may help preserve food (Jiang et al., 2023). Although bioactivity is a significant characteristic, real-world applications also depend on mechanical attributes including tensile strength, flexibility, and barrier qualities. According to some recent studies, when treated properly, edible films created from agricultural waste may have mechanical qualities comparable to those of standard plastic films. For example, films made from starch-agricultural wastes, such as maize husks or wheat bran, can achieve strength suitable for food packaging, conferring by the mechanical characteristics study conducted by tensile testing (Hofmann et al., 2023).

Sources of plant waste and their packaging applications

Plant-based residues, which include materials like cereal straw, husks, fruit peels, and other industrial by-products, are produced at every stage of agricultural, food processing, and forestry operations. Through varying proportions of cellulose, hemicellulose, lignin, pectin, and minor extractives, each of these elements has a distinct biochemical makeup that affects the final packing material's performance qualities as well as processing behavior. In order to choose the best pretreatment and manufacturing techniques, it is crucial to categorize these wastes according to their composition and place of origin.

Agricultural Residues

Mango peel, a component of food waste, is rich in polyphenols and flavonoids, which have strong antioxidant qualities and help keep food goods from oxidizing, extending their shelf life. Waste wheat straw fibers have been used to create molded pulp trays, which have shown mechanical qualities appropriate for a variety of packaging uses. The tensile modulus of a molded pulp tray made up of 80% straw fiber and held together by a biodegradable starch-based adhesive matrix was about 0.47 MPa. Although this modulus is less than that of many solid plastics, it is nevertheless completely biodegradable and represents the compliance of the extremely porous fiber-binder network (Curling et al., 2017).

Additionally, rice husks have been successfully added to composites and bio plastic sheets. For instance, rice husk fiber-reinforced starch-based films demonstrated increased tensile strength and decreased dependency on synthetic polymers (Srivastava et al., 2023). Commercial biodegradable tableware already uses sugarcane bagasse, a fibrous byproduct from sugar production (Stroescu et al., 2024). The use of corn leftovers like husks and stalks for packaging has also been investigated. According to one study, up to 80% of traditional fibers in paper packaging might be replaced with maize husk fibers without sacrificing mechanical integrity (Laftah & Wan Abdul Rahman, 2021).

Fruit and Vegetable Processing By-Products

Plant debris, including as peels, skins, pomace, and seed hulls, is produced in significant quantities by the food processing industry. These residues provide significant potential for the creation of edible or bioactive packaging materials since they are often high in pectin, fibers, and bioactive chemicals. For example, fruit peels have been effectively used to create bioplastic sheets. In order to create a biodegradable, antimicrobial bioplastic film that can prolong the shelf life of perishable fruits because of its antioxidant qualities (Zhang et al., 2024).

Additionally, vegetable by-products including tomato skins, potato peels, and carrot pomace are being valued. Edible films and loose-fill packing foams have been made from the starch and fibers of potato peels (Tsirigotis-Maniecka et al., 2024). Cruz-Tirado et al. (2019) produced a biodegradable foam tray with increased mechanical strength and decreased water absorption by adding fibers from sugarcane bagasse and asparagus peel to a sweet potato starch-based foam (Cruz-Tirado et al., 2019).

Main Components Bio-Waste Materials

The most prevalent polymer in wastes originating from plants, cellulose is a linear polysaccharide produces robust microfibrils that provide tensile strength and structural stiffness. Cellulose often makes about 35–50% of agricultural leftovers like straw (Sharma et al., 2019), and 15–25% of dry agricultural biomass is made up of lignin, a complex aromatic polymer (Madhu et al., 2023). As a natural binder in plant cell walls, it is hydrophobic by nature and offers stiffness and UV protection. Fruit wastes like citrus peels and apple pomace are particularly rich in pectin, a highly branched polysaccharide, with 20% concentrations that can surpass (Tsirigotis-Maniecka et al., 2024).

Conclusion

It is concluded from this article that agricultural residues are good source of food packaging because of their biodegradable, antioxidant and antimicrobial nature. These sources could be obtained from fruits, vegetables and other plants. These Agricultural residues have best edible film forming ability because of having rich content of cellulose, lignin and pectin.

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