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The Importance of Eco-Friendly Materials in the Food Industry

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Abstract

This review article explores the importance of eco-friendly materials in the food industry. Eco-friendly materials, often called green or environmentally friendly materials, are becoming increasingly popular in various sectors that aim to benefit the environment. One of the key advantages of using these materials is that they are often made from recycled or renewable resources. This approach helps to reduce waste, lower greenhouse gas emissions, and minimize carbon footprints. This is especially important in the food sector, like biofilm food packaging, beeswax food wraps, and waste food to ethanol. In addition, targets food protection and reduces environmental pollution.

Keywords: *eco-friendly, food industry, organic waste.*

Introduction

In the modern world, industries have developed a direction for eco-friendly materials, also known as environmentally friendly or green materials, which aim to utilize natural substances to benefit our environment (Abdur Rahman et al., 2023; Nowotna et al., 2019). One of the significant benefits of using eco-friendly materials is that they are often sourced from renewable or recycled resources, which helps reduce carbon footprints, greenhouse gas emissions, and waste (Abera, 2024). These materials can come from various sources, including plants such as bamboo, cork, and hempcrete (Orhon & Altin, 2020); agricultural waste such as fruits, vegetables, and grains (Kılınç & Korkmaz, 2024; Xie, Y. 2020; Kocabaş et al., 2021); as well as animal sources like crab, lobster, shrimp (Bakshi et al., 2000), and cow (Nowotna et al., 2019). Industries can greatly reduce their environmental impact by choosing materials that require less energy to produce and are either biodegradable or recyclable. This is especially important in the food industry and other sectors. It is essential to note that while all biodegradable products can be viewed as eco-friendly regarding waste decomposition, not all eco-friendly products are biodegradable. Some may be recyclable, reusable, or mitigate environmental impact differently.

Many sectors of the food industry are concerned about grocery spoilage and contamination due to microbes and lipid oxidation (Pinto et al., 2017). These issues render food products unsafe for consumption and can result in substantial financial losses. Effective food packaging can help reduce microbial spoilage, minimized lipid oxidation, extend shelf life, and enhance the visual appeal of food products.

The importance of eco-friendly materials in the food industry was studied under the titles a: biodegradable material used as biofilm or bio-plastic (starch, gelatin, and chitosan package), beeswax food wrap, and b: food and agriculture waste can produce biofuels such as bioethanol.

Biodegradable material used as biofilm or bioplastic

Plastic and food waste contribute significantly to environmental pollution and health issues (Ramadhan, 2020; Verma et al., 2016; Jambeck et al., 2015). As consumers become more aware of health and well-being, the transfer of substances from food packaging materials to the food itself has sparked debate among legal experts and researchers. Researchers are also working to reduce plastic waste by converting food waste into biodegradable packaging. These materials (biopolymers) can break down and return to natural elements within a short time in the environment, helping to protect our surroundings (Song et al., 2009; Mohammadalinejhad et al., 2020). Figures 1 and 2 several biodegradable materials are found in our environment, including polysaccharides, proteins, and lipids (Cazon et al., 2017; Nasrollahzadeh et al., 2020; Wu et al., 2017).

Polysaccharides and proteins are biopolymers derived from organic waste, bamboo plants, cork, and hempcrete. Although they currently hold little economic value, they offer a cost-effective option for use as biodegradable films, additives, or preservatives (Samrot et al., 2020). Recent research has explored the use of bioactive polyphenolic pigments extracted from food waste to create biodegradable films (Bhargava et al., 2020). These films can serve as eco-friendly and sustainable packaging materials.

A large number of studies have been conducted on biofilm packaging materials, such as polysaccharide films (including chitosan, starch, cellulose, and pectin), as highlighted by Cazon et al. in 2017; protein films (such as casein, whey, and gelatin) referenced by Chen et al. in 2019; and lipid films (like waxes) discussed by Callegarin et al., in 1997. These packaging materials demonstrate excellent oxygen barriers, adequate protection against oil and gas, antimicrobial properties, antioxidant strength, and flexibility (Moeini et al., 2022; Trinh et al., 2023).

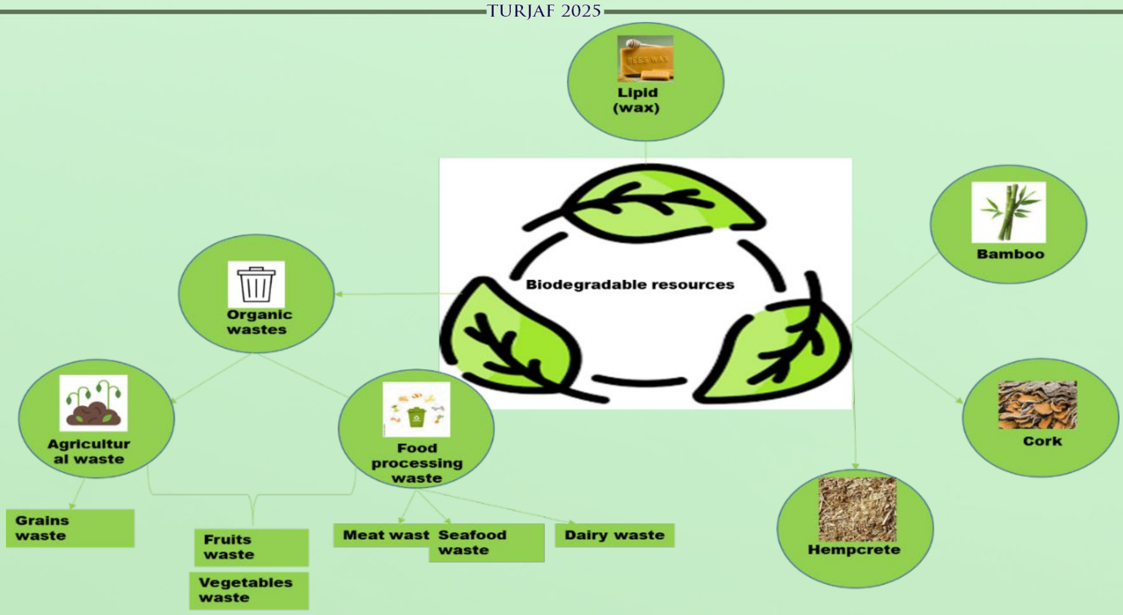

Figure 1. A brief overview of the classification of biopolymers by modified Popoola and Bukola (2022).

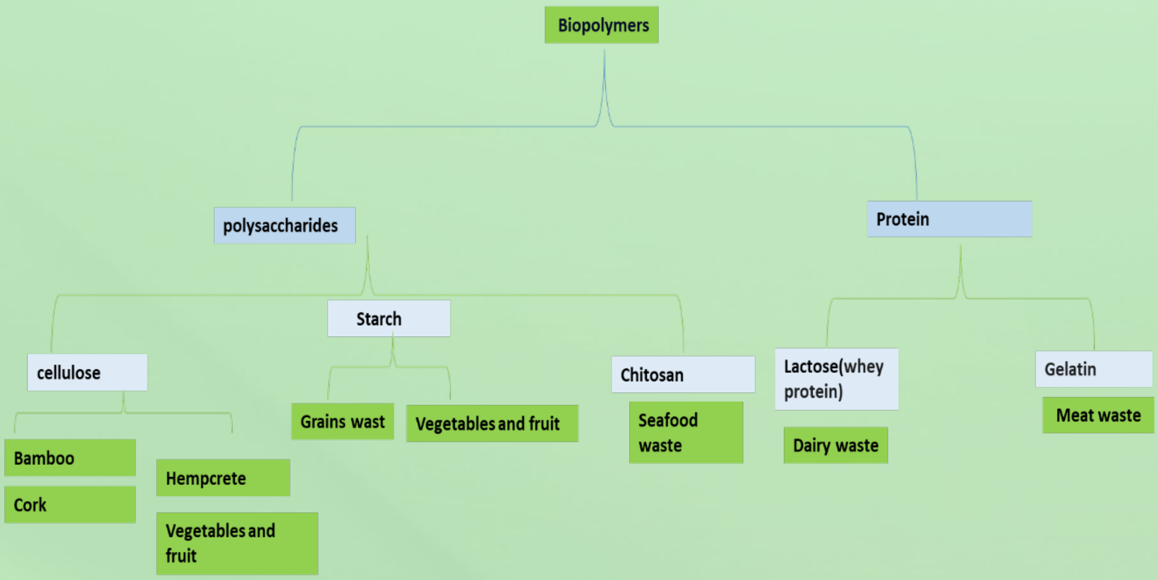

Figure 2. A brief overview of the classification of biopolymers. Inspired from Rhim et al. 2013 and Samrot et al. 2020.

Beeswax food wrap

Beeswax is a naturally antibacterial substance commonly used to create food wraps. It is biodegradable, sustainable, compostable, and environmentally friendly (Gupta et al., 2023).

Beeswax wraps are made from organic cotton, beeswax, plant oils, and tree resin, and they are promoted as a durable and flexible alternative to plastic wrap (Skiver, 2023). Some studies indicate that beeswax can positively affect the shelf life of food. Research from Fratini et al. (2016), Ghanem Nevine (2011), and Kacániová (2012) has reported that beeswax possesses antimicrobial properties, which may inhibit the growth of bacteria and fungi. Additionally, Pinto et al. (2017) found that Abeego wraps could inhibit food-borne bacterial pathogens and help prevent food spoilage.

Waste Food to Ethanol

Bioethanol has been utilized in the transportation and energy sectors for decades (Akin et al., 2021). It is produced from various sources, including sugarcane waste, food waste, biomass feedstocks, and crops such as corn and wheat (Byadgi & Kalburgi, 2016; Braide et al., 2016). This production can occur without negatively impacting the food supply or land use. Biomass energy is becoming increasingly popular as a clean and sustainable energy source (Bhatia et al., 2023).

One significant advantage of diverting food waste from landfills is reducing greenhouse gas emissions. When food waste decomposes in landfills, it generates methane, a potent greenhouse gas that contributes to climate change. By converting food waste into biofuel instead of allowing it to decompose in landfills, we can prevent methane release and significantly reduce our carbon footprint (Bhatia et al., 2032).

Additionally, a study by Gauder et al. (2011) showed that Brazilian food production increased fivefold from 1961 to 2008, with sugarcane crops representing 3% of agricultural production. This research analyzed the competition between bioethanol production and food production, revealing that over 20 million hectares of land will be available for agricultural production in the future. Three scenarios were explored, indicating that primary food production could increase 1.5 times and bioethanol production 1.8 times between 2007/2008 and 2020. This growth could meet 38% of the total energy demand in the Brazilian transport sector.

Conclusions

Biodegradable materials have become essential in our lives due to their significant impact on our environment and health. These materials are derived from natural sources, such as organic waste from food and agriculture, which are both abundant and cost-effective. Additionally, they offer antimicrobial and antioxidant properties, enhancing the performance of packaging systems. Moreover, biodegradable materials can be utilized as biofuels, such as bioethanol, in the food, transportation and energy sectors beyond. Developing biodegradable materials from food and agricultural waste offers several benefits, as it reduces the reliance on plastics, decreases plastic waste, and minimizes food waste simultaneously. This approach promotes overall environmental sustainability.

References

Abdur Rahman, M., Haque, S., Athikesavan, M. M., & Kamaludeen, M. B. (2023). A review of environmental friendly green composites: production methods, current progresses, and challenges. *Environmental Science and Pollution Research*, *30*(7), 16905-16929.

Abera, Y. A. (2024). Sustainable building materials: A comprehensive study on eco-friendly alternatives for construction. *Composites and Advanced Materials*, *33*, 26349833241255957.

Akin, M., Erduran, V., Altuner, E. E., Timuralp, C., Isik, I., & Şen, F. (2021). Fundamentals of alcohol fuel cells. In *Nanomaterials for Direct Alcohol Fuel Cells* (pp. 75-94). Elsevier.

Bakshi, P. S., Selvakumar, D., Kadirvelu, K., & Kumar, N. S. (2020). Chitosan as an environment friendly biomaterial–a review on recent modifications and applications. *International journal of biological macromolecules*, *150*, 1072-1083.

Bhargava, N., Sharanagat, V. S., Mor, R. S., & Kumar, K. (2020). Active and intelligent biodegradable packaging films using food and food waste-derived bioactive compounds: A review. *Trends in Food Science & Technology*, *105*, 385-401.

Bhatia, L., Jha, H., Sarkar, T., & Sarangi, P. K. (2023). Food waste utilization for reducing carbon footprints towards sustainable and cleaner environment: a review. *International journal of environmental research and public health*, *20*(3), 2318.

Braide, W., Kanu, I. A., Oranusi, U. S., & Adeleye, S. A. (2016). Production of bioethanol from agricultural waste. *Journal of fundamental and Applied Sciences*, *8*(2), 372-386.

Byadgi, S. A., & Kalburgi, P. B. (2016). Production of bioethanol from waste newspaper. *Procedia Environmental Sciences*, *35*, 555-562.

Callegarin, J.-A. Quezada Gallo, F. Debeaufort, A. Voilley, Lipids and biopackaging, J. Am. Oil Chem. Soc. 74 (1997) 1183–1192,

Cazon, P., G. Velazquez, J. A. Ram ırez, and M. Vazquez. 2017. Polysaccharide-based films and coatings for food packaging: A review. *Food Hydrocolloids* 68:136–48. doi: 10.1016/j.foodhyd.2016. 09.009.

Cazón, P., Velazquez, G., Ramírez, J. A., & Vázquez, M. (2017). Polysaccharide-based films and coatings for food packaging: A review. *Food Hydrocolloids*, *68*, 136-148..

Chen, H., Wang, J., Cheng, Y., Wang, C., Liu, H., Bian, H., ... & Han, W. (2019). Application of protein-based films and coatings for food packaging: A review. *Polymers*, *11*(12), 2039.

Fratini, F., Cilia, G., Turchi, B., & Felicioli, A. (2016). Beeswax: A minireview of its antimicrobial activity and its application in medicine. Asian Pacific Journal of Tropical Medicine, 9(9), 839-843.

Gauder, M., Graeff-Hönninger, S., & Claupein, W. (2011). The impact of a growing bioethanol industry on food production in Brazil. *Applied Energy*, *88*(3), 672-679.

Ghanem Nevine, B. (2011). Study on the antimicrobial activity of honey products and some Saudi Folkloric substances. Research Journal of Biotechnology, 6(4), 38-43.

Gupta, G., & Anjali, K. (2023, February). Environmentally friendly beeswax: properties, composition, adulteration, and its therapeutic benefits. In *IOP Conference Series: Earth and Environmental Science* (Vol. 1110, No. 1, p. 012041). IOP Publishing.

Jambeck, J. R., Geyer, R., Wilcox, C., Siegler, T. R., Perryman, M., Andrady, A.& Law, K. L. 2015. Plastic waste inputs from land into the ocean. *Science*, 347(6223), 768-771.

Kacániová, M., Vuković, N., Chlebo, R., Haščík, P., Rovna, K., Cubon, J., ... & Pasternakiewicz, A. (2012). The antimicrobial activity of honey, bee pollen loads and beeswax from Slovakia. Archives of Biological Sciences, 64(3), 927-93.

Kılınç, İ., & Korkmaz, M. (2024). Agricultural Waste-Based Composite Materials: Recycling Processes, Technical Properties, and Industrial Applications. *European Journal of Technique (EJT)*, *14*(2), 136-145.

Kocabaş, D. S., Akçelik, M. E., Bahçegül, E., & Özbek, H. N. (2021). Bulgur bran as a biopolymer source: Production and characterization of nanocellulose-reinforced hemicellulose-based biodegradable films with decreased water solubility. *Industrial Crops and Products*, *171*, 113847.

Moeini, A., Pedram, P., Fattahi, E., Cerruti, P., & Santagata, G. (2022). Edible polymers and secondary bioactive compounds for food packaging applications: Antimicrobial, mechanical, and gas barrier properties. *Polymers*, *14*(12), 2395.

Mohammadalinejhad, S., Almasi, H., & Moradi, M. (2020). Immobilization of Echium amoenum anthocyanins into bacterial cellulose film: A novel colorimetric pH indicator for freshness/spoilage monitoring of shrimp. *Food Control*, *113*, 107169.

Nasrollahzadeh, M., Sajjadi, M., Iravani, S., & Varma, R. S. (2020). Starch, cellulose, pectin, gum, alginate, chitin and chitosan derived (nano) materials for sustainable water treatment: A review. *Carbohydrate Polymers*, 116986.

Nowotna, A., Pietruszka, B., & Lisowski, P. (2019, June). Eco-friendly building materials. In *IOP Conference Series: Earth and Environmental Science* (Vol. 290, No. 1, p. 012024). IOP Publishing.

Orhon, A. V., & Altin, M. (2020). Utilization of alternative building materials for sustainable construction. In *Environmentally-benign energy solutions* (pp. 727-750). Springer International Publishing.

Popoola, Bukola. (2022). Biodegradable Waste. 10.5772/intechopen.107910.

Pinto, C. T., Pankowski, J. A., & Nano, F. E. (2017). The anti-microbial effect of food wrap containing beeswax products. *The Journal of Microbiology, Biotechnology and Food Sciences*, *7*(2), 145.

Ramadhan, M. O., & Handayani, M. N. (2020). The potential of food waste as bioplastic material to promote environmental sustainability: A review. *In IOP Conference Series: Materials Science and Engineering* (Vol. 980, No. 1, p. 012082).

Rhim, J. W., Park, H. M., & Ha, C. S. (2013). Bio-nanocomposites for food packaging applications. *Progress in polymer science*, *38*(10-11), 1629-1652.

Samrot, A. V., Sean, T. C., Kudaiyappan, T., Bisyarah, U., Mirarmandi, A., Abubakar, A., ... & Kumar, S. S. (2020). Production, characterization and application of nanocarriers made of polysaccharides, proteins, bio-polyesters and other biopolymers: A review. *International Journal of Biological Macromolecules*, *165*, 3088-3105.

Skiver, S. (2023). Beeswax Wraps as an Alternative to Single-Use Plastics.

Song, J. H., Murphy, R. J., Narayan, R., & Davies, G. B. H. (2009). Biodegradable and compostable alternatives to conventional plastics. Philosophical transactions of the royal society B: *Biological sciences*, 364(1526), 2127-2139.

Trinh, B. M., Chang, B. P., & Mekonnen, T. H. (2023). The barrier properties of sustainable multiphase and multicomponent packaging materials: A review. *Progress in Materials Science*, *133*, 101071.

Verma, R., Vinoda, K. S., Papireddy, M., & Gowda, A. N. S. (2016). Toxic pollutants from plastic waste-a review. *Procedia Environmental Sciences*, 35, 701-708.

Wu, X., Liu, Y., Liu, A., & Wang, W. 2017. Improved thermal-stability and mechanical properties of type I collagen by crosslinking with casein, keratin and soy protein isolate using transglutaminase. *International journal of biological macromolecules*, *98*, 292-301.

Xie, Y.; Niu, X.; Yang, J. (2020). Active biodegradable films based on the whole potato peel incorporated with bacterial cellulose and curcumin. Int. J. Biol. Macromol. , 150, 480–491

https://www.restaurantware.com/blogs/eco-friendly-solutions/biodegradable-vs-compostable-whats-the-difference