Chapter 11
Nanoclay Packaging Materials as Biodegradable

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ABSTRACT

Nanoclays are nanomaterials consisting of layered silicate clay minerals and have various applications in food packaging. They can improve the mechanical, thermal, and barrier properties of both petroleum-based and bio-based polymers, as well as provide other functions such as antimicrobial activity, colorimetric indication, biodegradability enhancement, additive partitioning, and control and release of active ingredients. This chapter reviews the types, properties, and manufacturing methods of nanoclay-based polymer nanocomposites for food packaging. In addition, the latest achievements and challenges related to the use of nanoclays as food packaging materials are discussed, and an overview of the current state of knowledge and future perspectives for the development of nanoclay technology in the food industry is provided.

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INTRODUCTION

Packaging for food is crucial because it protects the product until it reaches the customer. Packaging not only makes the product easier to handle, store, and transport, but it also protects the product from environmental hazards like bacteria and chemicals that might shorten its shelf life. Packaging must be able to preserve the food's color, flavor, weight, and texture because these aspects have come to get increased attention in recent years (Perera et al., 2023).

Plastic has long been the go-to for packaging; for example, yoghurt and sour cream containers are typically made from polypropylene, while polyamide, and ethylene vinyl alcohol are also frequently used. The food packaging industry extensively utilizes plastic-based packaging materials due to their remarkable mechanical and barrier qualities (Kausar et al., 2023). However, recent developments show a shift away from these materials and toward more environmentally friendly options like bioplastics and biopolymers. The rising environmental awareness of both customers and manufacturers has contributed to this shift, as more people are becoming aware of the harmful effects of plastic packaging. Additionally, nations including Kenya, Morocco, Oman, Moldova, and Ireland have passed laws prohibiting the use of single-use plastics. In addition, green procurement, educational campaigns, and economic mechanisms have all been employed to reduce plastic consumption (Nourmohammadi et al., 2023).

Thus, research into bioplastics and biopolymers, two types of packaging material that have very little environmental impact, is now underway in the food packaging business. The term "bionanocomposites" is currently employed to designate composite materials that incorporate at least one constituent derived from biological sources and particles with dimensions ranging from 1 to 100 nm (Majeed et al., 2023). These materials provide a burgeoning alternative due to their enhanced sustainability compared to plastic, while yet maintaining their useful properties. Given their ability to enhance the mechanical, thermal, and gas barrier properties of biopolymer materials while retaining their biodegradability, nanoparticles provide a potential path towards the development of a plastic packaging substitute that is acceptable to the environment. The mechanical and physical characteristics of materials used in food packaging are greatly improved by the nanoscale dispersion capabilities of nanocomposites (Khalaj et al., 2016). Researchers are interested in nanoparticles because of their antibacterial properties; examples of these are copper oxide, magnesium oxide, and zinc oxide. The European Union (EU) has granted permission for their utilization within specified limits. In accordance with EU laws, maximum permissible migration levels have been established for several nanoparticles, as outlined below: According to Nouri et al. (2018), Cu content in food or food simulant