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Abstract

Biopolymers, derived from renewable resources, are gaining increasing attention in the food industry for their potential in developing innovative preservation techniques for fresh produce. These natural polymers, including starch, chitosan, cellulose, and alginate, provide a sustainable alternative to synthetic preservatives and packaging materials. When applied in food preservation, biopolymers can enhance the shelf life of fresh fruits and vegetables by providing protective coatings, preventing moisture loss, and inhibiting microbial growth. The versatility of biopolymers in combination with other active agents, such as antimicrobial agents, antioxidants, and nutrients, further improves preservation techniques for fresh produce, highlighting their potential applications, challenges, and future directions for the food industry.

Keywords: Biopolymers; Food preservation; Fresh produce; Sustainable packaging; Chitosan; Cellulose; Antimicrobial agents

Introduction

Fresh produce, such as fruits and vegetables, is highly perishable and susceptible to spoilage due to microbial contamination, moisture loss, and oxidation. Traditional preservation techniques, such as refrigeration, chemical additives, and synthetic preservatives, are commonly used but come with limitations, including environmental concerns, health risks, and high costs. With increasing consumer demand for natural, healthy, and environmentally friendly alternatives, biopolymers have emerged as promising solutions for improving the preservation of fresh produce. Biopolymers are natural, biodegradable polymers derived from renewable resources like plants, animals, or microorganisms. Common examples include starch, chitosan, cellulose, and alginate, which possess unique properties that make them suitable for use in food preservation [1]. ese biopolymers are known for their ability to form lms and coatings, acting as barriers to moisture loss, gas exchange, and microbial contamination. Additionally, biopolymers can be combined with bioactive substances such as antimicrobial agents, antioxidants, and vitamins to enhance their functionality in preserving the quality and safety of fresh produce.

is article explores the role of biopolymers in innovative preservation techniques for fresh produce, focusing on their potential applications, bene ts, and challenges. By harnessing the unique properties of biopolymers, the food industry can create more sustainable, eco-friendly, and e ective sio the ripening process of fruits and vegetables. Biopolymer lms can slow down respiration rates, reduce moisture loss, and prevent physical damage, all of which contribute to extending shelf life [3].

Chitosan Films: Chitosan, a biopolymer derived from chitin found in the shells of crustaceans, is widely used for its antimicrobial and antifungal properties. When applied as an edible coating, chitosan lms inhibit the growth of spoilage-causing microorganisms, thereby extending the shelf life of fresh produce such as fruits, vegetables, and herbs. e lm also helps retain moisture, improving the texture and freshness of the produce.

Starch-Based Coatings: Starç AA-IIO Ps‡® aÆ:œ)¥Ó©:Xætž¹è±!•å-1 S P E V D F

such as essential oils (e.g., oregano, thyme, and clove oil) or metal nanoparticles (e.g., silver, zinc), enhances the antimicrobial properties of biopolymer lms. ese agents act as natural preservatives, inhibiting the growth of bacteria, fungi, and molds, which are responsible for food spoilage. For instance, incorporating garlic extract or cinnamon oil into chitosan-based lms has been shown to e ectively extend the shelf life of vegetables and fruits by preventing microbial contamination [6].

Antioxidants: Oxidation is another major factor that contributes to the deterioration of fresh produce. Incorporating antioxidants, such as ascorbic acid (vitamin C), polyphenols, or avonoids, into biopolymer lms can help delay the oxidation process and preserve the nutritional quality of the produce. ese antioxidants help maintain the color, avor, and nutritional value of fruits and vegetables, especially in highly perishable products like berries, apples, and leafy greens.

Biopolymer Films in Active and Intelligent Packaging

In addition to edible coatings, biopolymers are also used in the development of active and intelligent packaging systems that monitor and regulate the storage environment of fresh produce. Active packaging systems release or absorb substances to extend the shelf life of the product, while intelligent packaging incorporates sensors to monitor the freshness of the produce in real time [7].

Oxygen Scavengers and Moisture Regulators: Active packaging made from biopolymers can include oxygen scavengers that absorb excess oxygen, which helps prevent oxidation and slows down the ripening process. Moisture-regulating packaging is also important for reducing wilting and maintaining the desired texture of fresh produce, particularly leafy vegetables and herbs.

Smart Packaging with Sensors: Some biopolymer-based packaging