Chapter 14
Gum Arabic:
A Sustainable Biotechnological Solution to Prolong the Shelf Life and Improve Post-Harvest Quality of Fruits

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ABSTRACT

Gum Arabic, a natural biopolymer derived from Acacia trees, serves as an innovative and eco-friendly solution for developing bio-based packaging in the food industry. As an edible coating, it enhances fruit shelf life while preserving post-harvest quality by forming a natural barrier that reduces water loss, minimizes respiratory activity, and inhibits microbial growth. Compared to traditional plastic packaging, gum Arabic provides a biodegradable alternative, reducing plastic waste and supporting environmental sustainability. Despite its advantages, the material's sensitivity to humidity necessitates further research to enhance its stability under real-world storage and transportation conditions. Gum Arabic holds significant potential to address ecological challenges, decrease post-harvest losses, and offer a sustainable alternative to conventional packaging, aligning with the growing demand for greener solutions in the food sector.

1. INTRODUCTION

The widespread use of plastic packaging in the agri-food industry has become a significant contributor to environmental degradation (Williams & Phillips, 2009). Plastic materials, though indispensable for their durability and cost-effectiveness, are poorly recycled, leading to the accumulation of waste in terrestrial and marine ecosystems (Ali, Ziada, & Blunden, 2009). The reliance on fossil fuels for their production further exacerbates greenhouse gas emissions, intensifying the global environmental crisis

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(Gashua, Williams, & Baldwin, 2016). The growing awareness of these ecological challenges underscores the urgent need for sustainable alternatives to conventional plastic packaging.

In response to this pressing issue, considerable research has focused on developing biodegradable and eco-friendly materials for food preservation. Among these, gum Arabic—a natural biopolymer derived from the exudates of Acacia species—has emerged as a promising candidate (Randall, Phillips, & Williams, 1988). Traditionally utilized as a thickener, emulsifier, and stabilizer in various food applications, gum Arabic also exhibits unique physicochemical properties that make it suitable for bio-based packaging. Its ability to form transparent, flexible, and biodegradable films presents an innovative solution to reducing plastic waste while maintaining food quality during storage and transportation (Mendy et al., 2013).

This chapter aims to explore the potential of gum Arabic as a green biotechnological solution for the food industry. First, it highlights its physicochemical characteristics, including high water solubility, film-forming ability, and natural biodegradability, which are essential for sustainable packaging (Hassan et al., 2014). Additionally, gum Arabic's antimicrobial and antioxidant properties further enhance its application in prolonging the shelf life of fresh produce (Ali et al., 2013). Comparative analysis with traditional plastics will be presented, emphasizing the ecological benefits and limitations of gum Arabic-based coatings (Jahandideh, Ashkani, & Moini, 2021)..

By addressing the challenges associated with integrating gum Arabic into current packaging systems and providing insights into its potential scalability, this chapter contributes to advancing sustainable solutions for reducing the environmental footprint of food packaging (Gupta et al., 2018). The findings align with the growing demand for eco-friendly materials that support a circular economy and combat plastic pollution effectively (Tiamiyu, Adebayo, & Yusuf, 2023).

2. BACKGROUND AND BASIC CONCEPTS

2.1 Green Chemistry and Sustainable Development

2.1.1. Principles of Green Chemistry Applicable to Food Packaging

Green chemistry emphasizes the development of processes and products that minimize the use and generation of hazardous substances (Chien, Sheu, & Yang, 2007). Its principles are particularly relevant to the agri-food sector, where the environmental impact of packaging materials remains a critical concern. Key principales include:

- **Waste prevention:** Designing production methods that reduce waste at the source.
- **Use of renewable raw materials:** Promoting biological resources, such as biopolymers, over petroleum-based derivatives.
- **Biodegradability:** Developing materials that naturally decompose without harming ecosystems (Gashua, Williams, & Baldwin, 2016).

In the context of food packaging, these principles aim to address the dual challenge of reducing plastic waste and preserving food quality. The adoption of biodegradable materials not only contributes to waste reduction but also supports the circular economy by facilitating composting and enriching the soil (Mendy et al., 2013).