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Optimization of Maize-Tacca Starch Composite Edible Coating Using Response Surface Methodology for Prolonging Shelf Life of Tomato

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Abstract

Edible coatings play an important role in increasing the shelf life of fresh produce and have the potential to minimize postharvest losses. The present study evaluates the effect of composite edible coatings containing maize and tacca starch, black seed, and glycerol on the physicochemical attributes and microbial growth of tomatoes stored at an average temperature of 25.34 °C and relative humidity of 90.95%, respectively. Response surface methodology (RSM) based on D-optimal design was employed for the coating formulation with twenty (20) randomized experimental runs. The formulation design was constrained as follows: maize starch (20-40%), tacca starch (50-70%), black seed (5-10%) and glycerol (2-10%). The top three optimized coatings with the best desirability were then applied to tomato samples and stored with the control for a duration of 24 days. The result of the study shows that all coated samples exhibited lower degradation in weight loss, total soluble solids, titratable acidity, pH, and lycopene content in contrast to uncoated samples. Optimization analysis on the data obtained showed that a blend of 23.945% maize starch, 65.685% tacca starch, 2% glycerol, and 8.370% black seed recorded the least microbial count at the end of the storage period. The composite edible coating is promising for extending the shelf life of tomatoes.

Keywords: Edible-coating; Fruit; Maize; Preservation; Tacca; Tomato

Introduction

Tomato (Solanum lycopersicum L.) is the world's second-most-grown horticultural crop after potato, belonging to the family Solanaceae, usually grown in tropical to temperate regions of the world [1]. Tomatoes have a high nutritional value owing to their richness in vitamins, minerals, natural antioxidant compounds, and amino acids [2]. Several other health-promoting substances have been found in tomatoes, such as carotenoids, folic acid, ascorbic acid, lycopene, and β-carotene, which have been correlated with a reduced risk of cancer and some heart diseases in humans. However, it is classified as a climacteric and highly perishable fruit with a high respiratory peak associated with a high rate of ethylene production at postharvest [3]. To alleviate the wastage of tomatoes and extend their shelf life, it is necessary to explore new methods of preservation [4].

In recent years, the application of natural biopolymers to reduce postharvest losses in fresh fruit and vegetables has grown in prominence [5]. This can be explained by high consumer demand for nutritious food with low toxicity and increased environmental waste problems derived from the disposal of non-biodegradable petrochemical-based plastic packaging materials. Environmentally friendly edible coatings are thin materials developed from natural biopolymer materials applied in liquid form to food products to serve as surface barriers to moisture and gas movement [6]. Several biodegradable biopolymers exist, including polysaccharides, proteins, lipids, and their composites or combinations [5]. More recently, the use of edible coatings has been further promoted by coating functionalization with bioactive compounds, such as natural antimicrobial compounds, antioxidants, minerals, and vitamins, which contribute not only to improving safety and preserving the quality of food but also to delivering health benefits to the consumer [7].

A wide range of antimicrobial agents, such as essential oils, bacterions, and enzymes, can be integrated into edible coatings to reduce microbial proliferation in food products [5]. Recently, the incorporation of essential oils such as cumin oil, sunflower oil, black seed oil, cinnamon oil, citrus lemon essential oil, etc. as natural antimicrobial agents in edible coatings has received increasing attention to control the decay and extend the storage life of perishable foods [7,8]. The oil extracted from black seed (*Nigella sativa*) is beneficial to human health and nutrition on a protective and therapeutic level. It has about 24.9% carbohydrates, 26.7% protein, and 28.5% fat [8]. The oil is believed to possess a number of antioxidant, antidiabetic, antibacterial, and anti-inflammatory properties.

The optimization of analytical procedures has been carried out using multivariate statistical techniques, among which response surface methodology (RSM) is the most popular [9]. The RSM method is mainly employed to determine the best conditions from multiple experimental runs deduced from several variables to describe experimental data with polynomial equations and draw statistical conclusions [10]. Studies have reported the application