Algal Research 61 (2022) 102565

Contents lists available at ScienceDirect

Algal Research

journal homepage: www.elsevier.com/locate/algal

Characterization of biodegradable films based on extracellular polymeric substances extracted from the thermophilic microalga *Graesiella* sp.

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ARTICLE INFO

Keywords:
Graesiella sp.
EPS film
Physicochemical properties
Antioxidant
Meat shelf life

ABSTRACT

In this research, a new type of biodegradable film based on the extracellular polymeric substances (EPS) and isolated from the thermophilic microalga *Graesiella* sp., was formulated and characterized. The EPS film was 0.221 mm thick. Atomic force microscopy and scanning electron microscopy images revealed a homogeneous character with a lamellar microstructure. The EPS film displayed yellowish color, high transparency, high ultraviolet barrier properties, and low oxygen (0.008 SI), and water-vapor permeability (0.037 SI). Film tensile strength (16.24 MPa) and elongation at break (4.76%) were in the range of common biofilms and the thermal analyses showed high transition temperature (126 °C) and high thermal stability (up to 800 °C). Compared to ascorbic acid, results indicated that the EPS film shows a higher antioxidant activity, mainly as β-carotene anti-bleaching (84%), DPPH- free radical scavenging ability (80%), and ferrous iron-chelating (55%).

Graesiella sp., EPS film effects on beef meat packaging were studied during nine days of cold storage. Compared to polyvinylchloride-packed meat, EPS-packed meat samples showed higher stability of color (redness = 13.6) and pH (5.85) during storage and low proliferation of total viable counts (4.04 CFU·g^{-1}) and *Pseudomonas* bacteria (4.09 CFU·g^{-1}). They also exhibit lower drip loss (9%) and less metmyoglobin (32%), heme iron (4.87 μg·g^{-1}) total volatile basic nitrogen (TVB-N = 22.96 mg·kg^{-1}), and lipid oxidation (MDA = 0.025 mg·kg^{-1}). The obtained results highlight the potential for use of microalgae EPS as a new film-forming material that could be applied in beef meat preservation.

1. Introduction

Recently, plastics have become a source of worrying contamination due to their abundance, their persistence in nature, as well as their harmful effects on biodiversity and the environment [1]. Plastics are mainly used as packaging materials, up to 38%, and most are released into the environment after a single-use. Plastic waste, more than 170 million tons in 2017 [2,3], and their additives, including butylated hydroxytoluene (BHT) or butylated hydroxyanisole (BHA), cause serious pollution problems, particularly in soil and water [4,5]. Therefore, extensive research has been conducted to replace common synthetic materials with natural ones [6]. The exploitation of natural materials in the preparation of eco-friendly packaging films has been a new promising issue for meat products safety [7].

Biodegradable films are being successfully used as active packaging in several processed foods, including seafood/meat products and fruits, as oxygen scavengers, barriers to water and light, antibacterial, and anti-browning agents [9]. The bio-based films made from natural polymers have recently attracted considerable interest because of their ecological properties, their safety, and their biodegradability in nature [10].

Natural polysaccharides, proteins, and lipids biopolymers are used for bio-based film preparation. Besides their role as a barrier against the external environment, they provide active functions by prolonging the shelf life and improving the safety and the sensory properties of different products [8]. In recent years, the exploitation of extracellular polymeric substances (EPS) has been of particular interest. However, EPS have not

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https://doi.org/10.1016/j.algal.2021.102565
Received 24 June 2021; Received in revised form 1 November 2021; Accepted 10 November 2021
Available online 19 November 2021