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Valorization of food-grade industrial waste in the obtaining active biodegradable films for packaging

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ABSTRACT

The use of industrial waste as a material for the development of biodegradable and active packaging is economical and environmentally appealing. The aim of this study was to develop and characterize biodegradable and antioxidant packaging using wastes from the production of gelatin capsules and ingredients obtained from waste of juice blueberry processing. Fiber and ethanolic extract, obtained from the blueberry waste, were used at different weights in film formulation based on gelatin capsules waste: FF series with fiber concentration of 0.05, 0.10 and 0.15 g/mL; FE series with 30, 40 and 50 mL extract; and a control formulation. The morphological, mechanical, barrier, optical, thermal and antioxidant (AA) properties of the films were analyzed. The results suggest that the addition of fiber promoted a decrease in tensile strength from 2.51 (control formulation) to 1.51 MPa (0.15 g fiber/mL) and an increase in water vapor permeability from 59 (control formulation) to 99 (0.15 g fiber/mL) h g mm/m2 kPa. However, the addition of fiber also provided a significant increase in the UV light barrier at 500 nm (+0.16%) in AA films (+67.36%) and was effective in reducing lipid oxidation of sunflower oil. Films with added extract did not exhibit altered mechanical or barrier properties compared with the control formulation and were effective as a barrier to UV light. Furthermore, these films exhibited very stable antioxidant capacity for 28 days. The use of gelatin capsules and blueberry juice processing waste are promising for the development of environmental friendly packaging to be used in food preservation.

1. Introduction

In recent years, interest in biodegradable packaging as an alternative to synthetic packaging and non-biodegradable petroleum-based packages has increased in light of their promise to reduce the impact of packaging on the environment (Andrade-Molina et al., 2013). Adding antioxidants to these biodegradable packaging materials represents a promising alternative to reduce the oxidation of food products (Gómez-Estaca et al., 2014; Iahnke et al., 2015). These oxidative processes can cause the degradation of meat proteins, pigments and lipids, limiting the shelf life of food (Liu et al., 2010).

In this context, several studies have been conducted to evaluate the addition of antioxidants from natural sources, such as resveratrol (Pastor et al., 2013), plant extracts (Li et al., 2014), essential oils of herbs and spices (Wang et al., 2013), to biopolymers in packaging to replace synthetic antioxidants such as butylated hydroxyanisole (BHA) and butylated hydroxytoluene (BHT) as these synthetic antioxidants can constitute a potential danger to the health of consumers (Moure et al., 2001). Natural antioxidants can also be extracted from food industry waste, especially from the fruit processing industry due to the presence of compounds with high antioxidant value, including carotenoids and phenolic compounds (Gómez-Estaca et al., 2014; Mirabella et al., 2014; Su and Silva, 2006). According to Reque et al. (2014), blueberry pomace is rich in antioxidants, such as anthocyanins, because these compounds are preferably found in the blueberry fruit peel. These compounds play an important role in preventing cardiovascular disease, cancer and diabetes (Kończak and Zhang, 2004).

Different biopolymers can be used to produce films, including gelatin, which is obtained by thermal degradation of collagen. Gelatin represents an optimum material for biofilm formation due to its functional and biodegradable properties (Jridi et al., 2014). The waste produces of oil nutraceutical capsules (chia, linseed, coconut, and safflower) are comprised mainly of gelatin, which is generated in large quantities at a high waste treatment cost to the indus-

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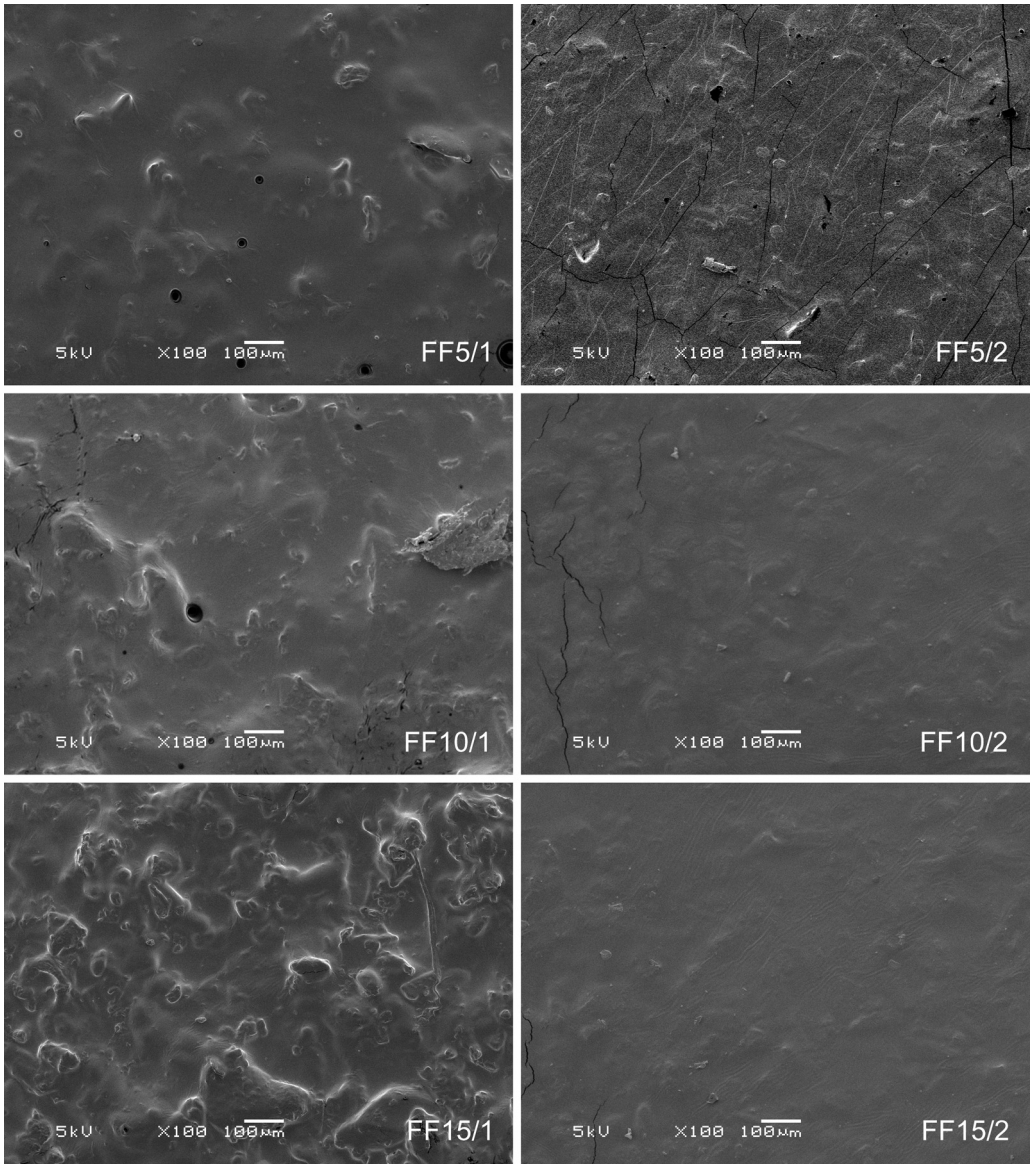

Fig. 1. Scanning electron microscopy (SEM) imgens (100× magnification) of films surface added blueberry fiber (FF); 1 -air side of the film; 2- plate side of the film.

try. This material can be 100% availed to obtain biodegradable and active biofilm, as it contains the gelatin, water and glycerol that are the important components for improving the properties of the films.

The aim of this study was to develop and characterize antioxidant biodegradable packaging using wastes from the production of nutraceutical capsules as biopolymer and blueberry juice processing waste.

2. Materials and methods

2.1. Materials

The waste from the chia oil nutraceutical capsules (gelatin capsules) production were provided by the Laboratory Chemical Pharmaceutical Tiaraju, located in Santo Angelo (RS/Brazil). The waste is composed of gelatin (48.2%), water (30%) and glycerol (21.8%). Organic frozen blueberries (*Vaccinium* sp.) of the cultivar Delite (Rabbiteye) were purchased from "*Fazenda Viva o Verde*" in Camaquã (RS/Brazil).

2.2. Obtainment of fiber and extract from blueberry pomace

The blueberry pomace was obtained using a centrifugal extractor (Walita-Philips®) where the juice was separated from the bagasse. The blueberry pomace dietary fiber was prepared in accordance with the methodology developed by Crizel et al. (2013). The fresh blueberry pomace was dried in an oven with forced air circulation (DeLeo, Model B5AFD, Brazil) at 55 °C for 24 h. After cooling to room temperature (~25 °C), the dried product was crushed in a mill (Model MCF55, Bertel Brand, Brazil) and was separated by screens on agitation. The separated particles were smaller than 125 mm (mesh 115). The fiber was packed in vacuum sealer (Model F200, Fastvac, Brazil) and stored in the dark at room temperature (~25 °C).

To obtain the extract was used the fresh blueberry pomace and PA ethanol as a solvent at a concentration of 1:1 on Ultra Turrax® (Ultra Turrax® (IKA Ultra Turrax digital, T25, Germany) for 1 min and subsequently centrifuged at 3000 *g* (Sigma, 4K15 model, England) for 15 min. The supernatant was obtained as the ethanolic extract.