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Characterization of ulluco starch and its potential for use in edible films prepared at low drying temperature

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ABSTRACT

The aim of this work was to characterize the starch obtained from ulluco (US) and evaluate its use in edible films prepared using different US concentrations (2.0, 2.5, and 3.0%) at low temperatures (simulating the storage conditions of different foods). US exhibited a high amylose content (35.3%), low stability against thermal degradation, and a B-type crystalline structure. In regards to the edible films prepared from US, good barrier properties related to the semicrystalline region were obtained. In addition, good mechanical properties, opacity and stability against thermal degradation were obtained. The extraction and use of US in the preparation of edible films could be an alternative method for adding value to this crop. Furthermore, the films appear as a potential material for food packaging.

1. Introduction

Currently, there is increased interest in the development of edible films and coatings based on natural polymers that can improve the shelf life of foods and reduce the pollution produced by plastics. For this purpose, different film-forming materials have been employed and tested, such as starch, gelatin, chitosan, gums, and proteins (Homez-Jara et al., 2018). Among these polymers, starch is a suitable material for large-scale production of coatings because of its abundance, low cost, non-toxicity, biodegradability, biocompatibility, film-forming capacity, and renewability. In this sense, different studies have evaluated the properties of films and coatings based on starch, alone or in combination with other materials (Mantovan, Bersaneti, Faria-Tischer, Celligoi, & Mali, 2018; Nogueira, Fakhouri, & de Oliveira, 2018; Podshivalov, Zakharova, Glazacheva, & Uspenskaya, 2017). Meanwhile, population growth is leading to an increased demand for starch by both food and non-food industries, which cannot be met without compromising food security. In this context, the search for non-conventional sources of starch for industrial uses has become a challenge for researchers (Fan et al., 2016; Leite, de Jesus, Schmiele, Tribst, & Cristianini, 2017).

Ulluco (*Ullucus tuberosus* Caldas) is an Andean crop plant distributed from Venezuela to northern Argentina at 2400–4250 m.a.s.l. (Daza, Homez-Jara, Solanilla, & Váquiro, 2018). Its tubers are considered a good source of carbohydrates (˜65% starch, dry basis), proteins, fiber, vitamin C, and betalains (Cejudo-Bastante, Hurtado, Mosquera, & Heredia, 2014). The use of ulluco tuber is typically limited to fresh consumption by the local population, which leads to a large number of postharvest economic losses. Hence, an alternative method to add value to this crop could be to extract its starch for industrial purposes. However, there are few studies describing the physicochemical properties and technological uses of ulluco starch (US). Therefore, more research is necessary in order to characterize US and better understand its potential as a raw material for industrial use. According to Valcárcel-Yamani, Rondán-Sanabria, and Finardi-Filho (2013), US presents a high content of amylose, which is desirable for obtaining edible films with good technological characteristics (Nogueira et al., 2018). In addition, the film-forming properties of US were evaluated by Daza et al. (2018), who concluded that edible films produced at elevated temperatures (40–60 °C) demonstrated high potential for use as biodegradable packaging materials for the food industry, mainly due to their favorable mechanical properties. However, refrigeration is one of the most widely used food preservation techniques worldwide. The understanding of how low temperatures affect barrier, mechanical, thermal and

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