

Article

Influence of Ulluco Starch Modified by Annealing on the Physicochemical Properties of Biodegradable Films

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Abstract: This work aimed to evaluate the use of annealing (ANN) ulluco starch in the preparation of biodegradable films and its impact on the physicochemical properties of the materials. Three film samples (FS1, FS2, and FS3) were prepared at a fixed starch concentration (2.6% *w/v*) using glycerol as a plasticizer and then compared to a control sample (FSC) prepared with native ulluco starch. The physical, mechanical, and thermal properties of the films were evaluated. The use of ANN starch decreased the solubility (from 21.8% to 19.5%) and the swelling power (from 299% to 153%) of the film samples. In addition, an increase in opacity and relative crystallinity (from 7.54% to 10.5%) were observed. Regarding the thermal properties, all the samples presented high stability to degradation, with degradation temperatures above 200 °C. However, the samples showed deficiencies in their morphology, which affected the barrier properties. The use of ANN starch has some advantages over native starch in preparing films. However, more analysis is needed to improve the barrier properties of the materials. This work reveals the potential of the ANN ulluco starch for biodegradable film preparation. In addition, the use of modified ulluco starch is an alternative to add value to the crop, as well as to replace non-biodegradable materials used in the preparation of packaging.

Keywords: *Ullucus tuberosus* Caldas; biopolymer; biodegradable films; packaging; starch modification



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1. Introduction

Plastics are inexpensive materials with exceptional characteristics, such as great strength, versatility, water impermeability, low conductivity, corrosion resistance, and durability, making them an essential raw material for different industries. As a consequence of its industrial importance, in 2020, the worldwide production of plastic reached 367 million metric tons [1]. Production is expected to increase twofold by 2040 [2]. However, plastics are non-biodegradable materials synthesized from non-renewable resources. Their post-consumer disposal, mainly of single-use plastics, can cause air, water, and soil pollution, severely impacting the environment and human health [3]. Consequently, different policies and strategies have been implemented to reduce their environmental impact [4]. Among these strategies, the search for biodegradable and renewable materials that can be used to prepare alternative substitutes for plastic has become highly relevant [5].

Biodegradable packaging materials are sustainable and eco-friendly materials based on synthetic (polylactic acid (PLA), polyvinyl alcohol (PVA), and polycaprolactone (PCL)) or natural (proteins, polysaccharides, and lipids) polymers, which can serve as substitutes for non-biodegradable plastics [3]. Among the natural polymers, starch is one of the most widely used in preparing biodegradable packaging due to its abundance, biodegradability, low cost, and renewability. Different studies have evaluated the potential of starches obtained from non-conventional sources to produce biodegradable packaging [6] to ensure