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Non-conventional starch from cubio tuber (*Tropaeolum tuberosum*): Physicochemical, structural, morphological, thermal characterization and the evaluation of its potential as a packaging material

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ABSTRACT

This work aimed to characterize the physicochemical, structural, morphological, and thermal properties of a non-conventional starch obtained from cubio (*Tropaeolum tuberosum*), as well as to evaluate the potential use of this native Andean tuber in the preparation of biodegradable packaging. The cubio starch (CUS) showed an intermediated apparent amylose content (31.2 %) accompanied by a high CIE whiteness index (90.8). About the morphology and particle size, the CUS exhibited irregular oval and round shapes and a smooth surface with a mean particle diameter of 14.04 ± 0.1 μm. Although it showed good stability regarding pasting properties, the final viscosity was low. Native CUS exhibits a typical B-type diffraction structure, with a relative crystallinity of 16 %. The resistant starch (RS) fraction of the CUS was 94 %, indicating a low susceptibility to enzymatic hydrolysis. The thermal analysis demonstrated that the CUS showed good thermal stability. Additionally, the films prepared using CUS as raw material showed continuous surfaces without porosities, good thermal stability, and high transparency. The results of this work demonstrate the industrial potential of the CUS as it presents characteristics comparable to commercial potato starch.

1. Introduction

Starch is the main carbohydrate reserve in plants. It consists of two glucose polymers, namely amylose and amylopectin, which form a semi-crystalline granule. Amylopectin consists of α-(1,4)-D-glucan short chains linked through α-1,6-linkages, and amylose, which essentially is a linear chain of α-(1,4)-D-glucopyranose subunits with a small number of branches [1]. Starch is an inexpensive, non-toxic, biodegradable, and renewable material used in the food, pharmaceutical, biomedical and plastic industries for different purposes [2]. Currently, starch for industrial use is primarily obtained from corn, potato, wheat, and rice; around sixty million tons of starch are obtained annually worldwide from these crops [3]. Despite its importance for both the food and non-food industries, and considering the growth in world population, industrial demand for starch cannot be met without compromising food security. In addition, the use of starches varies according to their physicochemical properties, which mainly depend on their botanical source [4]. Consequently, researchers are constantly looking for new sources of starch to evaluate its physicochemical properties and determine its industrial potential, adding value to non-conventional crops and promoting socio-economic development [5].

The use of plastics derived from the petrochemical industry has generated worldwide concern due to its negative impact on the environment. Only in 2019, the highest demand for plastic was from the packaging industry, comprising 39 % of European production (50.7 Mt) [6]. In this regard, different policies have been implemented to reduce the impact of non-biodegradable packaging [7]. However, more strategies are necessary to mitigate the problem. Biodegradable packaging appears as an environmentally friendly alternative to replace petroleum-based packaging. This type of material is prepared from polymers obtained from nature that present high biodegradability, which makes it necessary to search for new raw materials to obtain them [8,9].

Although tubers are used primarily in human nutrition, either as raw or processed products, mainly for their carbohydrate content, potatoes

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