

ORIGINAL ARTICLE

Annealing treatment of ulluco starch: Effect of moisture content and time on the physicochemical properties

Daniela O. Parra¹ | Luis Daniel Daza Ramírez^{1,2}  | Angélica Sandoval-Aldana¹  |
Valeria S. Eim²  | Henry A. Váquiro¹ 

¹Departamento de Producción y Sanidad Vegetal, Facultad Ingeniería Agronómica, Universidad del Tolima, Ibagué, Colombia

²Departamento de Química, Universidad de las Islas Baleares, Palma de Mallorca, Spain

Correspondence

Luis Daniel Daza Ramírez, Departamento de Producción y Sanidad Vegetal, Facultad Ingeniería Agronómica, Universidad del Tolima, Ibagué 730006, Colombia.
Email: lddazar@ut.edu.co

Funding information

Universidad del Tolima; l'Oficina de Cooperació al Desenvolupament i Solidaritat (OCDS) de la Universitat de les Illes Balears (UIB); Direcció General de Cooperació del Govern de les Illes Balears

Abstract

Annealing is a modification method that can improve the physicochemical properties of starch. The effect of moisture content (MC) and time (*t*) on the physicochemical properties of ulluco starch obtained by annealing (ANN) modification was studied. The results showed the ulluco-modified starches improved physicochemical properties such as solubility, water-holding capacity (WHC), oil-holding capacity (OHC), pasting properties, and the texture of the gel formed. Furthermore, the ordered structure and granules shape of starches were not significantly affected by the ANN modification. Regarding the influence of the process parameters on the properties of the modified starches, MC was the one that influenced the most, followed by *t*. The ANN treatment applied to ulluco starch proved to be an efficient, low cost, and green method for improving its physicochemical properties. This study showed that the native and physically modified ulluco starch is an industrial alternative to starches obtained from traditional crops, contributing to food security.

Novelty impact statement: Annealing is a physical method used to modify starch that can improve the physicochemical characteristics of the material. It is also a low-cost and environmentally friendly method. The modification of starches is an alternative to add value to different crops.

1 | INTRODUCTION

Ulluco (*Ullucus tuberosus* Caldas), the only species of the monotypic genus *Ullucus* from the Basellaceae family, is an Andean tuber usually cultivated around 2,800 m.a.s.l (Cejudo-Bastante et al., 2014). The tubers showed smooth and waxy skins with spherical (between 2 and 10 cm diameter) or curved and elongated shapes (between 2 and 15 cm in length). It has a wide range of bright colors on the skin, including white, yellow, orange, red, magenta, and green. In South America, its sowing and harvesting occur throughout the year, mainly in rainy seasons (Parra-Quijano et al., 2012). Its use is currently limited to consumption in nature, as an ingredient in preparing typical dishes, by the local population due to their nutritional composition, mainly its high starch content (~65% dry basis). However, its limited use and industrial exploitation result from the lack of information about its technological potential. As a result of the above, in recent

years, the interest in this crop has increased. Various studies have demonstrated their biological potential due to secondary metabolites, mainly flavonoids and betalains (Cejudo-Bastante et al., 2014; Pacheco et al., 2019). Nevertheless, the most interesting approach is obtaining native starch, which has demonstrated technological potential for its use in the food industry as raw material for preparing edible films or coatings. Galindez et al. (2019) demonstrated that edible films prepared with ulluco starch showed good mechanical properties, low water vapor permeability, and good stability against thermal degradation, which could be promising for their potential use in the transportation of food in various environmental conditions, these characteristics were associated with the amylose content of the starch (35.3%) (Pérez & Bertoft, 2010; Wang et al., 2014).

Although the starch obtained from ulluco has a high industrial potential for the food or packaging industry, it may show limited functional properties in its native form. Low thermal, shear, and acid stability, and