LWT - Food Science and Technology 44 (2011) 673–680

Contents lists available at ScienceDirect

LWT - Food Science and Technology

journal homepage: www.elsevier.com/locate/lwt

# Development of extruded snacks using taro (*Colocasia esculenta*) and nixtamalized maize (*Zea mays*) flour blends

J. Rodríguez-Miranda [a], I.I. Ruiz-López [b], E. Herman-Lara [a], C.E. Martínez-Sánchez [a], E. Delgado-Licon [c], M.A. Vivar-Vera [a,*]

[a] *Instituto Tecnológico de Tuxtepec, Coordinación de Posgrado e Investigación, Av. Dr. Víctor Bravo Ahuja s/n. Col. 5 de Mayo. Tuxtepec, Oax, C. P. 68350, México*
[b] *Facultad de Ingeniería Química, Colegio de Ingeniería en Alimentos. Benemérita Universidad Autónoma de Puebla. Av. San Claudio y 18 Sur s/n. Col. San Manuel. Puebla, Pue. C. P. 72570, México*
[c] *Instituto Tecnológico de Durango, Blvd. Felipe Pescador 1830 Ote. Col. Nueva Vizcaya Durango, Dgo. C.P. 34080 A.P. 465, México*

A R T I C L E  I N F O

*Article history:*
Received 16 October 2009
Received in revised form
29 June 2010
Accepted 30 June 2010

*Keywords:*
Taro flour
Maize flour
Extrusion process
Snacks

A B S T R A C T

Extruded snacks were prepared from flour blends made with taro and nixtamalized (TF–NMF) or non-nixtamalized maize (TF–MF) using a single-screw extruder. A central composite design was used to investigate the effects of taro flour proportion in formulations (0–100 g/100 g) and extrusion temperatures (140–180 °C) on the following indices: expansion (EI), water solubility (WSI), water absorption (WAI) and fat absorption (FAI). Moreover, selected TF–NMF and TF–MF extruded products were partially characterized through proximate chemical analysis, resistant starch, color, pH, water activity, apparent density, hardness, and sensory analysis. Results indicated that EI and WSI of both TF–MF and TF–NMF extrudates were significantly increased by the use of higher proportions of taro flour, while the opposite behavior was observed for the FAI ($p < 0.05$). Taro flour at higher proportions in both extrudates did not produce a significant change of WAI, while the use of higher extrusion temperatures only caused a significant increase of FAI in TF–MF extrudates ($p < 0.05$). This study showed that flour mixtures made from taro and nixtamalized maize flour produced puffed extruded snacks with good consumer acceptance.

© 2010 Elsevier Ltd. All rights reserved.

## 1. Introduction

Taro (*Colocasia esculenta* (L.) Schott) is an edible starchy tuber belonging to the *Araceae* family. Nowadays, this tuber is one of the most widely cultivated edible aroids in the tropical and subtropical regions of the world including West Africa and Indies, Asia, Caribbean, Pacific and Polynesian Islands and South America (FAO, 2008; Onwueme, 1999). Taro tuber crop cultivation in developing countries has taken importance in recent years due to its high fibre content (0.6–0.8 g/100 g), proteins (2–6 g/100 g), mucilage, vitamins, phosphorous, calcium and starch content (70–80 g/100 g d b), with small granules (1–4 μm) which are highly digestible in the gastrointestinal human tract (Sefa-Dedeh & Agyir-Sackey, 2002; Sefa-Dedeh & Agyr-Sackey, 2004). Despite their nutritional and health values, the use and consumption of taro tubers are generally limited by the fact that they are subjected to extensive post harvest losses as a consequence of their high moisture content, sustained metabolism, and microbial attack, leading to damage during harvest and storage (Agbor-Egbe & Rickard, 1991). These problems could be solved by converting the tubers from perishable to non-perishable products through food processing operations in order to manufacture new food products such as snack foods. These products have become a part of the feeding habits of the majority of the world population because they provide convenient portions and fulfill short-term hunger (Kuntz, 1996). One of the most important technologies which has shown great potential for the development of new snack products is extrusion cooking. Extrusion is a continuous food processing technique classified as a high temperature-short time operation in which raw food materials are thermo-mechanically cooked in a screw-barrel assembly by a combination of moisture, pressure and temperature in order to be mechanically sheared and shaped (Riaz, 2001). Product quality can vary considerably depending on the extrusion variables such as screw speed, feed moisture, temperature profile in the barrel, feed rate and die geometry. Extruder type and chemical composition of raw materials also affect product characteristics (Guy, 2001; Riaz, 2001).

Cereal grains are the commonest raw materials employed in the manufacture of extruded products (Ding, Ainsworth, Plunkett,

* Corresponding author. Tel.: +52 2878751044x143; fax: +52 2878751044x112.
*E-mail address:* mangeles@ittux.edu.mx (M.A. Vivar-Vera).

0023-6438/$ – see front matter © 2010 Elsevier Ltd. All rights reserved.
doi:10.1016/j.lwt.2010.06.036

Tucker, & Marson, 2006; Hagenimana, Ding, & Fang, 2006). Maize (*Zea mays* L.) is the third cereal in importance after wheat and rice as a staple human food, principally in Latin America. Mexico has the highest world *per capita* consumption and the major genetic diversity with more than 300 varieties of native maize grains (Billeb & Bressani, 2001) which are used in the manufacture of several derivative products after an alkaline cooking with lime known as nixtamalization. This thermal-alkaline process improves physicochemical, functional and nutritional properties. For example, nixtamalization has been reported to increase protein quality, calcium content and niacin bioavailability, while reducing aflatoxin levels of maize grains (Sefa-Dedeh, Cornelius, Sakvi-Dawson, & Ohene-Afoakwa, 2004). Extruded snacks based on maize has been obtained with good physical, functional, nutritional and sensory characteristics varying some process conditions such as temperature, moisture level, screw speed, residence time and calcium hydroxide concentration (Lasekan, Lasekan, Idowu, & Ojo, 1996; Zazueta-Morales, Martínez-Bustos, Jacobo-Valenzuela, Ordorica-Falomir, & Paredes-López, 2002).

For extruded snacks, one of the most desirable physical properties is the degree of expansion because it determines their structure and consequently their quality. Expansion of extrudates can vary considerably depending on both processing conditions and feed composition. Starch based materials are preferred as raw materials to enhance the puffing of extruded snacks. Roots and tubers provide high quantity of starch but low nutritional value. The development of composite extrudates through the mixture of starchy raw materials with other products has been an alternative for obtaining extruded snacks with better sensory, physicochemical and nutritional characteristics (Guy, 2001). Some studies have focused on the preparation of extruded snacks from starch mixtures of different sources such as corn and cassava in combination with other raw materials, where the effect of several formulations and extrusion conditions on the properties of extruded snack products has also been investigated (Rampersad, Badrie, & Comissiong, 2003). Few research works about the processing of taro flour into extruded products have been conducted. Maga, Bang-Liu, and Rey (1993) produced extruded snacks using taro flour as starting raw material. However, even when these products exhibited good expansion characteristics, they had an odd flavour and acrid taste. In addition, the viscous properties of taro flour extruded with whey proteins has also been investigated to simulate weaning foods, where taro flour has been suggested as a possible replacement for corn or wheat starch (Onwulata & Konstance, 2002). However, no information has been reported yet regarding the combined use of taro flour with more nutritional and commercially acceptable raw materials such as nixtamalized maize grains to produce new composite extruded snacks with better characteristics. Therefore, the aim of this work was to investigate the processability of flour mixtures made from taro and nixtamalized or non-nixtamalized maize flours to produce snack foods in a single-screw extruder. Also, the composition of raw materials was determined and the effects of extrusion temperature and the proportion of taro flour in formulations on some physical and functional properties of extruded snacks were evaluated. Additionally, selected products were partially characterized.

## 2. Materials and methods

### 2.1. Raw materials

White taro tubers (*C. esculenta* L. Shott) were kindly supplied by a local producer from Paso Nuevo, Oaxaca (Mexico). The corms were harvested in May 2007 after 10 months of cultivation. The tubers were washed, disinfected, dried with a cloth, and stored in polyethylene bags under refrigeration at 6 ± 1 °C until their use for no more than a week. Maize (*Z. mays* L.) grains of criollo variety were obtained from a local market in Tuxtepec, Oaxaca (Mexico) and stored in costal bags at room temperature (25 ± 1 °C) until their use.

### 2.2. Preparation of taro flour

Taro tubers were washed in tap water, peeled, washed in purified water and then cut into slices of approximately 0.5 cm thickness using a stainless steel knife. The slices were oven dried at 65 °C for 25 h (Felisa, model FE294AD, Mexico). The dried samples were milled using a Cross Beater Mill (Glen Mills Inc., New Jersey) and then sieved at 0.500 mm. The resulting taro flour (TF) was transferred to glass containers, which were sealed and stored at room temperature (25 ± 1 °C) for further usage.

### 2.3. Preparation of maize flour and nixtamalized maize flour

Maize flour (MF) was prepared from maize grains dried at 55 °C during 25 h, which were subsequently ground in a hammer mill (Pascall Engineering CO.LTD), and then milled and sieved in the same way as the TF.

Nixtamalized maize flour (NMF) was prepared according to the procedure of Milan, Gutiérrez, Cuevaz, Garzón, and Reyes (2004) and the NMX-F-046-S-1980 method from Normas Mexicanas (1980). Maize portions of 100 g were soaked and cooked in alkaline solution (1.08 g $Ca(OH)_2$/100 mL of water) in a concentration of 0.33 g of maize grain/mL of lime water at 85 °C during 45 min. After a resting period of 8 h, the cooking solution or “nejayote” was eliminated, and the cooked maize grains were rinsed four times with purified water. The resulting grains were dried at 55 °C during 25 h, ground, and sieved at the same form as MF. Both flours were separately stored in sealed glass containers at room temperature (25 ± 1 °C) until their use.

### 2.4. Chemical composition of the flours

The TF, MF and NMF were analyzed by triplicate for their moisture content, crude protein (N × 6.25), total fat, crude fibre and ash, according to AOAC (1995) methods 925.10, 920.87, 920.39, 925.08 and 923.03 respectively. Starch content was determined according to the enzymatic method described by Rose et al. (1991). Carbohydrates were determined by difference. Amylose content was determined using the iodocolorimetric method reported by Farhat, Oguntona, and Neale (1999). The amylopectin percentage was calculated by difference.

### 2.5. Physicochemical properties of the flour

The pH of TF, MF and NMF was recorded using a calibrated pH meter (Ultrabasic Denver UB-10). One gram of each flour sample was mixed with 10 mL of distilled water at 25 ± 1 °C. The pH electrode was immersed into the dispersion, shaken and allowed to equilibrate until a stable reading was observed.

Flour color was determined using a Hunter Lab colorimeter Model 45/0L (Hunter Associates Lab., Ind., USA). The $L^*$, $a^*$ and $b^*$ parameters as measures of lightness, redness/greenness and yellowness/blueness, respectively, were used to determine the color characteristics of the samples. The instrument was calibrated against a standard white tile ($L^* = 97.63$, $a^* = 0.78$, $b^* = -0.25$). The samples were compared with that standard to obtain the total color difference (ΔE).

Download English Version:

https://daneshyari.com/en/article/4564077

Download Persian Version:

https://daneshyari.com/article/4564077

Daneshyari.com