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Pasta products made from sweetpotato fortified with soy protein

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Abstract

Sweetpotato flour (Beauregard cultivar) was treated with sodium hydroxide solution and then fortified with defatted soy flour (DSF) or soy protein concentrate (SPC) at levels of 0, 15, 30, and 45 g/100 g. Pasta made from 100 g/100 g alkaline-treated sweetpotato flour (ASPF) had the lowest cooking loss (9.9 g/100 g) with the highest firmness (1.8 N). Cooking loss increased as levels of DSF and SPC increased (from 9.9 to 16.6 g/100 g). Addition of DSF and SPC increased the lightness (''L*'' value) from 40.6 to 48.7, and decreased the redness (''a*'' value) from 21.6 to 15.2. Substitution of DSF and SPC decreased firmness from 1.8 to 0.4 N, cohesiveness from 0.6 to 0.5 and springiness from 1.2 to 1.1 mm. Pasta made from 100% ASPF had highest β-carotene content (9.0 mg/100 g). The β-carotene contents decreased from 7.9 to 2.7 mg/100 g as the levels of DSF and SPC increased.

Keywords: Sweetpotato flour; Pasta products; Soy protein; β-carotene; Cooking quality

1. Introduction

Sweetpotato is a great source of carbohydrates, β-carotene (provitamin A), and fiber. It is considered as a staple and co-staple in many Asian and African countries (Woolfe, 1992). Sweetpotato flour has been added in pasta formulation but just used as a minor ingredient (Collado & Corke, 1996; Collins & Pangloli, 1997; Thirumaran & Ravindran, 1992). In wheat pasta, gluten protein contributes the desirable cooking qualities and texture of products (Feillet & Dexter, 1996). Since sweetpotato lacks gluten protein, it is difficult to make the pasta from the whole sweetpotato by applying for the wheat pasta manufacturing method. The production of rice noodles, which are popular in Southeast Asian countries such as Thailand and Vietnam, can be made in the absence of gluten. In these types of products, the starch pasting properties play an important role to the product qualities (Miskelly, 1993).

Chemical modifications were applied to various types of starches to improve physicochemical properties of starches. Sodium hydroxide was used to isolate starch from Legume flour, oat flour, and cowpea flour (Lim, Ling, Seib, & Rao, 1992; Prinyawiwatkul, McWatters, Beuchat, & Phillips, 1997; Schoch & Maywald, 1968). Sodium hydroxide can separate starch by dissolving protein without gelatinization of starch (Schoch & Maywald, 1968). Our previous study did not show significant difference in characteristics of cooked pasta between that made from sweetpotato flour treated with sodium hypochlorite and sweetpotato flour treated with sodium hydroxide. In this study, sweetpotato flour treated with sodium hydroxide was used to produce pasta by an extrusion process. Since the protein content in sweetpotato was low, protein sources such as soy flour and soy protein concentrate (SPC) were added to enhance the nutritive quality of products. The objectives of this study were to develop new pasta from alkaline treated sweetpotato flour fortified with soy proteins and to examine quality of the cooked new pasta product including cooking characteristics, protein content and β-carotene content.

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2. Materials and methods

2.1. Materials

Sweetpotato flour was prepared from sweetpotato roots of jumbo-sized, deep orange color of Beauregard cultivar, which were purchased from Leeland Farm in Leesberg, GA, USA. The roots were washed, hand-peeled, and sliced to 2 mm thickness. Sweetpotato slices were soaked in 0.1 g/100 g sodium metabisulfite before drying at 70 °C for 12 h in an oven. The dried sweetpotato chips were ground in a Super Masscolloider (Masuko Sangyo Co., Ltd., Japan) and subsequently sifting by using a Sweco Seperator (Sweco, Inc., Ft. Smith, AR, USA) through 80-mesh sieve sifted. The prepared flour was vacuum-packaged in Cryovac® bags and stored at −18 °C until used. Defatted soy flour (DSF) (Soyafluff® 200W) and SPC (Procon® 2000) were provided by Central Soya Company, Inc. (Fort Wayne, IN, USA). Commercial wheat noodles and rice noodles were purchased from Asian market in Atlanta, GA, USA.

2.2. Preparation of alkaline-treated sweetpotato flour (ASPF)

ASPF was prepared by the modified method of Forssell, Hamunen, Autio, Suortti, and Poutanen (1995). The pH of a 20 g/100 g (db) sweetpotato flour suspension was adjusted to 10.5 with 2 mol/l NaOH solution, stirred for 3 h, and neutralized with 1 mol/l sulfuric acid. The suspension was vacuum-filtered, washed twice with distilled water, dried in an oven at 50 °C overnight, and ground by Ultra Centrifugal Mill Model ZM 100 (F. Kurt Retsch GmbH & Co., Haan, Germany) to pass through 0.5 mm screen.

2.3. Preparation of pasta

Pasta samples were prepared from ASPF with a replacement of DSF and SPC at the levels of 0, 15, 30 and 45 g/100 g. No DSF and SPC substitutes in pasta formulation served as control sample. A mixture of flour and water (50 g/100 g) was mixed in a KitchenAid Mixer (Model KSM50PWH, St. Joseph, MI, USA) for 10 min, and steam-cooked using a steamer with boiling water for 5 min. The cooked dough was kneaded in the KitchenAid Mixer for 2 min in order to distribute the heat to gelatinize the dough which in turn was extruded through 2-mm die using a Chinese noodle maker (Shanxi Manufacturer Co., Shanxi, China). The extruded pasta was dried at ambient temperature with 30 ml/100 ml rh for 4 h until the moisture content reached to approximately 10 g/100 g. The dried pasta had the dimension of 0.6 mm width × 1.0 mm thickness. Each formulation was prepared in triplicates.

2.4. Proximate composition of ingredients

Proximate composition of samples was determined by AOAC (1997) methods as follows: moisture by the vacuum oven method 925.09; ash by the muffle furnace method 923.03; crude protein by Kjeldahl method 960.52 (using 6.25 as conversion factor); crude fat by petroleum ether extraction method 920.85; crude fiber by ceramic fiber filter method 920.86; and carbohydrate by subtracting percentage of other solids (ash + fat + protein + fiber) from 100 g/100 g.

2.5. Color measurement

The color of ingredients and cooked pasta was measured using a hand-held Minolta Chroma meter (Model CR-200, Minolta Corporation, Tokyo, Japan). Samples were placed in the sample cup for measurement. Color values were recorded as "L^*" (lightness), "a^*" (redness), and "b^*" (yellowness). From a^* and b^* values, the hue angle ($\tan^{-1} b^*/a^*$) and chroma ($(a^{*2}+b^{*2})^{1/2}$) were calculated.

2.6. Cooking quality of pasta

Cooking loss was measured by a modification of AACC (1995) method. Samples (5 g) were cooked in 200 ml boiling distilled water for 5 min, rinsed with 50 ml distilled water and drained for 5 min. The cooking and rinse water was collected, dried in an air oven at 100 °C and then weighted to determine cooking loss, which was expressed as percentage of initial dry matter.

2.7. Texture analysis of cooked pasta

Pasta firmness test was modified from AACC (1995) method. The firmness of cooked pasta was measured using an Instron Universal Testing Machine Model 1122 (Instron Corporation, Canton, MA, USA) equipped with a 50 N load cell and a cutting plexiglass blade. Three strands of cooked pasta were placed on a sample holder parallel to each other. Testing parameters for analysis were set at 5 mm/min crosshead speed. The maximum forces required to shear the sample were recorded. All trials were done in triplicates. The average forces were calculated for one strand of pasta.

A texture profile analysis (TPA) of pasta was conducted to determine adhesiveness (stickiness), cohesiveness and springiness of cooked pasta by using the method of Voisey, Wasik, & Loughheed (1978) and Tang, Hseih, Heymann, & Huff (1999) with modification. One strand of pasta were placed on a sample holder, which had a 90° groove surface, and compressed to 75 mm/100 mm of the depth of pasta with a flattened cylinder aluminum plunger (5.5 cm diameter) using 5 mm/min crosshead speed. On the force–time curve, adhesiveness was defined as the negative force area after the first compression, representing the work necessary to pull the compressing plunger away from the sample. Cohesiveness was defined as the ratio of the area under the second peak to the area under the first peak. Springiness was defined as the distance at which a deformed sample went back to its nondeformed condition