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Physico-chemical and Functional Properties of Sweet Potato-Soybean Flour Blends

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ABSTRACT

The study investigated the physicochemical and functional properties of sweet potato-soybean flour blends. Defatted soybean and sweet potato flours were blended in the ratios of 10:90, 25:75, 30:70 and 40:60, respectively, while 100% sweet potato flour was used as a control. The moisture, crude protein, crude fat, ash, crude fibre and carbohydrate contents of the flour blends were significantly different (p<0.05)with the values ranging between 7.28-7.32, 7.05-12.4, 2.62-3.22, 1.87-2.62, 3.76-4.55 and 68.10-76.63%, respectively. The bulk density, degree of starch damage, water absorption index, swelling power, amylose content and water solubility index of the flour blends were also significantly different (p < 0.05) with values ranging between 0.59-0.68 g/cm3, 0.74-1.17%, 2.34-2.81%, 1.46-1.56g/g, 12.62-12.91%, and 1.12-1.41% respectively. The results revealed that the increase in percentage of defatted soybean led to increase in moisture, protein, ash, crude fat, bulk density, degree of starch damage, water absorption index, swelling power and water solubility index of the flour blends but decrease in carbohydrate, crude fibre and amylose content of the flour blends. The study showed that the flour blends from defatted soybean and sweet potato had higher protein content and better physico-chemical properties making it a potential ingredient in baking products, extruded snacks and complementary/weaning foods formulations.

Keywords: defatted soybean flour; physico-chemical properties; proximate composition; sweet potato flour

INTRODUCTION

Sweet potato (*Ipomoea batatas*), a dicotyledonous plant belongs to the family convolvulaceae (Douglas, 1987). It is an important food crop of the tropics with potential to alleviate food insecurity, improve nutrition and economy of many African countries including Nigeria (Hurton, 1998; Saeed *et al*., 2012). It is an important alternative source of carbohydrates and attains fourth place after rice, corn and cassava (Saeed *et al*., 2012).West African sweet potato production is about 2.516 million tonnes per annum with Nigeria being one of the largest producers (FAO, 2006).
The crop is reported to be of low income value but with a significant social importance due to its high potential food source for most developing nations with limited resources as a result of its short maturity time, ability to grow under diverse climatic condition on less fertile soil (Saeed et. al., 2012). Sweet potato flour has been reported as a source of energy and carbohydrates, beta carotene (pro Vitamin A), Vitamin C, Vitamin B6, minerals (calcium, phosphorus, iron, manganese and potassium) and dietary fibre, which can add natural sweetness, colour and flavour to processed food products (Ulm, 1998; Woolfe, 1992; Onabanjo and Ighere, 2014). The underutilization of this crop, despite the industrial applications of its flour, has been reported (Putri *et al*., 2014; Mohd-Hanim *et al*., 2014). For instance, the flour could be used in production of cakes, muffins, cookies and noodles, extruded snacks, chiffons even as cereal flour supplements in bakery products such as pancakes and pudding (Zainun *et al*., 2005; Jennifer, 1992).

Soybean (*Glycine max*), a grain legume cultivated in many areas of the world, belongs to the family leguminosae and sub-family papillionnideae (Sanful and Darko, 2010). It is an excellent source of protein (40-45%) and the seeds are the richest in food value of all plant food consumed in the world (Egunlety and Aworh, 1990). Igbabul *et al*., (2013) reported that soybean contributes protein, fat, vitamins, and minerals in the diet of people in developing countries. Soybean contains some anti-nutritional factors, which inhibit the availability of the desirable elements such as protein, minerals and vitamins. However, several studies have been reported that most of these anti-nutritional factors can be destroyed through processing (Enwere, 1998; Osho and Dashiell, 1998). However, many studies had reported the improvement of protein quality of cereals and tuber crops, for instance, in production of soy-'ogi' (Adeyemi and Beckley, 1986), yam-soy flour (Akingbala *et al*., 1995), and soy-'agidi'(Akpapunam *et al*., 1997).

However, it should be noted that sweet potato has high carbohydrate content but low in protein content and many studies have reported this, for instance Mais (2008) reported that sweet potato tubers are regarded as being relatively high in starch and dietary fibre but low in protein. Since, sweet potato tuber is low in protein content, there is therefore, a need to supplement its flour with high protein content sources, such as legume flour, which could increase the nutritional qualities of the flour. In view of the increasing utilization of sweet potato in composite flours for various food formulations, its physico-chemical and functional properties are of greater significance (Mohd-Hanim *et al*., 2014; Mais, 2008). This study is thus, aimed at determining the physico-chemical properties of the flour blends from defatted soybean and sweet potato flours.

MATERIALS AND METHODS

Materials

Fresh sweet potato tubers (white variety) were purchased at Mile 12 market, Lagos state while soybean (variety – TGX 1485 – ID) was obtained at Kuto market, Abeokuta, Ogun state.

Preparation of flour samples

The methods described by Omoniyi (2003) were used for the preparation of sweet potato flour and defatted soybean flour. The sweet potato tubers were sorted, washed, peeled under water, cut into thin chips (1.5–2.0mm), washed again and dried in cabinet dryer (60^0C for 18h). The dried chips were then milled and sieved (250µm) to obtain flour. The soybean seeds were sorted, heated in the cabinet dryer at temperature of 60^0Cfor 1 h and soaked in clean water for 18 h. It was then washed with clean water and dehulled. After dehulling, it was autoclaved for 30 mins and then dried at a temperature of 65^0C for 24 h. The dried soybean seeds were then milled using hammer mill (Glen Crescent Ltd., Germany). The soybean flour was defatted using soxhlet extraction method (using n-hexane as solvent) for a period of 6 h. Thereafter, the defatted soybean was dried at temperature of 65^0C for 2 h, cooled, milled and packaged in sealed polyethylene bag.

Blending of sweet potato-soybean flour samples

Soybean and sweet potato flour samples were blended in ratios of 10:90, 25:75, 30:70, 40:60, respectively while 100% sweet potato flour was used as control sample (Table 1).

Analyses

Determination of proximate composition

The moisture content, protein content, crude fat, crude fibre and ash were determined according to AOAC (2000) while the carbohydrate content was obtained by difference.

Determination of physico-chemical properties

The bulk density, degree of starch damage and swelling power were determined according to method described by Onabanjo and Ighere, (2014), Williams and Fegol (1969), and Adeleke, and Odedeji, (2010) respectively. Amylose content was determined using the method described by Hoover and Ratnayake (2001), while water absorption and water solubility indexes were determined according to a prescribed method (Ruales *et. al*.,1993).

Statistical analysis

All data were obtained in triplicate; while analysis of variance (ANOVA) of the data was carried out using SPSS (21.0) and means separated using Duncan's multiple range test (DMRT).

RESULTS AND DISCUSSION

Table 2 shows the proximate composition of sweet potato-soybean flour blends. The proximate composition of the blends were significantly different ($p<0.05$) with the values ranging from 7.28 to 8.19 %, 2.21 to 12.42 %, 1.02 to 3.22 %, 1.73 to 2.62 %, 3.76 to 4.62 % and 69.38 to 84.22 % for moisture, crude protein, crude fat, ash, crude fibre and carbohydrate contents, respectively. Table 3 shows the physicochemical properties of sweet potato-soybean flour blends. The physicochemical properties of the blends were also significantly different ($p<0.05$) with values ranging from 0.59 to 0.68g/cm^3, 0.56 to 1.17%, 2.35 to 2.81%, 1.21 to 1.56g/g, 12.62 to 12.94%, and 1.12 to 1.41% for bulk density, degree of starch damage, water absorption index, swelling power, amylose content and water solubility index, respectively.

Table 1: Composition of sweet potato-soybean flour blends.

Samples	Soybean (%)	Sweet potato (%)
SPF	0	100
SS1	10	90
SS2	25	75
SS3	30	70
SS4	40	60

Where SPF–100% Sweet potato flour; SS1– 90% Sweet potato flour:10% Soybean flour; SS2–75% Sweet potato flour:25% Soybean flour; SS3–70% Sweet potato flour:30% Soybean flour; SS4-60% Sweet potato flour:40% Soybean flour

Table 2: Proximate composition (%) of Sweet potato-soybean flour blends.

Samples	Moisture content	Crude protein	Crude fat	Ash	Crude fibre	Carbohydrate
SPF	8.19^{a}	2.21^{e}	1.02^{e}	1.73^{e}	4.62^{a}	83.14^{a}
SS1	7.28^{c}	7.05^{d}	2.62^{d}	1.87^{d}	4.55^{b}	76.63^{b}
SS2	7.29^{bc}	9.55^{c}	2.67^{c}	2.02^{c}	4.27^{c}	72.90^{c}
SS3	7.30^{bc}	11.54^{b}	3.04^{b}	2.42^{b}	3.89^{d}	69.61^{d}
SS4	7.32^{b}	12.42^{a}	3.22^{a}	2.62^{a}	3.76^{e}	68.10^{e}

Means with different superscripts in a column are significantly different ($p < 0.05$)
Where SPF–100% Sweet potato flour; SS1– 90% Sweet potato flour:10% Soybean flour;
SS2–75% Sweet potato flour:25% Soybean flour; SS3–70% Sweet potato flour:30% Soybean flour;
SS4-60% Sweet potato flour:40% Soybean flour

Table 3: Physico-chemical properties of Sweet potato-soybean flour blends.

Samples	Bulk density (g/ml)	Degree of starch damage (%)	Water absorption index (%)	Swelling power (g/g)	Amylose content (%)	Water solubility index (%)
SPF	0.66^{b}	0.56^{d}	2.35^{d}	1.42^{d}	12.94^{a}	0.98^{e}
SS1	0.59^{d}	0.74^{c}	2.34^{d}	1.46^{c}	12.91^{b}	1.12^{d}
SS2	0.62^{c}	0.84^{b}	2.58^{c}	1.47^{c}	12.87^{c}	1.25^{c}
SS3	0.65^{b}	1.14^{a}	2.71^{b}	1.51^{b}	12.81^{d}	1.29^{b}
SS4	0.68^{a}	1.17^{a}	2.81^{a}	1.56^{a}	12.62^{e}	1.41^{a}

Means with different superscripts in a column are significantly different ($p < 0.05$)
Where SPF–100% Sweet potato flour; SS1– 90% Sweet potato flour:10% Soybean flour;
SS2–75% Sweet potato flour:25% Soybean flour; SS3–70% Sweet potato flour:30% Soybean flour;
SS4-60% Sweet potato flour:40% Soybean flour

The increase in percentage of defatted soybean led to increase in moisture, protein, crude fat and ash contents of the flour blends samples. Though an increment was recorded for the moisture contents of flour blends at increased percentage defatted soybean, but the values are lower than the13% maximum moisture content recommended for flour by Christensen and Kaumann (1973). Thus, the low moisture content is expected to lead to longer shelf life of the flour blends. The increase in protein content of sweet potato-soybean flour blends may be attributed to the high quantity of protein in defatted soybean flour (up to 40%) and this could improve the nutritional value of the flour blends. The same observation was reported for wheat-soy–plantain (Olaoye *et al*., 2006), fermented soybean-sweet potato (Abayomi *et al*., 2013) and soy-plantain (Abioye *et al*., 2011) flour blends. Similar observation on the increase in ash and crude fat contents of sweet potato-soybean flour blends was also reported for soy-plantain and fermented soybean-sweet potato flour blends (Abioye *et. al*.,2011; Abayomi *et. al.*, 2013). The increase in ash contents of the flour blends showed that the blends might be very rich in macronutrients. The decrease in carbohydrate contents recorded for the flour blends when the percentage defatted soybean flour increases, is supported the observations of Oyewole and Aibor (1992) on increase in protein and decreased carbohydrate contents of soy-fortified fufu. The increase in defatted soybean substitution led to increase in bulk density, degree of starch damage, water absorption index, swelling power and water solubility index of the flour blends but with decreased amylose content of the flour blends. The high bulk density value recorded for the flour blends might likely aid its industrial applications, according to a past study (Oladebeye *et al*., 2009) that suggested the suitability of high bulk density-sweet potato as drug binder and disintegrant in pharmaceuticals industries. It should be noted that as the degree of starch damage in the flour blends increases, there was increase in water absorption index of the blends as well. This observation is in support of the findings of Adeyemi and Beckley (1986) that reported a direct relationship between the water absorption indexes and higher damaged starch of the flour. The increase in water absorption index might be due to the increase in protein and carbohydrate contents reported for the flour blends. This correlates with the study of Afoakwa (1996) that reported the importance of protein and starch (cellulose) in water uptake of flour at room temperature.

CONCLUSION

The study showed that the flour blends from defatted soybean and sweet potato had high protein content and better physico-chemical properties which could make it a potential and functional ingredient in the production of baking and complementary/weaning food products.

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