Journal of Applied Biosciences (2009), Vol. 13: 703 - 706.
ISSN 1997 – 5902: www.biosciences.elewa.org

Evaluation of physicochemical and rheological characteristics of soybean fortified yam flour

K.O. Jimoh [1] and O.P. Olatidoye [2]

[1] Department of Food Science and Technology, The Polytechnic Ibadan, Nigeria.
[2] Department of Food Science and Technology, Igbinedion University, Okada, Nigeria.

Corresponding author e-mail: wasdam2006@yahoo.com. *Published online on January 5, 2009.*

ABSTRACT

Objectives: To evaluate the effect of soy flour fortification on the physicochemical and rheological characteristics and acceptability of yam flour paste (local name: *amala*).

Methodology and results: Yam flour was fortified with soybean flour at 10, 20 and 30% (w/w) with the aim of producing a more nutritionally balanced product (*amala*). The protein content of the resulting flour increased significantly from 3.16 to 18.21%, with a corresponding decrease in the carbohydrate content from 80.6 to 64.2%, swelling power (9.6 to 6.8%) and brown index (73.1 to 65.6), as proportion of soy flour in the mix increases. Pasting characteristic (peak viscosity, final viscosity and holding strength) also decreased significantly as proportion of soy flour increases above 10%. The set back value and breakdown viscosity of yam flour containing zero or 10% soy flour were significantly lower than those containing 20 and 30% soy flour. Apart from producing a nutritionally balanced *amala* meal, 10% fortification was more stable against retrogradation and was assessed to be more acceptable in terms of key quality index (texture and colour).

Conclusion and application of findings: Apart from adding value and varieties to *amala* meal due to its colour and textural improvement, fortifying yam flour with soy bean flour at 10% level would also reduce the problem of food security especially among children in the sub Sahara region of Africa where malnutrition due to protein deficiency is common.

Keywords: Yam flour, soybean flour, fortification, rheological properties.

Citation: Jimoh KO. and Olatidoye OP, 2009. Evaluation of physicochemical and rheological characteristics of soybean fortified yam flour. *Journal of Applied Biosciences* 13: 703 - 706.

INTRODUCTION

Yam *(Dioscorea spp)* belongs to the semi-perishable class of food due to its relatively high moisture content. In absence of good storage facilities, yams tubers are prone to gradual physiological deterioration after harvesting. However, yams can be processed into less perishable products such as yam flour through a drying process. The flour can later be reconstituted with hot water to form paste or dough. The reconstituted flour (known as Kokonte in Ghana and *Amala* in Nigeria) is popular for feeding both adults and children, and it is an important source of carbohydrate for many people in yam zone of West Africa (Akissoe *et al.,* 2003).

The yam tuber from which flour is made consists mostly of carbohydrate, and has very low protein content, which raises major concern in relation to its consumption alone (Abulude & Ojediran, 2006). In Nigeria, there have been several attempts at overcoming the nutritional deficiency of cassava based diets by fortifying with soya bean, which has high protein content of good quality (Sanni & Sobamiwa, 1994; Kolapo & Sanni, 2005). Results of previous studies on fortification of yam, cassava and plantain flours using soybean has shown that fortification improves nutritional quality of resulting meals, including *amala* (Abulude & Ojediran, 2006). However, fortification may also affect the functional and pasting characteristics of flour oriented foods (Abulude & Ojediran, 2006; Adebowale *et al*., 2008; Akanbi & Oladeji, 2008). This paper reports on the effect of soybean fortification on the physicochemical and rheological properties of yam flour.

MATERIALS AND METHODS

Flour preparation: Freshly harvested yam tubers of *D. rotundata* local cultivar *(Omolokun)* and soybean seeds were purchased from a local market. Yam flour was prepared by the method of Akissoe *et al*. (2003) while soybean flour was produced using the method of Sanni and Sobamiwa (1994). The yam flour was fortified by adding 10, 20 or 30% soy flour.

Physicochemical characteristics: Proximate composition of the fortified flour was determined according to the method of AOAC (1984) for crude protein, fat, % ash, moisture content and fibre. Carbohydrate was obtained by difference.

Pasting properties of flour were characterized using rapid visco analyzer (RVA) as described by Declour *et al.* (2000) for peak viscosity, holding strength set back, breakdown viscosity and final viscosity. Water binding capacity was determined using the method of Medcalf and Gillies (1965) while swelling power was determined by the method of Leach *et al*. (1959). Colour of pastes was measured using a minolta portable chroma meter. The hunter lab colour coordinate L* a* b* values were recorded and brown index was calculated as (100-L*) (Akissoe *et al.,* 2003)

Sensory evaluation: The prepared flour pastes (*amala*) were assessed organoleptically for texture, taste and colour using 10 panelists that are familiar with *amala*.

Data analysis: Data were analyzed by general linear model procedure using SAS package (Statistical Analysis System). Means were separated using Duncan's Multiple Range Test at a significance level of 0.05.

RESULTS AND DISCUSSION

The proximate composition result showed that protein, fat and ash increased as the proportion of soy flour increased, ranging from 3.2 - 18.2%, 0.3 - 4.1% and 2.0 - 3.2%, respectively (Table 1). A decrease was observed in the level of carbohydrate from 80.6 - 64.6%, as well as the moisture content of fortified samples from 12.3 - 8.4%, as the proportion of soy flour increased (Table 1). This result indicates that the purpose of fortification, which was to increase the protein content, was achieved while at the same time producing a more shelf stable product due to is lower moisture content. These findings agree with those of Kolapo and Sanni (2005).

Table 1: Proximate composition (%) of fortified and unfortified yam flour.

Soy flour (%)	% Protein	% Fat	% Ash	% Moisture	% Fibre	% Cho
0	3.16^{c}	0.30^{c}	2.03^{b}	12.30^{a}	1.65^{a}	80.56^{a}
10	8.88^{b}	1.88^{b}	2.60^{ab}	10.50^{a}	1.62^{a}	74.52^{b}
20	14.33^{ab}	3.22^{a}	2.90^{a}	9.00^{b}	1.58^{a}	68.97^{bc}
30	18.21^{a}	4.10^{a}	3.15^{a}	8.40^{b}	1.59^{a}	64.55^{c}

Values are means of triplicate tests. Within column, values with different superscripts (letters) are statistically different at $P \leq 0.05$.

There were significant differences ($P<0.05$) in functional properties between the unfortified and the fortified flour (Table 2). The water binding capacity and swelling power of yam flour reduced as the proportion of soy flour increased in the mixture. This effect is probably due to loose association of amylose and amylopection in the native granules of starch and weaker associative forces maintaining the granules structure (Lorenz & Collins, 1990).

Yam flour paste (*amala*) is normally greyish in colour and the brown index is the most representative colour index (Mestres *et al.,* 2004). Generally, there was a significant difference in the brown index of unfortified and the fortified flour except where 10% soy flour was added. The increase in discoloration of the paste is linked to thermal degradation of original colourless complex phenolics (promthocyanidins and lignins) to coloured phenols (anthocyanidins) (Swam & Hillies, 1959).

Table 2: Functional properties of yam flour fortified with soybean flour.

Functional property	Soy flour (% composition)			
	Zero	10	20	30
Water binding capacity (%)	88.48[a]	74.40[b]	68.33[bc]	64.24[c]
Swelling power (%)	9.58[a]	7.06[b]	6.82[c]	6.78[c]
Brown index of paste	73.12[a]	72.40[a]	66.50[b]	65.55[b]

Values are means of triplicate tests. Within row, values with different superscripts (letters) are statistically different ($P \leq 0.05$) according to Duncan's Multiple Range Test.

Significant differences ($P<0.05$) were observed between the pasting profile of the fortified and unfortified flour, except in setback value and breakdown viscosity of the unfortified sample and 10% soy fortified flour (Table 3). Unfortified flour produced a paste that remained undisrupted even when subjected to long periods of constantly high temperature due to its significantly higher peak viscosity (203.08RVU), final viscosity (216.60RVU) and holding strength (199.83RVU). The low set back value and breakdown viscosity of unfortified flour and that with 10% fortification indicates that their pastes would have a high stability against retrogradation (Mazurs *et al*., 1957).

Table 3: Pasting characteristics of yam flour fortified with soybean flour.

Pasting characteristic	Soy flour (% composition)			
	Zero	10	20	30
Peak viscosity	203.08[a]	168.00[b]	140.40[c]	138.66[c]
Holding strength	199.83[a]	154.00b[c]	143.83[c]	136.48[c]
Set back	46.67[b]	48.08[b]	52.25[a]	54.25[a]
Breakdown	53.50[b]	55.28[b]	70.18[a]	69.94[a]
Final viscosity	216.20[a]	172.41[b]	168.41[b]	152.31[c]

Values are means of triplicates determination. Within row, values with different superscripts (letters) are statistically different ($P \leq 0.05$)

Sensory evaluation of fortified yam flour paste (*amala*) showed no significant variation in the texture, taste and colour below 10 and above 20% soybean flour composition (Table 4). This implies that fortifying yam flour with soy flour at 10% did not affect acceptability of *amala*.

Table 4: Sensory evaluation of pastes made from yam flour fortified with soybean flour.

Soybean flour (%)	Texture	Taste	Colour
Zero	7.53[a]	7.07[a]	5.98[a]
10	6.98[a]	5.13[ab]	6.07[a]
20	4.93[b]	4.67[b]	5.20[b]
30	4.13[b]	3.87[b]	5.07[b]

Values are means of triplicate tests. Within column, values with different superscripts (letters) are statistically different ($P \leq 0.05$) according to Duncan's Multiple Range Test.

Results from this study suggest that fortifying yam flour with soybean flour at 10% would not only produce a more nutritionally balanced and acceptable products but one with almost same functional quality index with the regularly consumed *amala*. Being cheaper and readily available, soy bean fortification of yam flour would have little or no effect on the price of the product.

REFERENCES

Abulude FO. and Ojediran VA, 2006. Development and quality evaluation of fortified '*amala*'. Acta Sci. Pol., Technol Aliment 5 (2): 127 - 134.

Adebowale AA, Sanni LO, Fadaunsi EL, 2008. Functional Properties of Cassava - Sweet Potato Starch Blend. Proceeding of the 32nd Annual Conference of Nigerian Institute of Food Science and Technology. Pg. 304 - 305.

Akanbi CT. and Oladeji BS, 2008. Pasting Performance of Composite flour from Yam, Cocoyam, Breadfruit and Plantain blends. Proceeding of the 32nd Annual Conference of Nigerian Institute of Food Science and Technology. Pg. 312 - 313.

Akissoe N, Joseph H, Christian M, Nago N, 2003. Effect of tuber storage and pre- and post blanching treatments on the physicochemical and pasting properties of dry yam flour. Food Chemistry 85: 1414 - 1419.

AOAC, 1984. Official Methods of Analysis: Association of official Analytical Chemists, Washington D.C.

Delcour JA, Vanstelandt J, Hythier MC, Abecassis J, 2000. Fractional and Reconstitution experiment providing insight into the role of starch gelatinization and pasting properties in pasta quality. J. Agric. Food Chem. 48: 377 - 378.

Kolapo AL. and Sanni MO, 2005. Processing and characteristics of soybean - fortified Tapioca. Journal of Women in Technical Education 4: 59 - 66.

Leach HW, Mc Cowen LD, Schoch JJ, 1959. Structure of the starch granule. Swelling and solubility patterns of various starches. Cereal chemistry 36: 534-544.

Lorenz K. and Collins F, 1990. Quinoa (*Chenopodium quinoa*), starch physicochemical properties and functional characteristics. Starch/starke 42 (3): 81 - 86.

Mazurs EG, Schoch TJ, Kite FE, 1957. Graphical analysis of the brabender viscosity curves of various starches. Cereal chemistry 34 (3): 141 - 153

Medcalf DG. and Gillies KA, 1965. Wheat starches 1: Comparison of Physicochemical properties. Cereal Chemistry 42: 558 - 568.

Mestres C, Nago M, Akissoe N, Hounhouigon J, 2004. Prediction of sensorial properties (colour and taste) of *amala*, a paste from yam chips flour for West Africa through flour biochemical properties. Plant foods Human Nutrition 59 (3): 93 – 99.

Sanni MO. and Sobamiwa AO, 1994. Processing and Characteristics of soybean fortified Garri. World Journal of Microbiology and Biotechnology 10: 268 - 270.

Swam T. and Hillies WE, 1959. The Phenolic constituents of *Pruniss domestica*. The quantitative analysis of phenolic compounds. Journals of sciences of Food and Agriculture 10 (1): 63 - 68.