Fjrs.futa.edu.ng
FUTA Journal of Research in Sciences
ISSN: 2315 – 8239 (Print); E-ISSN: 2489 - 0413

FUTA Journal of Research in Sciences, Special Edition, Vol. 13 (3), December, 2017: 396-402

CHEMICAL COMPOSITIONS, FUNCTIONAL AND SENSORY PROPERTIES OF INSTANT POUNDED YAM 'SIMULATE' FROM YAM (DIOSCOREA ROTUNDATA) AND UNRIPE PLANTAIN *(MUSA PARADISIACAL*) FLOUR BLENDS

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ABSTRACT
Plantain *(Musa paradisiacal*) flour (PF) was mixed with the yam(*Dioscorea rotundata)* flour (YF) in the ratios 5:95, 10:90, 15:85 and 20:80 to produce pounded yam 'simulate' when reconstituted in hot water. The proximate compositions, functional properties and consumers acceptability of the yam flour (YF) and the plantain flour (PF) blends were determined. The composite flours were then reconstituted in boiled water at 100^{o}C to produce yam-plantain dough which is a simulate of mechanically pounded yam and the quality attributes were compared with instant pounded yam dough produced from 100% yam flour and 100% plantain flour. Sensory evaluations were carried out on the samples. The proximate compositions of the flour blends are in the following ranges 1.66-1.71% (protein), 0.98-1.05% (fat), 0.49-0.94% (crude fibre), 1.65-3.05% (ash), 11.22-12.88% (moisture) and 81.29-83.24% (carbohydrate). The ranges of values for functional properties are 145-250% (water absorption capacity), 135-245% (swelling power), 0.63-0.78g/ml (bulk density) and 60-70.75% (dispersibility). Sensory evaluation results showed that the dough obtained from the 100% instant pounded yam flour had the highest general acceptability score and the sample from 100% plantain flour was the least preferred. The inclusion of unripe plantain flour in instant pounded yam flour does not significantly improve the texture and functional properties of the yam flour for the production of pounded yam but it increased the crude fibre in the flour blends
Key words:Yam, plantain, pounded yam 'simulate', properties.

INTRODUCTION

Yams are members of the genus *Dioscorea* in the family, *Enantiophyllum*. Yams (*Dioscorea*) are a vital component of the agricultural sector of West Africa, in terms of food, social, and cultural values. Yam is grown and cultivated for its energy-rich tuber. White yam (*Dioscorea rotundata* Poir), is the most favoured yam species in West Africa because it possesses a highly viscous starch. Boiled yam, pounded yam and *amala* are yam food products mostly consumed in West Africa. Yam is an excellent source of starch, which provides caloric energy.

Plantain is a staple food commonly consumed in the tropical regions of the world, treated in the same way as potato and yam with a similar texture and neutral flavor when the unripe fruit is cooked by steaming, boiling or frying. Plantain is extremely low in fat and protein but high in fibre and starch. Unripe plantain is a good source of vitamin A, B_6 and C which helps maintain vision, good skin and builds immunity against diseases respectively. It is also rich in potassium, magnesium and phosphate when cooked green (Ogazi *et al*., 1996). FAO (2009) has reported that more than 2.5 million metric tons of plantains are produced in Nigeria. Traditionally, unripe plantain can be processed into flour. The flour is mixed with boiling water to make a stretchable paste (known as Amala) which is eaten with various soups. However, plantain is increasingly finding a gradual application in weaning food formulation and composite flour preparations (Ogazi *et al*., 1996; Otegbayo *et al*., 2002). Unripe Plantain is sometimes added during traditional mechanical pounding of pounded yam made from freshly harvested yam tubers to act as a binder and to improve its textural quality. Quality factors such as textural quality, appearance and taste are the main acceptability factors used by consumers to assess the quality of pounded yam; but the most important is textural quality (Otegbayo et al., 2007). These sensory factors are influenced by the physico-chemical and functional properties of yam starch since it accounts for about 60-80% of the dry matter of yam tuber (on dry weight basis). Amani et al., (2004) reported that it is a dominant factor in determining the physicochemical, rheological and textural characteristics of food products from different yam species. Instant pounded yam flour is usually processed from yam tubers by peeling, washing, dicing, sulphiting, blanching, drying and milling of yam tubers into flour. The yam flour is then reconstituted into glutinous dough by stirring in boiling water to produce pounded yam simulate. Instant pounded yam four have the advantage of reducing the drudgery of boiling, pounding and kneading of yam and also reduce processing time. Hence it provides a more convenient method of producing pounded yam for majority of urban dwellers. However, despite the advantages of instant pounded yam flour over pounded yam made from fresh tubers, culturally consumers still prefer the textural quality of pounded yam made from fresh tubers. Unripe plantain is sometimes added during traditional mechanical pounding of pounded yam made from freshly harvested yam tubers because it is claimed that it acts as a binder and improves its textural quality. The aim of this study is to evaluate the physicochemical properties of instant pounded yam flour produced from blends of yam flour and unripe plantain flour with a view to assess the effect of unripe plantain addition on acceptability of 'instant poundo yam simulate' produced from the blends.

MATERIALS

The white yam (*Dioscorea rotundata*) tubers and unripe plantains*(Musa paradisiacal*) used for this research were purchased from Odo-ori market, Iwo, Osun state. The chemicals and reagents used for this research were sourced from the Food Science and Technology Laboratory of Bowen University Iwo, Osun state and were of analytical grade.

PRODUCTION OF INSTANT POUNDED YAM FLOUR SAMPLE

Yam tubers were selected and weighed, then washed, drained and peeled. The tubers were diced ($2cm^3$) and immersed in sodium metabisulphite solution (800ppm for 20 min) to delay enzymatic browning. The diced yams were thereafter blanched at 70^oC for 10 minutes. Diced yam samples were dried in a cabinet dryer at 60^oC for 72 hours, milled to powder by a micro mill and sieved (600 μm).

PREPARATION OF PLANTAIN FLOUR SAMPLE

Unripe plantains (weighing 6.5 kg) were peeled and washed with portable water. These were sliced uniformly. The slices were blanched in a Clifton water bath (model serial number: 15147, Nickel electro Ltd, England) at 100°C for 20 min. The cooked slices were dried in a cabinet dryer (Serial No: 3113 Leec Ltd Colwick, Nottingham) for 48 hrs and then milled to get the instant plantain flour. The milled flour was sieved and then packaged in an airtight polyethylene bag until ready for use.

CHEMICAL ANALYSES

Carbohydrates, crude proteins, ashes, fats, moisture, crude fibres of yam and plantain flour blends were determined using the methods of AOAC (2005).

Determination of pH of samples:

Each sample (5g) was homogenized in 50 ml of distilled water. The resulting suspensions were decanted and their pH determined using pH meter (model: 350 pH meter Jenway) already standardized with buffer solutions of pH 4.0 and 7.0.

FUNCTIONAL PROPERTIES

The bulk densities, swelling powers, water absorption capacities and dispersibilities of flour blends were determined using the methods described by AOAC (2005).

Preparation of Instant poundo yam 'simulate'

Yam flour (YF) was substituted with plantain flour (PF) at four levels of substitution: 95:5, 90:10, 85 : 15 and 80 : 20 respectively. The flour samples were each stirred into boiling water to make glutinous dough which were then compared with dough samples made from 100% of instant pounded yam flour (YF) as well as 100% of plantain flour (PF) to serve as control samples.

SENSORY EVALUATION

Sensory evaluation of the pounded yam samples was conducted using a panel of 20 judges who were regular consumers of pounded yam. The judges were asked to score for colour, aroma, texture and general acceptability using a 5-point hedonic scale, where 1 represent dislike extremely and 5 represent like extremely respectively.

Statistical analysis

Data generated from the chemical and sensory analysis were subjected to Analysis of variance (ANOVA) using the SPS statistical package version 20.0. Means were separated using Fischer's LSD at 5% level of probability.

RESULTS AND DISCUSSION

Proximate Composition of the flour blends.

The result of the proximate compositions of the flour samples showed that there were significant differences in their protein, ash, fibre, carbohydrate, moisture and fat contents ($P<0.05$). The moisture contents of the flour samples ranged from 12.88±0.78% to 11.22±0.17% with 100% plantain flour having the least value of 11.22% and sample with 15% plantain flour having the highest of 12.88%. The fat content of the flour samples ranged from 1.05 ±0.05% to 0.98±0.01%, with 100% PF having the least value of 0.98% and 100% YF having the highest value of 1.05%. The ash content of the flour samples ranged from 3.05±0.05% to 1.65±0.05% with 100% plantain flour having the highest value of 3.05% and sample containing 90%IPYF having the least value of 1.65%. The fibre contents of the flour samples ranged from 0.42±0.01% to 0.91±0.01% with 100% plantain flour having the highest value of 0.94% and 90% YF sample having the least value of 0.49%.The protein contents ranged from 1.71±0.04% to 1.66±0.18%. The sample with 100%YF recorded the highest value of 1.71% and the one with 100%PF had the least value of 1.66%. The values obtained in this research are slightly different from the values obtained by Akinwande *et al*. (2008) and Fagbem (1999). The carbohydrate contents were obtained by difference. The carbohydrate content ranged from 83.24±0.70% to 82.06±0.32%. The blend with 90% YF had the highest value and the sample with 80% YF had the least value. The values obtained in this research are slightly different from the values obtained by Akinwande *et al*. (2008) and Fagbemi (1999) for YF and plantain flours respectively; this can be due to the variation in the *Dioscorea rotundata* species used and drying methods used in the production of the flours.

Table 1: Proximate composition of yam flour (YF) and plantain flour (PF) blends (%)

YF:PF	Protein	Fat	Ash	Fibre	Moisture	Carbohydrate
100:0	1.71±0.04 [a]	1.05±0.05 [a]	2.05±0.05 [d]	0.42±0.01[d]	11.54±0.26[b]	82.74±0.40[a,b]
95:5	1.70±0.04[a,b]	1.04±0.05[a,b]	1.95±0.05[e]	0.49±0.01[d]	11.47±0.24[b]	82.19±0.30[b,c]
90:10	1.71±0.13[a]	1.04±0.01[a,b]	1.65±0.05[f]	0.72±0.01[cd]	11.43±0.63[b]	83.24±0.70[a]
85:15	1.70±0.04[a,b]	1.03±0.01[b]	2.25±0.05[c]	0.82±0.01[c]	12.88±0.78[a]	81.29±0.81[c]
80:20	1.67±0.04[c]	1.03±0.01[b]	2.45±0.05[b]	0.92±0.01[b]	11.83±0.23[b]	82.06±0.32[b,c]
0:100	1.66±0.18[c]	0.98±0.01[c]	3.05±0.05[a]	0.94±0.01[a]	11.22±0.17[b]	82.16±0.31[b,c]

Means within a column with the same superscript were not significantly different at 5% level of significance.

FUNCTIONAL PROPERTIES

Water absorption capacity (WAC)

The water absorption capacity of the flour samples ranged between 250±10.00% and 145±5.00% with 95%YF having the highest value and 100% plantain flour having the least value. Water absorption capacity is the ability of flour to absorb water and swell for improved consistency in food. It is desirable in food systems to improve yield and consistency and give body to the food (Osundahunsi *et al*., 2003). Although 100% plantain flour had the least water absorption capacity, but there was no consistent decrease in the water absorption capacity of the YF as the proportion of plantain flour increased in the blends. The water absorption capacities of yam and plantain flour reported in this research are slightly different from those reported by Malomo *et al*., (2012) and Ogazi (1996) respectively. The observed variations in the result could be attributed to the differences in the drying method used in the production of the yam and plantain flours. Drying increases the absorption capacity of flour. According to Circle and Smith (1972), water absorption capacity is a useful indication of whether flours can be incorporated into aqueous food formulations especially those involving dough handling.

Bulk density (BD)

The bulk density of the flour samples ranged from 0.78±0.01g/ml to 0.63±0.00g/ml with 100% yam flour having the highest (0.78g/ml) and 100% plantain flour having the least (0.63g/ml).The bulk density of the flour samples decreased with increased proportion of plantain flour in the blends. 100% YF had the highest value indicate that it was denser than plantain flour. The bulk density is influenced by particle size and the density of the flour and is important in determining the packaging requirement and material handling. Karuna (1996) and Plaami (1997) reported that bulk density is influenced by the structure of the starch polymers and loose structure of the starch polymers could result in low bulk density.The bulk density is affected by the particle size and the density of the flour which is very important in determining the packaging requirements, material handling and the application in wet processing in food industry (Adebowale *et al*., 2008). Generally, higher bulk density is desirable for greater ease of dispersability and reduction of paste thickness (Padmashree *et al*., 1987); it is also a good physical attribute when determining mixing quality of particulate matter (Lewis 1990)

Swelling power (SP)

The swelling power of the flour samples ranged from 245+25.00% to 135+25.00 with 90%YF having the highest value of 245% and 100% plantain flour having the least value of 135%. The swelling power is an indication of presence of amylase which influences the quantity of amylose and amylopectin present in the flour. Moorthy *et al*., (1986) reported that the swelling power of flour granules is an indication of the extent of associative forces within the granule. Swelling power is also related to the water absorption index of the starch-based flour during heating (Loss *et al*., 1981).Therefore, the higher the swelling power, the higher the associate forces. High swelling power is desirable in poundo yam

Dispersability (DIS)

The dispersability of the flour samples ranged from 70.75+0.25% to 60.00+0.00% with 100% plantain flour having the highest value and 95% YF having the least value.The inclusion of plantain flour inproved the dispersability of the blends in boiling water to give a consistent paste..

pH

The pH of the flour samples ranged from 7.15+0.05 to7.35+0.05. The values of pH obtained in this research, for yam and plantain flour is slightly different from the values reported by Malomo *et al*.,(2012) and Ogazi (1996) respectively; these may be due to the variation in period of harvesting and storage and also slight changes in production process.

Table 2: Functional properties of flour blends from yam flour (YF) and plantain flour (PF).

YF : PF	WAC (%)	SP (%)	BD(g/ml)	pH	DIS (%)
100 : 0	205+5.00[b,c]	235+25.00[b]	0.78+0.01[b]	7.35+0.05[a]	62.5+0.50[d]
95 : 5	250+10.00[a]	240+30.00[b]	0.77+0.00[b]	7.15+0.05[c]	60+0.00[f]
90 : 10	220+0.00[b]	245+25.00[b]	0.76+0.01[b]	7.15+0.05 [c]	61.75+0.25[e]
85 : 15	180+10.00[d]	160+10.00[c]	0.75+0.01[c]	7.25+0.05[b]	63.00+0.00[c]
80 :20	**195+25.00[c,d]**	**215+5.00[b]**	**0.75+0.01[c]**	**7.35+0.05[a]**	**63.5+0.00[b]**
0 : 100	145+5.00[e]	135+25.00[c]	0.63+0.00[d]	7.15+0.05[c]	70.75+0.25[a]

Means within a column with the same superscript were not significantly different at 5% level of significance.
WAC: Water Absorption Capacity, SP: Swelling Power, BD: Bulk Density, DIS: Dispersability

SENSORY EVALUATION

There were significant differences (P<0.05) in all the sensory attributes. The sample containing100% YF was scored highest for all the sensory attributes (colour, aroma and texture); Paste from PF (100%), on the other hand, was scored lowest for all the sensory attributes (colour, aroma and texture). The mean rating for the overall acceptability followed the trend of all other sensory attributes with 100% YF samples being the most preferred while 100% plantain flour was the least preferred of all samples. The scores for the general acceptability of all the samples indicated that substitution of YF with PF did not ssignificantly improve the functional properties of instant yam flour for the production of pounded yam simulate.

Table 3: Sensory evaluation of the pounded yam "simulate" produced from Yam flour(YF) and plantain flour(PF) blends.

YF:PF	Colour	Aroma	Texture*	General acceptability
100 : 0	$4.2\underline{+}1.01^{a}$	$3.5\underline{+}1.05^{a}$	$3.65\underline{+}1.14^{a}$	$3.8\underline{+}0.89^{a}$
95 : 5	$3.7\underline{+}0.92^{a,b}$	$3.45\underline{+}0.10^{a}$	$2.85\underline{+}1.09^{b}$	$3.2\underline{+}0.89^{a,b}$
90 : 10	$3.25\underline{+}1.12^{b,c}$	$3.1\underline{+}0.97^{a,b}$	$2.9\underline{+}0.97^{b}$	$3.2\underline{+}1.01^{a,b}$
85 : 15	$3.3\underline{+}1.08^{b,c}$	$3.05\underline{+}1.05^{a,b}$	$3.05\underline{+}\ 1.10^{a,b}$	$3.2\underline{+}\ 0.70^{a,b}$
80 : 20	$2.9\underline{+}0.97^{c}$	$3.35\underline{+}0.81^{a}$	$3.1\underline{+}1.12^{a,b}$	$3.1\underline{+}0.72^{b,c}$
0 : 100	$2.2\underline{+}\ 1.06^{d}$	$2.25\underline{+}1.10^{b}$	$2.75\underline{+}1.12^{b}$	$2.55\underline{+}1.05^{c}$

** measured as cohesiveness (mouldability)Means within a column with the same superscript were not significantly different at 5% level of significance.*

CONCLUSION

The study showed that, the inclusion of unripe plantain flour to instant pounded yam flour does not significantly improve the functional properties of the yam flour for the production of pounded yam, although it increased the crude fibres in the flour blends. The consumption of instant pounded yam from plantain flour or the inclusion of plantain flour in instant pounded yam flour is recommended for its health benefits, a good source of resistant starch that reduces the risk of diabetes by aiding in blood sugar control.

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