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Development of reconstitutable yam /cassava flour blends enriched with soy flour for pounded yam preparation

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Abstract

Yam flour was mixed with cassava starch (25% w/w). The firmed yam flour was then fortified with soybean at 0–30% levels. The nutritional composition, functional and sensory properties of the complementary blends was analyzed. The results showed significant increases ($p<0.05$) in protein from 10% for yam flour/ cassava starch without soybean flour to 58% for yam flour/ cassava starch fortified with 30% soybean flour. Fat content increased from 4.6% to 70.9% for samples fortified at 0% and 30% soybean flour addition. However, carbohydrate decreased significantly ($p<0.05$) from 77.5% to 59.9% with increased soybean flour substitution. The micronutrient composition showed that chromium, cadmium, lead and zinc were absent while iron and calcium were trace. There was significant increases ($p<0.05$) in amount of potassium, magnesium and phosphorus with increased soybean addition. Sensory analysis showed that panelists accepted the blends up to 30% soybean flour addition.

Keywords

Yam Flour, Cassava Starch, Soybean Flour, Pounded Yam, Yam Meal

1. Introduction

This work was aimed at producing yam flour that could be reconstituted into yam meal having the firm consistency of the traditional pounded yam delicacy enjoyed with soup in Nigeria. This was done by firming yam flour with cassava starch. To improve its nutritional status soybean flour was incorporated. Yam occupies a significant place in many traditional marriage ceremonies and in special dishes for fetish priests in sacrificial ceremonies in many cultures in West Africa. It is reported to be high in potassium and low in sodium which is likely to produce a good potassium-sodium balance in the body and so protect against osteoporosis and heart disease. Apart from being a good calorie source, yam is also a significant source of vitamin C, iron, calcium and nicotinic acid (Ukpabia, 1992). Its low level of saturated fat is also helpful in protecting against heart disease. However, as a result of the combination of high degree of perishability, bulkiness and distance from production area to the consuming centers and the seasonal nature of production, attention has therefore been drawn to the processing of yam tubers into flour which depends on some vital functional properties of yam varieties (Lasisi, 2009).

Presently production of yam flour and subsequent reconstitution leads to a dumping lacking in firmness, texture and rigidity of the conventional pounded yam. This witling down of the conventional pounded yam consistency makes many not to accept reconstituted yam flour meal as pounded yam. It became necessary therefore to fortify yam flour with available local firming agents to produce firm and consistent yam meal close to the convectional pounded yam meal.

According to Lasisi (2009) yam flour meal gives more sustainable energy and better protection against obesity and diabetes but can not be adopted as growth and development food because it is poor in protein and therefore requires supplementation with legumes and or oilseed proteins. In Nigeria there have been several attempts of overcoming the nutritional deficiency of yam based diets. This is achieved by

fortifying with soybean, which is high in protein that is of good quality (Kolapo and Sanni, 2005). Soybean is considered an increasingly important crop in Asia, several African countries and at present has a tremendous potential for alleviating protein-energy malnutrition (Osho and Dashelli, 1995). According to (Alabi 2008) soybean is an important source of high quality, inexpensive protein and oil, compared to other protein- rich foods such as meat, fish and eggs. Its oil is low in cholesterol; therefore its intake reduces the incidence of cardiovascular diseases. Yam flour firmed up with cassava starch had been developed (Lasisi, 2010). This current work is aimed at determining the effect of addition of full fat soybean flour on the food qualities of blends of yam flour and cassava starch mixtures.

The specific objectives include:

(a) To determine the proximate and mineral compositions of the blends

(b) Evaluate the pasting characteristics of the enriched blends and

(c) To determine the acceptability of the blended meals.

2. Materials and Methods

Yam (*Dioscorea rotundata*) and cassava (*Manihot esculenta*), used for this study were purchased from the Central Market, Minna, Niger state Nigeria. Soybean (TGX 144-2E) was obtained from the seed store of the National Cereals Research Institute Badeggi Nigeria.

Yam flour, cassava starch and full-fat soybean flour were prepared as shown in figures 1,2 and 3 respectively according to Lasisi (2009) and Anuonye,(2006).

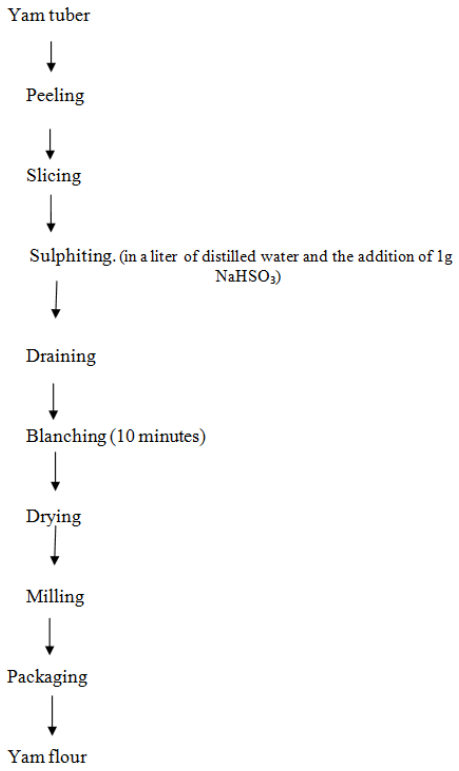


Fig 1. *Flow chart of yam flour production. Source: (Lasisi, 2009).*

The yam flour was firmed up with 25% cassava starch as previously reported (Lasisi 2009). Full-fat soybean was incorporated into the blend at 0-30% levels of substitution as reported by Anuonye (2006).

3. Analysis

Proximate and mineral composition, pasting profile and acceptability of the blends were evaluated. The Proximate composition (Fat, Moisture, Protein, Crude Fiber, Ash and Carbohydrate) were determined according to AOAC, (2005). The micronutrients including magnesium, potassium, sodium, calcium and iron were evaluated using an Atomic Absorption Spectrophotometer (Buck 210VGP) Germany according to AOAC (2005)

The pasting profile of the samples was evaluated using 20 minutes-rapid visco analyzer (RVA) (Newport Scientific 910140, Sydney Australia) as reported in Anuonye, *etal* (2010).

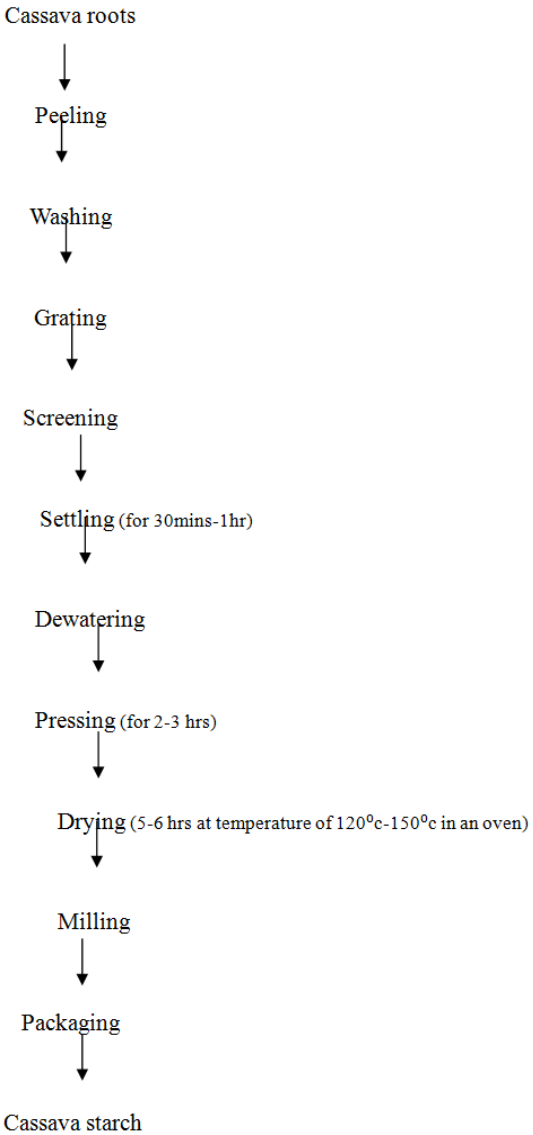


Fig 2. *Flow chart of cassava starch production. Source : Lasisi(2009)*

Acceptability of the blends were evaluated using a 16-man untrained panel consisting of students ad staff of the Federal University of Technology Minna who were randomly selected. Fortified yam meal was reconstituted for sensory evaluation as reported by Lasisi(2009). A nine point hedonic scale where 1 represented disliked extremely and 9 liked extremely was used according to Iwe (2004). The panelist were provided with 5 coded samples of the blend and were asked to assess the color, odour, texture, taste, moldability and overall acceptability of the samples using the appropriate score and rating for each sample.

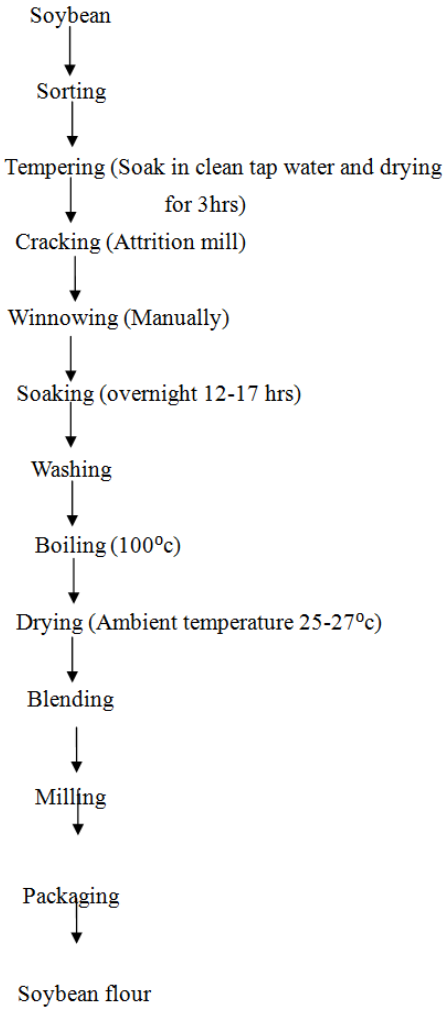


Fig 3. *Flow chart of soya bean flour production (Anuonye, 2006)*

4. Results and Discussions

The results of the proximate composition of the blends is shown in Table 1

The results were indicative that increasing the level of soybean flour in the blends led to significant($P\leq 0.05$) increases in the protein, fat and energy levels of the samples according to established trends(Anuonye *etal* 2010). There was corresponding decrease in carbohydrate levels.

Compared to sole yam meal the results showed that full fat soybean flour addition improved the proximate quality of the yam flour/cassava starch meal by (17.81-54.30%). However the results showed that addition of cassava starch and soybean flour led to significant ($P\leq 0.05$) decreases in the fiber content of the meals at all levels added. This might be due to the breaking down of the native starch profile as shown in figures (2-6).

Table 1. *Proximate Composition of Yam Flour Enriched with Cassava Starch/Soybean blend*

Samples						
Parameter	**A**	**B**	**C**	**D**	**E**	**LSD**
Protein (%)	5.78^{d}	7.00^{d}	8.55^{c}	10.21^{b}	12.67^{a}	1.36
Fat (%)	1.14^{d}	3.49^{c}	4.057^{bc}	4.607^{b}	5.66^{a}	0.83
Moisture (%)	6.10^{a}	5.86^{a}	5.843^{a}	5.553a	6.075^{a}	NS
Ash (%)	0.48^{a}	0.50^{a}	0.510^{a}	0.280^{a}	0.523^{a}	NS
Fiber (%)	1.16^{a}	0.68^{b}	0.68^{b}	0.68^{b}	0.68^{b}	0.30
Carbohydrate (%)	85.32^{a}	82.43^{b}	80.60^{bc}	78.54^{c}	74.40^{d}	2.14
Energy value(kJ/100g)	1591.12^{d}	1649.90^{c}	1665.51^{bc}	1679.20^{ab}	1689.79^{a}	1747.00^{a}

Values in the same column followed by the same superscript are not significantly different ($P\geq 0.05$). KEY: A = 100%Yam flour B = 90: 10 Yam/Soybean C = 85: 15 Yam/Soybean D = 80: 20 Yam/Soybean E = 70: 30 Yam/Soybean

The mineral composition of the blends compared to 100% yam flour meal is shown in Table 2. There was no particular trend for the micronutrient results. Though phosphorus, potassium and sodium increased but not significantly ($P\geq 0.05$) calcium and magnesium recorded non-Significant ($P\geq 0.05$) dilutions. Anuonye *etal* (2010), Salunkhe, (1992) have reported that similar meal fortified with full fat soybean flour did not record significant mineral increases. However the results obtained in the present study agreed with earlier results of obatolu (2002) Iwe (2003).

Table 2. *Mineral Composition of Yam Flour/Cassava Starch Flour Enriched with Soybean flour*

Samples						
Parameter	**A**	**B**	**C**	**D**	**E**	**LSD**
P (mg/100g)	0.31	0.32	0.32	0.92	0.35	NS
Na (mg/100g)	0.28	0.31	0.47	0.45	0.35	NS
K (mg/100g)	0.38	0.41	0.42	0.47	0.42	NS
Ca (mg/100g)	0.34	0.37	0.31	0.30	0.30	NS
Mg (mg/100g)	0.37	0.28	0.14	0.22	0.19	NS

Values in the same column followed by the same superscript are not significantly different ($P\geq 0.05$). KEY: A = 100%Yam flour B = 90: 10 Yam/Soybean C = 85 : 15 Yam/Soybean D = 80 : 20 Yam/Soybean E = 70 : 30 Yam/Soybean

The results of the pasting profile of the fortified meals are shown in Table 3. The pasting characteristics of yam flour and cassava starch meal (viscogramme A) showed that the meal had intermediate peak and final viscosities when compared to conventional pounded yam meal which have been reported by Saad (2014) to have a peak viscosity of 507.80 and a final viscosity of 189.30 RVU. The significant decrease in peak viscosity and final viscosity is attributable to the destructured pattern of its starch components during processing (drying and milling into flour).

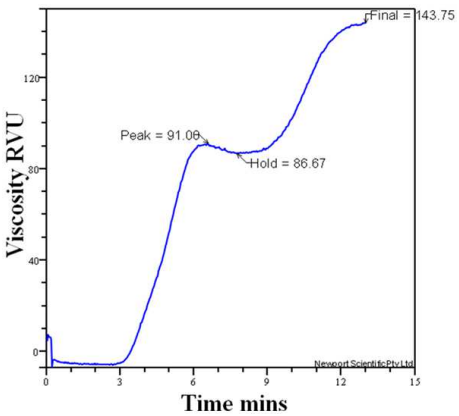
When yam flour/cassava starch was fortified with soybean flour, (viscogramme B-D) there was a reduction in the pasting profile at all levels of addition. This was expected as earlier reported by Anuonye *etal* (2010) and Jideani *etal* (1996). According to these reports addition of soybean flour to cereal meals resulted in significant lowering of all pasting parameters. This was explained by Vickie and Elizabeth, (2008) is as result of the modification of the starch profile of the meals by protein from soybean flour incorporation.

Trough is the minimum viscosity value in the constant temperature phase of the RVA profile and measures the ability of paste to withstand breakdown during cooling. Babajide and Olowe (2013) recorded a higher trough value (108.92RVU-201.46 RVU) in water yam/ cassava starch blends. Lower trough values recorded in this present studies are attributable to the soybean flour added. Otegbayo *et al*., (2006) reported that final viscosity is an indication of whether the starch material forms a gel or a paste on cooling and indicates stress of cooked paste. Values obtained in this present study were significantly lower compared to the figures (369.92RVU-230.58RVU) reported by Babajide and Olowe (2013). The results for pasting temperature showed that addition of soybean flour at all the levels tested did not significantly affect the pasting temperature of the samples. This was in tandem with the peak time or cooking time of the samples which also was not significantly different (P≥0.05). The results were indicative that all the samples would cook within 7 minutes.

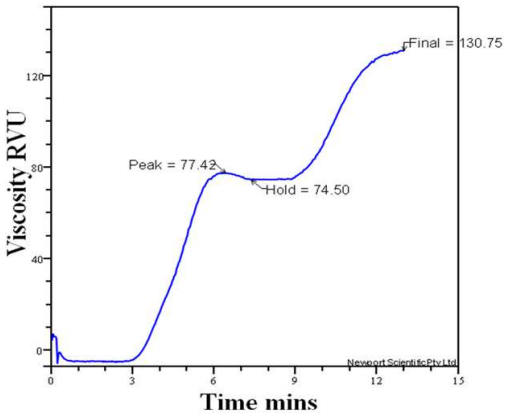
Table 3. *Pasting characteristics of Yam Flour /Cassava starch Flour enriched with Soybean Flour*

Treatment					
	A	**B**	**C**	**D**	**E**
Peak Vis	90.83[a]	90.21[a]	77.55[bc]	74.80[b]	60.92[c]
Trough	89.16[a]	80.84[a]	74.50[b]	70.46[bc]	58.67[c]
Breakdown	10.66[a]	2.25[b]	3.05[b]	3.54[b]	4.38[b]
Final Vis	142.96 [a]	140.13[a]	129.63 [ab]	126.29[b]	116.42[b]
Setback	60.79[a]	56.29[b]	55.13[b]	55.84[b]	57.50[b]
Peak time	6.96[a]	6.44[a]	6.44[a]	6.52[a]	6.36[a]
Pasting Temp.	61.85[a]	61.65[a]	62.05[a]	61.70[a]	61.25[a]

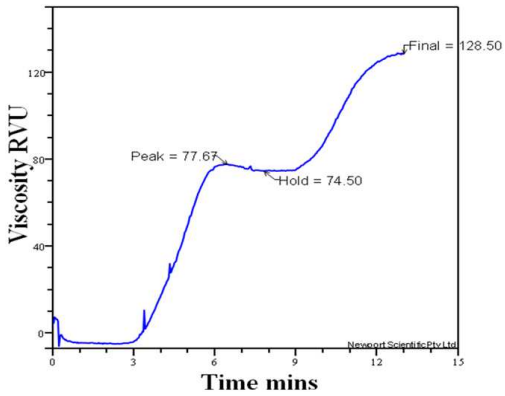
Values in the same column followed by the same superscript are not significantly different (P≥0.05). KEY: A = 100%Yam flour B = 90 : 10 Yam/Soybean C = 85 : 15 Yam/Soybean D = 80 : 20 Yam/Soybean E = 70 : 30 Yam/Soybean



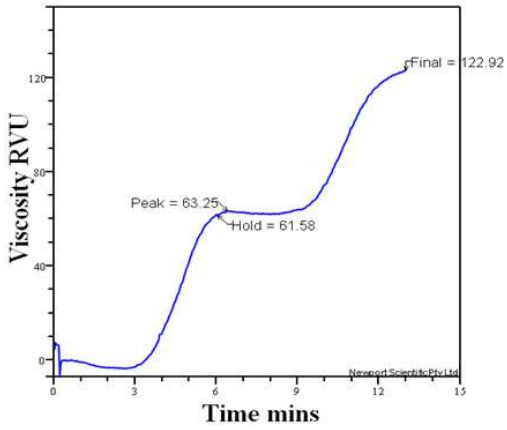
Viscogramme of yam/cassava flour blend (A)



Viscogramme of Blend+10% soybean flour (B)



Viscogramme Blend+20% soybean flour (C)



Viscogramme Blend+30 soybean flour (flour (D)

The results of the acceptability of the yamflour/cassava starch meals enriched with soybean flour is presented in Table 4. There were no significant differences (p≥0.05) in the taste perception of the samples. The results however showed that the moldability (a measure of the textural stability) of the samples ranged from ranged from 70-80%. This indicated that soybean flour addition at all levels did not create obvious textural problems for the meals. The overall acceptability also showed that the meals had between 73-88% acceptability. Though yam flour and cassava starch meal had higher mean scores the results showed that it did not significantly (P≥ 0.05) differ from from the samples fortified with soybeans at 10% levels.

Table 4. *Sensory Characteristics of Pounded Yam Meal Prepared From Yam Flour Enriched with Cassava Starch/Soybean Flour*

Samples						
Parameter	**A**	**B**	**C**	**D**	**E**	**LSD**
Color	8.19^{a}	7.88^{ab}	6.81^{c}	6.94^{bc}	6.69	1.00
Smell	7.81^{a}	7.88^{a}	7.19^{ab}	7.44^{ab}	6.69^{b}	0.93
Texture	8.44^{a}	7.56^{ab}	6.88^{b}	7.25^{b}	7.06^{b}	1.02
Taste	8.00^{a}	7.75^{a}	7.06^{a}	7.50^{a}	7.13^{a}	NS
Mouldability	8.44^{a}	7.69^{ab}	7.06^{b}	7.69^{b}	7.31^{ab}	1.06
Overall acceptability	8.81^{a}	8.63^{a}	7.38^{b}	7.56^{b}	7.44^{b}	0.98

Values in the same column followed by the same superscript are not significantly different ($P \geq 0.05$). KEY: A = 100%Yam flour B = 90 : 10 Yam/Soybean C = 85 : 15 Yam/Soybean D = 80 : 20 Yam/Soybean E = 70 : 30 Yam/Soybean

5. Conclusion

The results of this study have shown that substitution of soybean flour in yam flour and cassava starch blends is possible. The proximate and mineral composition was enhanced as a result of soybean flour substitution. The composite meal could help in reducing protein energy and micronutrient deficiency prevalent in developing countries such as Nigeria. It is concluded that yam flour firmed –up with 25% cassava starch could be enriched with full fat soybean flour up to 30% without significant textural and organoleptic challenges.

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