

Impact of Defatted Moringa Seed and Plantain Flours Substitution on the Properties of Trifoliolate Yam Flour

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Abstract

Effect of defatted moringa seed and plantain flours substitution on the properties of trifoliolate yam flour was evaluated. Freshly harvested trifoliolate yam tuber was peeled, soaked in warm water (60 °C) for 12 hrs, washed, sliced and dried. The dried chips were milled and added to plantain and defatted moringa flour at ratio 7:2:1. Proximate, pasting and functional properties of the flours were determined using standard methods. The results showed that substitution of moringa flour to the blend increased the protein content of the flour thereby reducing the carbohydrate composition of the blend. The blend had lower peak viscosity (146.42 RVU), breakdown (34.53 RVU) but had higher final viscosity (187.90 RVU), setback (76.01 RVU) and pasting temperature (68.08 °C). The bulk density of substituted flour was significantly different ($p < 0.05$) from plantain and trifoliolate flours (0.73 g/cm³). Substitution with moringa seed slightly reduced the water absorption capacity (1.80ml H₂O/g) and swelling index of the flour (2.00). Addition of defatted moringa flour into yam flour used for stiff dough production improved the nutritional value of the product and could solve the problem of protein energy malnutrition in the yam zone.

Keywords: Moringa flour, Plantain flour, Stiff dough, Substitution, Trifoliolate yam

INTRODUCTION

Yams belong to the monocotyledonous family *Dioscoreaceae* and genus *Dioscorea*. They are grown for their tubers or storage organs, which may be subterranean or aerial and serve a dual agricultural function as source of food and planting material (Ile *et al.*, 2006). Production of flour from yam tubers is a way of preserving yam tubers in a storable form so as to make it available during the off season thereby reducing storage losses as well as marketing and transportation

costs (Iwuoha, 2004). Yam flour is the major ingredient in making 'amala' largely eaten by ethnic Yorubas of South Western part of Nigeria when reconstituted. It is a traditional thick paste prepared from blanched dried yam flour with a particular texture (Akissoe *et al.* 2006). According to Omuetti and Morton (1996), *amala* primarily contains carbohydrates and as a result does not provide adequate nutrients. Protein energy malnutrition (PEM) is therefore prevalent, particularly among rural women and children in developing

countries where yam serves as the staple food and could be reduced by the availability of cheap, nutritious foods based on simple processes through supplementation (FAO, 1990; Achi, 1999; Awoyale *et al.*, 2010). The supplementation of staple root and tuber-based foods with legumes showed higher protein content and better protein quality and a nutritional value similar to products based on animal protein (Gupta and Kapon, 1980; Awoyale *et al.*, 2010). According to Akingbala *et al.* (1996) and Abiodun and Oladapo (2010) supplementing yam flour with soybean improved the protein contents of the yam flour. Likewise, Achi (1999) observed increase in protein content of yam flour with cowpea substitution. Awoyale *et al.* (2010) also reported an increase in the protein content of amala with addition of distiller's spent grains. Substitution of yam flour with moringa flour had not been widely studied. *Moringa oleifera* is well known for its nutritional and medicinal values by many communities in northern Nigeria (Kawo *et al.*, 2009). *Moringa oleifera* was reported to be a good source of vitamins and amino acids (Olugbemi *et al.*; 2010). In developing countries, moringa has potential to improve nutrition, boost food security, foster rural development and support sustainable land care (National Research Council, 2006). Martin *et al.* (1983) reported poor binding capacity of trifoliate yam flour while Abiodun *et al.* (2010) reported improvement in the textural quality of trifoliate yam with cassava starch substitution. Also, Abulude and Ojediran (2006) observed similar report with

plantain and cassava flour substitution on yam flour. However, this work determined the impact of defatted moringa seed and plantain flours on the properties of trifoliate yam flour.

MATERIALS AND METHODS

Trifoliate yam (*Dioscorea dumetorum*) white cultivar, matured lantain (*Musa parasidiaca*) and moringa seeds (*Moringa oleifera*) were purchased at Oja-Oba market, Osogbo, Osun State, Nigeria.

Production of trifoliate yam flour

The freshly harvested yam tuber was washed, drained and peeled. The peeled tuber was soaked in warm water (60 °C) for 10 min and left in the water for 12 hrs at ambient temperature. The tuber was sliced and dried in the oven 60 °C for 48 hrs. The dried chips were milled into flour with hammer mill and sieved with 600µm sieve size (Abiodun *et al.*, 2013).

Production of plantain flour

Matured green plantain were separated from the bunch, peeled and dried in the oven at 50°C for 72 hrs, milled and packaged.

Production of moringa seed flour

Moringa seeds were removed from the pods and dried. The seeds were milled and soaked in n-hexane for 12 hrs. The n-hexane was removed and the moringa flour was thoroughly dried in hot air oven to remove excess hexane. The trifoliate yam, plantain and moringa flours were added in

ratio 7:2:1 and they were properly mixed together.

Analyses

Proximate analysis was carried out on the samples using AOAC (1990) while the pasting properties were determined using Newport Scientific method. Bulk density was determined using the method of Udensi and Okaka (2000), water absorption capacity and swelling index were done according to Iwuoha (2004). Analyses were carried out in triplicates and the data collected were evaluated for significant differences in their means with Analysis of Variance (ANOVA) ($p \leq 0.05$). Mean separation was carried out using Tukey's as packaged by SPSS 17.0 software.

RESULTS

Proximate compositions of the flours are shown in Table 1. Protein contents of the substituted flour (15.22 %) were significantly different ($p > 0.05$) from plantain and trifoliate yam flour. Plantain flour had higher fat (1.57 %), ash (1.81 %), fibre (2.06 %), moisture (9.39 %) and carbohydrate (79.46 %) contents than trifoliate and substituted flour. Substituted flour had the least carbohydrate (73.77 %) content. The pasting properties of the flours are shown in Table 2.

There were significant differences ($p > 0.05$) in the peak viscosities of the flours. Plantain flour had higher peak value (208.91 RVU) while the substituted flour had the least peak viscosity (146.42 RVU). Table 3 showed the functional properties of

the flours. There were significant differences ($p < 0.05$) in the bulk densities of the flours. The substituted flour had higher bulk density (0.73 g/cm^3) than other flours. Trifoliate yam flour had higher water absorption capacity ($1.92 \text{ ml H}_2\text{O/g}$) and the swelling index (2.21).

DISCUSSION

The protein content (8.65 %) observed in trifoliate yam flour was lower than the reported value. Trifoliate yam flour had been reported to have higher protein contents (9.6 %) than other yam species (Martins *et al.*, 1983). This may be due to the species used, method of analysis and cultural practices adopted during planting of the yam. Protein content (4.72 %) recorded for plantain flour was higher than the reported values (3.2- 3.5 %) (Fagbemi, 1999; Suntharalingam and Ravindran, 1993) but within the values observed for different varieties of banana flours (Da Mota *et al.* (2000).

Moringa seed had been reported to have high protein contents when compared to other legumes. Abiodun *et al.* (2012) observed higher protein (50.80%) content in defatted moringa seed flour. The protein value obtained for the moringa substituted yam flour was higher than the value (10.81 %) of soybean substituted yam flour as reported by Abiodun and Oladapo (2010). Addition of defatted moringa to the blend increased the protein content of the flour. Plantain flour had higher fat, ash, crude fibre, moisture and carbohydrate contents but no significant differences ($p < 0.05$) in

the crude fibre contents of all the flours. Fat contents of trifoliate yam and substituted flour were low when compared to the plantain flour. The storage life of the substituted flour may be elongated owing to low fat content since all fats and fat containing foods are potentially susceptible to oxidative rancidity (Ihekeronye and Ngoddy, 1985). There was reduction in the carbohydrate content of the substituted flour as a result of increase in the protein content of the flour.

Inclusion of moringa seed flour decreased the peak viscosity of the flour. Similar observation was reported when substituting soybean into trifoliate yam flour (Abiodun and Oladapo, 2010). Trifoliate yam flour was significantly different ($p>0.05$) from plantain and substituted flours in holding strength. Substituted flour had lower breakdown value (34.53 RVU) indicating its ability to withstand shear stress during cooking. Substituted flour was significantly different ($p>0.05$) from plantain and trifoliate yam in final viscosity and setback values. The final viscosity value signifies that the substituted flour had higher tendency to form viscous gel after cooking and cooling than the other flours. Set back viscosity indicates gel stability and potential for retrogradation (Eke-Ejiofor and Owuno, 2012). Trifoliate yam flour required more time (4.89 min) to cook at low temperature (49.11°C) than other flour.

Higher bulk density in the substituted flour showed its ability to weigh more than the

other flours during reconstitution. The water absorption capacity and swelling power values of substituted flour were slightly lower than trifoliate yam flour but higher than plantain and moringa flour. High water absorption is desirable in flour because it is an indication of the extent to which protein can be incorporated into food formulation (Balogun and Olatidoye, 2010). It improves yield and give body to the food (Osundahunsi *et al.*, 2003; Malomo *et al.*, 2012). The lower water absorption capacity in moringa seed and plantain flour could be attributed to the quantity of damaged/undamaged starch and the hydrophobic/hydrophilic nature of the protein (Asiedu, 1989; Butt and Batool, 2010). The substituted flour could absorb water and swell more than the plantain flour. Addition of plantain and moringa flour to trifoliate yam flour increased the bulk density but slightly reduced the water absorption capacity and swelling index of the flour.

CONCLUSION

Yam flour had been known to contain mainly carbohydrate which supplies energy to the body. Substitution with *Moringa oleifera* improved the protein composition of the flour used for stiff dough. The pasting and functional properties of the substituted flour compared well with other flours. Therefore, the use of moringa seed flour in flour used for stiff dough (amala) resulted in improved product with high nutritional value.

Table 1: Proximate composition of flour

Sample	Protein (%)	Fat (%)	Ash (%)	Fibre (%)	Moisture (%)	Carbohydrate (%)
Plantain flour	4.72 ±0.22c	1.57±0.10a	1.81± 0.05a	2.06±0.07a	9.39± 0.10a	79.46±0.40a
Trifoliate yam flour	8.65±0.09b	0.42±0.27c	1.23±0.19c	1.67±0.12a	9.11±0.16c	78.92±0.11b
Substituted flour	15.22±0.11a	0.69±0.17b	1.48±0.22b	1.69±0.10a	9.15±0.20b	73.77±0.14c

Table 2: Pasting properties of flours

Sample	Peak viscosity (RVU)	Holding strength (RVU)	Breakdown (RVU)	Final Viscosity (RVU)	Setback (RVU)	Peak time (min)	Pasting temperature (°C)
Plantain flour	208.91±0.37a	102.42±1.89c	104.99±1.64a	144.74±1.97c	42.32±1.08c	3.13±0.01c	65.16±0.54b
Trifoliate yam flour	172.88±0.89b	124.55±0.61a	48.33±0.23b	185.34±0.41b	60.79±0.99b	4.89±0.02a	49.11±0.04c
Substituted flour	146.42±1.23c	111.90±1.10b	34.53±0.13c	187.90±0.61a	76.01±0.49a	4.25±0.10b	68.08±0.02a

Table 3: Functional properties of flours

Samples	Bulk density (g/cm ³)	Water capacity (ml H ₂ O/g)	absorption Swelling index
Plantain	0.65±0.37c	1.57±0.66c	1.57±0.12c
Moringa flour	0.43±0.26d	1.31±0.30d	1.08±0.09d
Trifoliate yam flour	0.68±0.15b	1.92±0.72a	2.21±0.10a
Substituted flour	0.73±0.21a	1.80±0.39b	2.00±0.11b

REFERENCES

- Abiodun O.A., Adegbite, J.A. and Oladipo, T.S. (2010). Effect of cassava starch substitution on the functional and sensory properties of trifoliate yam (*Dioscorea dumetorum*) flour. *African Journal of Food Agriculture Nutrition and Development (AJFAND)*, 10 (7): 2837-2849.
- Abiodun, O.A. and Oladapo, A.S. (2010). Effect of cassava starch and soybean substitution on the properties of trifoliate yam flour. *Journal of Applied Bioscience*, 36: 2340-2345.
- Abiodun, O.A., Adegbite, J.A. and Omolola, A.O (2012). Chemical and Physico-chemical properties of moringa flours and oil. *Global Journal of Science Frontier Research: Biological Sciences*, 12 (5): 12-17.
- Abiodun, O.A., Akinoso, R., Oladapo, A.S and Adepeju, A.B. (2013). Influence of soaking method on the chemical and functional properties of trifoliate yam (*Dioscorea dumetorum*) flours. *Journal of Root Crops*, 39 (1): 84-87
- Abulude, F.O. and Ojeniran, V.O. (2006). Development and quality evaluation of fortified amala. *Acta Sci. Pol. Technol. Aliment.* 5 (2): 127-134
- Achi, O. K. (1999). Quality attributes of fermented yam flour supplemented with processed soy flour. *Plant Foods in Human Nutrition*, 54:151-158.
- Akingbala, J. O., Oguntimein, T. B. and Sobande, A. O. (1996). Physicochemical properties and acceptability of yam flour replaced by soy flour. *Plant Foods in Human Nutrition* 48:73-80.
- Akissoe N, Akissoes C, Hounhouigan J and Nago M (2006) Prediction of the sensory texture of a yam thick paste (amala) using instrumental and physicochemical parameters. *Journal of Texture Studies* 37 (4):393-402
- AOAC (1990). Association of Official Analytical Chemists Official methods of Analysis 15th edition. Washington, DC, USA.
- Asiedu, J.J., 1989. Processing of tropical and subtropical crops. Machnillan Education Publisher Ltd, London and Basingstoke.
- Awoyale W, Maziya-Dixon B, Sanni L and Shittu TA (2010) Nutritional and sensory properties of amala supplemented with distiller's spent grain (DSG). *Journal of Food, Agriculture & Environment* 8 (3&4) : 66 - 70 .
- Balogun, I.O. and Olatidoye, O.P (2010). Functional properties of dehulled and undehulled velvet beans flour (*Mucuna utilis*). *Journal of Biological Sciences and Bioconservation*, 2:1-10
- Butt MS, Batool R (2010). Nutritional and Functional Properties of Some Promising Legumes Protein Isolates. *Pakistan Journal of Nutrition*, 9(4): 373-379
- Da Mota, R.V., Lajolo, F.M., Cordenunsi, B.R. and Ciacco, C. (2000) Composition and Functional Properties of Banana Flour from Different Varieties. *Starch*, 52(2-3): 63 - 68

- Eke-Ejiofor, J and Owuno, F (2012). Functional and Pasting Properties of Wheat/ Three-leaved Yam(*Dioscorea dumetorum*) composite flour blend. *Global Research Journal of Agricultural and Biological Sciences* 3(4): 330 –335
- Fagbemi, T.N. (1999) Effect of blanching and ripening on functional properties of plantain (*Musa AAB*) flour. *Plant Foods for human Nutrition*, 24 (3): 261-269.
- FAO (1990). Effect of processing on the nutritional value. *Roots, tubers, plaintains and banana in human nutrition*. FAO, United nations, 76 - 78.
- Ihekoronye AI, Ngoddy PO. Integrated Food Science and Technology for the tropics. Macmillian Publisher, London. 1985; 236-358.
- Ile, E.I., Craufurd, P.Q., Battey, N.H. and Asiedu, R. (2006). Phases of dormancy in yam tubers (*Dioscorea rotundata*). *Annals of Botany* 97.4:497-504.
- Iwuoha, C. I. (2004). Comparative evaluation of physicochemical qualities of flours from steam-processed yam tubers. *Journal of Food Chemistry* 85: 541-551.
- Kawo, A.H., Abdullahi, B.A., Gaiya, Z.A., Halilu, A., Dabai, M. and Dakare, M.A. (2009). Preliminary phytochemical screening, proximate and elemental composition of moringa oleifera lam seed powder. *Bayero Journal of Pure and Applied Sciences*, 2(1): 96 - 100
- Malomo O, Ogunmoyela OAB, Adekoyeni OO, Jimoh O, Oluwajoba SO and Sobanwa MO (2012). Rheological and functional properties of soy-poundo yam flour. *International Journal of Food Science Nutrition and Engineering* 2(6): 101-107.
- Martins, G.S., Treche, L., Noubi, T., Agbor, E. and Gwangwa, A. (1983). Introduction of flour from *Dioscorea dumetorum* in a rural area. In: Terry, E.R., Doku, E.V., Arene, O.B. and Mahungu, N.M. (eds), *Tropical Root Crops: Production and uses in Africa*. Proceeding of the Second Triennial Symposium of the International Society for Tropical Root Crops Africa, Doaula, Cameroon. Pp161-163
- National Research Council (2006). *Moringa. Lost crops of Africa; Volume II: Vegetables*. National Academies Press. P 247.
- Olugbemi, T.S, Mutayoba, S.K. and Lekule, F.P. (2010). Effect of Moringa (*Moringa oleifera*) Inclusion in Cassava based diets to broiler chickens. *International Journal of Poultry Science* 9 (4): 363-367.
- Omuetti, O. and Morton, I. D. (1996). Development by extrusion of soybean snack sticks, a nutritionally improved soya-maize product based on the Nigeria snack (*kokoro*). *International Journal Food Science and Nutrition* 47:5-13.
- Osundahunsi OF, Fagbemi, TN, Kesselman E and Shimoni, E (2003). Comparison of the physicchemical properties and pasting characteristics of flour and starch from red and white sweet potato cultivars. *Journal Agriculture and Food Chemistry* 5: 2232-2236

- Gupta, Y. P. and Kapon, A. C. (1980). Chemical evaluation of protein quality of various grain legumes. *Indian Journal of Agricultural Science* 50:393-398.
- Suntharalingam S and Ravindran G. (1993). Physical and biochemical properties of green banana flour. *Plant Foods for Human Nutrition*, 43(1): 19-27.
- Udensi, E.A. and Okaka, J.C. (2000). Predicting the effect of blanching, drying temperature and particle size profile on the dispersibility of cowpea flour. *Nigerian Food Journal*, 18:25-31.