PJN

ISSN 1680-5194

PAKISTAN JOURNAL OF NUTRITION

ANSInet

308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Mob: +92 300 3008585, Fax: +92 41 8815544

E-mail: editorpjn@gmail.com

Pakistan Journal of Nutrition 10 (2): 124-128, 2011
ISSN 1680-5194

Evaluation of the Proximate, Pasting and Sensory Characteristics of Cassava Flour (*Fufu*) Fortified with Pigeon Pea Flour

S.S. Akoja and A.O. Mohammed
Department of Food Technology, The Federal Polytechnic, P.M.B. 50, Ilaro, Nigeria

Abstract: The nutritious value of Fufu-fermented cassava flour was improved through supplementation with 10, 20, 30 and 40% pigeon pea flour and the products were subjected to proximate composition, pasting characteristics and sensory tests, with 100% cassava flour as control. The results showed that the pigeon pea Fufu flour contained 7.70% protein, 0.27% fat, 1.08% ash at 10% level of inclusion and this increased to 16.45, 0.54 and 1.24% for protein, fat and ash respectively at 40% level of inclusion. Meanwhile, the carbohydrate contents decreased from 90.28 to 80.81% at 10% and 40% inclusion of pigeon pea flour respectively. Pasting characteristic decreased with increased pigeon pea inclusion. Peak viscosity decreased from 341.92 to 219.80 (RVU) final viscosity from 301.71 to 191.00 (RVU), setback value from 82.29 to 58.21 (RVU) likewise the peak time from 4.93 to 4.33 min at 10% and 40% level of inclusion of pigeon pea respectively. There was a slight significant difference in overall acceptability between 10% level of inclusion and the control (100% cassava flour).

Key words: Fufu, pigeon pea flour, pasting characteristics and sensory evaluation

INTRODUCTION

Cassava *(Manihot esculetus Crantz)* is a root crop cultivated and consumed as a staple in many regions of the developing countries (Grace, 1977). Cassava plays a food security role in areas prone to drought, famine and in periods of strives and civil disturbance. The crop's ability to provide a staple food base is a function of its flexibility in terms of planting and harvesting strategies and because of its relative tolerance of poor solids and pest/disease problems (Adebowale, 2005). Cassava is a major source of dietary energy for low-income consumers in many parts of tropical Africa, including major urban areas (Berry, 1993; Dahniya *et al*., 1994; Nweke, 1994a,b). However, the utilization of cassava is limited by its extremely low protein content and so the consumption of its products has been implicated in malnutrition. The low protein intake in Africa has been attributed to the increasing high cost of traditional sources of animal protein (Osho, 2003). Legumes are some of the low-priced sources of protein-rich foods that have been important in alleviating protein malnutrition (Aykroyd *et al*., 1992). Accordingly the compositional evaluations of leguminous seeds such as soybean, cowpea, groundnut, pigeon pea, chicken pea and red gram have been carried out in different locations by many investigators (Ologhobo and Fetuga, 1982; 1984; Oloyo, 2002). Cultivation of pigeon peas which has started as far back as 3000 years ago, are now widely cultivated in all tropical and semi-tropical regions of both the old and the new world. It is a source of quality and inexpensive protein of about 14-28.9% and an excellent source of Vitamin B (Pushpamma, 1975). Therefore, Pigeon pea as one of the ideal source for protein supplementation of starchy foods has been proposed. The work reported here was aimed at determining the effect of different levels of pigeon pea flour substitution on the proximate, sensory and pasting characteristics of the pigeon pea-fufu dough.

MATERIALS AND METHODS

Matured and healthy cassava roots were obtained from a local farm in the outskirt of Ilaro while pigeon peas (*Cajanus cajan*) were purchased from Abeokuta main market in Ogun State.

Processing method: The cassava roots were sorted and cleaned to remove dirt and soils. The following steps were adopted in the production of fufu: manual peeling of cassava roots, washing, soaking, sieving, sedimentation, decantation, drying and milling (Fig. 1).

Pigeon pea flour: The pigeon pea were sorted and handpicked to remove dirt and stones. The pigeon pea seeds were washed and soaked in 0.2% sodium hydrogen carbonate solution at temperature of 29°C for 8 h. The seeds were dehulled, oven dried at a temperature of 60°C for 24 h in an air drought oven. The dried seeds were milled and sieved through a 0.4 mm mesh screen (Fig. 2).
The blends were prepared (homogeneously) and labeled as shown in (Table 1).

Chemical analyses: Triplicate samples of each blend were analyzed for fat, protein (N x 6.25) crude fiber and ash in accordance with the procedures of AOAC (1995).

Corresponding Author: S.S. Akoja, Department of Food Technology, The Federal Polytechnic, P.M.B. 50, Ilaro, Nigeria

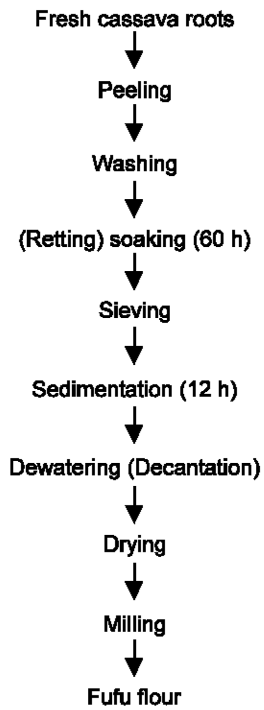

Fig. 1: Production of Fufu

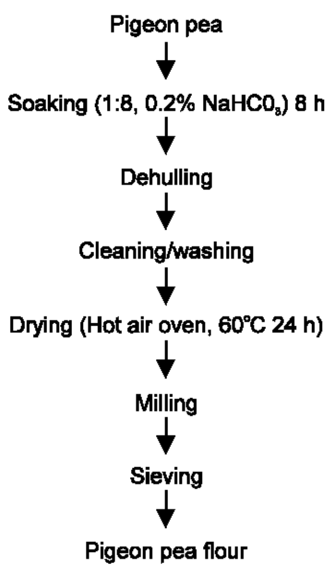

Fig. 2: Production of pigeon pea flour

Total lipids were estimated by petroleum ether extraction. Carbohydrate content was estimated by difference. The total ash was estimated after ashing for 12 h at 550°C.

Pasting characteristics of the flours were evaluated using a Rapid Visco Analyzer (RVA) (Model RVA 30+ Newport Scientific Australia) at the International Institute of Tropical Agriculture, Ibadan. First 2.5 g of samples were weighed into a dried empty canister; then 25 ml of distilled water was dispensed into the canister containing the sample. The solution was thoroughly mixed and the canister was well fitted into the RVA as recommended. The slurry was heated from 50-95°C with a holding time of 2 min followed by cooling to 50°C with 2 min holding time. The rate of heating and cooling were at a constant rate of 11.25°C per min. Peak viscosity; trough, breakdown, final viscosity; set back, peak time and pasting temperature were read from the pasting profile with the aid of thermocline for windows software connected to a computer (Newport Scientific, 1998).

Table 1: Fufu and pigeon pea flour blends

Samples	Fufu (%)	Pigeon pea (%)
FF_0	100	0
PF_0	0	100
FPF_1	90	10
FPF_2	80	20
FPF_3	70	30
FPF_4	60	40

FF = Fufu flour; PF = Pigeon pea; FPF = Fufu-Pigeon pea blend

Sensory evaluation: The sensory evaluation was carried out on the following parameters: appearance, taste, aroma, mouth feel (texture) and overall acceptability by a panel of ten members using a 9-point Hedonic scale. The rating of the samples ranged from 1 (Dislike extremely) to 9 (Like extremely).

Statistical analysis: The statistical significance of the observed differences among the means of triplicate readings of experimental results were evaluated by Analysis of Variance (ANOVA) while means were separated using Duncan's Range Test. These analyses were carried out using SPSS (2001) Package (Version 11.0).

RESULTS AND DISCUSSION

Proximate composition of the samples are shown in Table 2. The results show that the blend FPF_4 (Fufu flour/Pigeon pea flour, 60:40) had the highest protein content while sample FPF_1 (Cassava flour/Pigeon pea, 90:10) has the lowest. There was significant difference ($p \leq 0.05$) in protein content among the blends. The high protein content of the FPF_4 (Fufu flour/Pigeon pea flour 60:40) is due to the level of pigeon pea flour, which contains high protein content. According to Padmaja and Jisha (2005), protein content of the Cassava based composite flours could be elevated through the incorporation of legume flours.

The blend FPF_1 (Fufu flour/Pigeon pea flour 90:10) had the highest carbohydrate content while the blend FPF_4 (Fufu flour/Pigeon Pea flour 60:40) had the lowest. There was significant difference ($p \leq 0.05$) among the blends and the high carbohydrate content of FPF_1 and low carbohydrate content of FPF_4 explains the difference.

There was high content of fat in FPF_4 (Fufu flour/Pigeon pea flour 60:40) followed by FPF_3 (Fufu flour/Pigeon pea

Table 2: Proximate composition (%) of developed supplements

	Proximate composition (%)				
Samples	Protein	Ash	Fat	Fiber	Carbohydrate
FF_0	3.10^a	0.96^a	0.18^a	0.34^a	95.42
FPF_1	7.70^b	1.08^a	0.27^b	0.67^b	90.28
FPF_2	13.65^c	1.13^b	0.39^c	0.79^c	84.04
FPF_3	15.40^d	1.17^b	0.46^d	0.88^d	82.09
FPF_4	16.45^e	1.24^c	0.54^e	0.96^e	80.81

Values are means of triplicates. Mean with similar alphabets are not significantly different from each other at the 5% statistical level (FF_0 = 100% Cassava (Fufu): FPF_1 = 90:10% of Fufu and Pigeon pea: FPF_2 = 80:20% of Fufu and Pigeon pea; FPF_3 = 70: 30% of Fufu and Pigeon pea; FPF_4 = 60:40% of Fufu and Pigeon pea

flour 70:30) and then FPF_2 (Fufu flour/Pigeon pea flour 80:20). There was significant difference among the blends.

The protein content of Fufu increased significantly with the addition of pigeon pea flour. Thus, the proximate composition of pigeon pea-Fufu appears to be dependent on the level of pigeon pea inclusions. The protein was highest in sample FPF_4 of 40% pigeon pea inclusion also the Ash content, fibre and fat. But carbohydrate content is higher in sample FPF_1 at 10% inclusion of pigeon pea flour.

This work confirms earlier report by Fashakin *et al.* (1986) on the beneficial effect of vegetable protein supplementation.

Pasting characteristics: Amylographic studies (Table 3) showed that the Rapid Visco Analyses (RVA) viscosities of the Fufu-pigeon pea flours are generally lower than the FF_0 flour.

The peak viscosity, which is the maximum viscosity developed during or soon after the heating portion. The peak viscosity of FF_0 is 371.75 RVU at a temperature of 75.83°C in 4.33 min. The Fufu-pigeon pea flours had lower values in the range of 219.80-341.92 RVU. This suggests that the presence and interaction of components like fats and protein (from pigeon pea) with starch lowers its peak viscosity (Egouletey and Aworh, 1991) and Karlson and Svanberg (1982). High peak viscosity reflects fragibility of the swollen granules, which first swell and then break down under the continuous mixing of the Rapid Visco Analyzer.

The apparent gelatinization (pasting) temperature of FF_0 flour was 75.83°C while those of Fufu-pigeon pea flours varied from 77.13-79.55°C. This may be due to the buffering effect of fat (from pigeon pea) on starch which interferes with the gelatinization process (Egouletey and Aworh, 1991). The pasting temperature is one of the pasting properties which provide an indication of the minimum temperature required for sample cooking, energy cost involved and other components stability. It is clear from the results that the control sample FF_0 will cook faster and less energy consumed, thereby saving cost and time compared to other samples because of its lower pasting temperature.

The breakdown viscosity of FF_0 is 209.04 (RVU). The Fufu-pigeon pea flours had lower values in the range of 87.00-122.50 (RVU). Adebowale *et al.* (2005) reported that the higher the breakdown in viscosity, the lower the ability of the sample to withstand heating and shear stress during cooking. Hence sample FPF_4 might be able to withstand heating and shear stress compared to other samples because of its low breakdown value.

The final viscosity ranged from 191.00-338.42 RVU. The control sample FF_0 had the highest (338.42 RVU) final viscosity, while sample FPF_4 had the lowest. Shimels *et al.* (2006) reported that final viscosity is used to indicate the ability of starch to form various paste or gel after cooling and that less stability of starch paste is commonly accompanied with high value of breakdown. This implies that sample FF_0 will be less stable after cooling compared to Fufu-pigeon pea flours blend. The variation in the final viscosity might be due to the simple kinetic effect of cooling on viscosity and the re-association of starch molecules in the samples.

The extent of increase in viscosity on cooling to 50°C reflects the retrogradation tendency of the products. Of the FPF flours studied, FPF_1 had the highest retrogradation tendency 82.28 RVU, followed by FPF_2 (68.59 RVU) and FPF_3 (62.50 RVU) while FPF_4 had the lowest value 58.21 RVU. The increase in the set back value in Fufu-pigeon pea flours maybe due to increased hydrogen bonding during cooling and the high amylose content of the starch of FF (Alais and Linden, 1986). This increased hydrogen honding activity may be due to the hydrothermal treatment and the interaction between the polysaccharide and protein (peptide bonds). This leads

Table 3: Pasting properties of Fufu-pigeon pea flours

	Viscosity (RVU)						
Samples	Viscosity	Trough at 95°C	Breakdown	Final Viscosity	Setback	Peak Time (min)	Pasting Temp(°C)
FF_0	371.77^e	262.71^e	209.04^e	338.421^e	75.71^d	4.33^a	75.83^a
FPF_1	341.92^d	219.42^d	122.50^d	301.71^d	82.29^e	4.93^b	77.13^b
FPF_2	297.09^c	195.20^c	101.80^c	263.80^c	68.59^c	5.07^c	77.13^b
FPF_3	271.38^b	176.96^b	94.42^b	239.46^b	62.50^b	4.67^a	77.50^b
FPF_4	219.80^a	132.79^a	87.00^a	191.00^a	58.21^a	5.27^c	79.53^c

Values are means of triplicate. Mean with similar alphabets are not significantly different from each other at the 5% statistical level

Table 4: Sensory evaluation scores for reconstituted pigeon pea-Fufu flour

Samples	Appearance	Taste	Aroma	Texture	Overall acceptability
FF_0	8.1^c	7.8^c	7.4^c	7.9^c	8.0^c
FPF_1	7.5^{bc}	6.8^{bc}	5.9^{bc}	6.6^{bc}	6.5^b
FPF_2	6.0^{ab}	5.3^b	5.3^b	5.0^a	5.2^a
FPF_3	5.8^a	5.2^b	5.2^b	5.5^{ab}	5.5^{ab}
FPF_4	6.0^{ab}	3.3^a	3.3^a	5.1^a	5.3^a

Means with similar alphabets are not significantly different from each other at the 5% statistical level. (FF_0 = 100% Fufu, FPF_1 = 90:10% of Fufu and Pigeon pea, FPF_2 = 80:20% of Fufu and Pigeon pea, FPF_3 = 70:30% of Fufu and Pigeon pea; FPF_4 = 60:40% of Fufu and Pigeon pea

to the growth of gel micellar regions, hence increase in index of retrogradation (Hodge and Osman, 1971), making entrapped water more prone to expression. Table 4 shows the result of sensory evaluation. It was observed that there was significant difference between the control samples and other pigeon pea-Fufu flours in terms of overall acceptability. The control food sample was rated higher than pigeon pea-Fufu flours. This could be attributed to the fact that panelist have been used to control sample (FF_0). FPF_1 pigeon pea flour supplementation was rated next to the control food sample but there was no significant difference between FPF_3 and FPF_4 in overall acceptability.

Conclusion: This study has shown that the nutritional status of Fufu can be enhanced through Pigeon pea flour supplementation and the developed Pigeon pea Fufu flour were nutritious and can easily be prepared by using simple domestic processing techniques. The developed composite flour can be incorporated into the diet to prevent protein energy malnutrition in the community.

REFERENCES

Adebowale, A.A., 2005. Rheology and Storage Properties of Tapioca. An unpublished Ph.D. Thesis University of Agriculture, Abeokuta, Nigeria.

Adebowale, A.A., L.O. Sanni and S.O. Awonorin, 2005. Effect of texture modifiers on the physicochemical and sensory properties of dried Fufu. Food Sci. Technol. Intl., 1: 373-382.

Alais, C. and G. Linden, 1986. Energy and protein intakes of infants and children from the low income group of Ibadan.

AOAC, 1995. Official methods of analysis. 16th Edn., Arlington VA Association of official Analytical Chemists.

Aykroyd, W.R., J. Doughty and A. Walker, 1992. Legumes in Human Nutrition. FAO Food and Nutrition paper No. 20, Rome, pp: 67-68.

Berry, S.A., 1993. Socio-economic aspect of Cassava cultivation and Use in Africa: Implication for development of appropriate technology. IITA, Ibadan.

Dahniya, M.T., M.O. Akoroda, M.B. Alvarez, P.M. Kalndaneh, J. Ambe-Tumanteh, J.E. Okeke and A. Jalloh, 1994. Development and dissemination of Appropriate Root crops Packages to farmers in Africa: In Afort, F. and S.K. Hahn (Eds.) Proceeding of 9th Symposium of the International Societyy of Tropical Root Crop 20-26 Oct. 1999, Accra, Ghana.

Egouletey, M. and O.C. Aworh, 1991. Production and Physiocochemical properties of tempe-fortified maize based weaning food. In proceedings of seminar on Development of the protein energy foods from grain legumes (Sefe Dedeh S. Ed). University of Lagos, pp: 5-7.

Fashakin, J.B., M.B. Awoyefa and P. Furst, 1986. The Application of protein concentrate from locally available legumes in development of weaning foods. J. Nutr. Sci. Emahrung Swise, 25: 220-227.

Grace, M.R., 1977. Cassava processing. FAO Plant Production and Protection Series.

Hodge, J.E. and E.M. Osman, 1971. Carbohydrates. In O.R. Fenema (Ed) Principle of Food Science (Part I Food Chemistry). Mercel Dekker Publishers, New York, pp: 41-138.

Karlson, A. and U. Svanberg, 1982. Dietary bulk as a limiting factor for nutrient intake in primary school children IV Effect of digestive enzymes on the viscocity of starch based weaning food. J. Trop. Pediatric, 28: 230-235.

Newport Scientific, 1998. Applications manual for the rapid visco-analyzer using thermocline for windows. Newport Scientific pty Ltd. Aust., pp: 2-26.

Nweke, F.I., 1994a. Cassava Distribution in Africa IITA, Ibadan.

Nweke, F.I., 1994b. Farm level practice relevant to Cassava plant protection. Afr. Crop Sci. J., 2: 563 - 582.

Ologhobo, A.D. and B.L. Fetuga, 1982. Chemical composition of Promising Cowpea (*Vigna unigulata*) varieties, Nutr. Re. Internl, 25: 913-919.

Ologhobo, A.D. and B.L. Fetuga, 1984. Biochemical Assessment of some new varities of soybeans Food Chem., 13: 103-115.

Oloyo, R.A., 2002. Processing effects on the chemical composition and nutritional potential of Pigeon pea. La Rivista Italiana Delle Sostanze Grasse, LXXIX: 273-276.

Osho, S.M., 2003. The processing and acceptability of a fortified Cassava based product (garri) with Soybean. Nutr. Food Sci., Vol. 33.

Padmaja, G. and S. Jisha, 2005. Nutritional characteristics of cassava based composite flours J. Root Crops, 31: 40-49.

Pushpamma, P., 1975. Evaluation of nutritional value, cooking quality and consumer, preferences of grain legumes. International Workshop on gran legumes. pp: 213-220. Hyderabad, India In. Crops Res. Inst. Semi and Trop., pp: 350.

Shimels, A.E., M. Meaza and S. Rakshit, 2006. Physico-chemical properties, Pasting Behaviour and Functional characteristics of flour and starches from improved Bean (*Phaseoluus vulgaris* L.). Varieties Grown in East Africa, CIGRE J., 8: 1-18.

SPSS for Windows, 2001. Statistical package for Social Sciences, 11th Edn., Lead Technologies Inc.