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Quality evaluation of cocoyam and fermented plantain composite flour and their cooked paste

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Abstract
Blends of cocoyam and fermented plantain flours in the ratio of 90:10, 80:20 and 50:50 were produced while 100% cocoyam flour served as the control. The samples were analyzed for their proximate, selected functional, mineral and sensory properties using standard methods. Results of the proximate composition showed that the moisture content ranged between 7.00% and 8.50%; ash (4.00-5.00%); crude fibre (1.25%-6.00); fat (6.50%-11.50%); protein (3.50%-6.13%); carbohydrate (67.37%-76.24%) and energy value (370.50-406.50kcal). There was no significant difference in the values for bulk density that ranged from 1.29-1.43g/cm^3. A higher water absorption capacity of 210.00% was obtained from sample with the highest plantain four (50:50) and all the samples gelled between 4.00-8.00. Potassium was the most abundant mineral element determined ranging between 28.90 and 38.30ppm while iron was the least (0.61-0.84ppm). The Na/k ratio of less than 1 (0.39-0.44) was obtained for the flours in this study. Acceptability of cocoyam and fermented plantain flour blends pastes had no significant ($p>0.05$) difference in all the sensory properties (colour, taste, aroma, texture and general acceptability) assessed this study.

Keywords: Flour, fermentation, chemical, sensory, functional

Introduction
Cocoyam ranks third in important after cassava and yam among the root and tuber crops cultivated in Nigeria (FAO, 2005, Okoye 2006) [7, 16]. Cocoyam both xanthosoma sp and colocasia sp is an importance staple food in the plant family, cultivated in south eastern and south western part of Nigeria (Onyenweaku, 2005; Ojiakor *et al*. 2007) [18]. It is a food security crop variously grown by resources poor farmers especially women who often intercrop it with yam, maize, plantain, banana, vegetable (Ikwelle *et al.*, 2003) [9].
Cocoyam is highly medicinal for diabetic patients because it has low starch content, is easily digestible and contains protein more than the other root tubers. The leaves of colocosia esculenta have been shown to be a rich source of folic acid, reboflavin, vitamin A and C, calcium and phosphate. The leaves are consumed because they are rich in protein and vitamins while the roots is rich in carbohydrates and minerals (Duru and Uma, 2002) [3]. Cocoyam is useful cover crop and the corms are ready to harvest in 8-12 months (Uguru, 1996) [25]. The corms and cormels are boiled, baked and tubers are sometimes ground to produce paste for use in stews and soups. Also in southeast Asia cocoyam leaves are consumed as a green vegetable and the stem is either cooked or eaten on its own or together with other dietary staples or pounded into flour (Serem *et al.*, 2008) [21]. The dried peeled corms are grinded to produce flour which is considered to be as palatable as cassava flour but more nutritious (Igbokew, 2004) [8]. Cocoyam is therefore undoubtedly an important food crop in Sub- Saharan Africa (SSA), particularly in Nigeria, Ghana and Cameroon. However, the increasing production in the religion has depended largely on farming more land rather than increasing crop yields.
Plantain (*Musa* spp) is one of the important crops in the tropics. It is estimated that close to seventy million people in west and central Africa derive about 25 of theirs carbohydrates from plantain. Plantain is thus an important source of food energy in the Africa an lowland humid forest zone. About 82% of the crop in Africa is produced in Guinea, Liberia and the democratic republic of congo.it is estimated that west central Africa produce 61 and 21%, respectively (F.A.O 1986) [6]. Preserving plantain fruits in the green state is difficult. A lot of plantain fruit spoil in the hot weather within which it is produced and distributed (Serem *et al.*, 2008) [21]. Plantain production is characterized by a period of abundance and a period of shortage (Sery, 1988) [22].

During the shortage period, there is an increase in the prices and in the period of abundance; prices are very low leading to low incomes for farmers. Plantain fruits comparatively have higher rate of respiration than banana and are highly perishable. At ambient tropical temperatures, plantains have an average market life of 1-10 days. Compared with several weeks for yam (Serem *et al*., 2008) [21].

Pasting properties are functional properties relating to the ability of an item to act in paste like manner (Otegbayo *et al.*, 2006) [20]. Starch granules when heated become hydrated, swell, and are transformed into a paste. The granule structure collapses due to melting of crystallites, unwinding of double helices and breaking of hydrogen bonds. These changes are collectively referred to as starch gelatinization and are accompanied by the loss of characteristics birefringence of intact granules. On cooling, the disaggregated starch chains retrograde gradually into partially ordered structures that differ from those in native granules several products most especially plantain flour is being produced as consumed by local populace.

Hence, objective of the study was to determine the proximate, functional and mineral properties of blends produced from cocoyam and fermented plantain flours at ratio 90:10, 80:20 and 50:50 respectively while 100% cocoyam flour served as the control. Moreover, the sensory properties of Amala produced from the flour blends and the control will be assessed.

Materials and methods

Collection of Materials: The cocoyam and plantain used for this research was sourced from Ajoke market in Oka-Akoko and Emure market in Owo Local government area of Ondo State Nigeria. While the cabinet dryer and other equipment used for this research were from the Department of Food Science and Technology, Rufus Giwa Polytechnics, Owo, Ondo State.

Preparation of Cocoyam and Fermented Plantain Flour: The cocoyam was washed peeled, sliced, weighed and rewashed. The sliced cocoyam was treated with 0.12% sodium metabisulphate solution for 10 minutes, placed in thermo-plastic baskets to drain and then cabinet dried at 60 for 5 days. The drained samples was milled and sieved (1mm pore sized sieves was used) into flour (Enwere, 1998) [5]. Unripe plantain fingers was washed, peeled, sliced, weighed and rewashed. The sliced plantain were soaked in distilled water for 24 hours for fermentation to take place. The fermented plantain was placed in thermo-plastic baskets to drain and then cabinet dried at 60 for 5 days. The dried samples was milled and sieved 1mm pore sized sieves was used into flour (Enwere, 1998) [5].

Flour samples were blended at different proportion of 100% cocoyam flour (A) 90;10 cocoyam and plantain flour (B) 80;20 cocoyam and plantain flour (D) 50:50. This formulation was based on preliminary study carried out on selection of blends with relatively better psysico-chemical properties. All flour samples were then packaged with air tight sample bottles and kept for further analysis.

Proximate Analysis: Protein, fat, crude fibre, moisture and ash were determined by the methods of analysis of the Association of Officials Analytical Chemists (2005) while carbohydrate was determined by difference.

Energy Value: The food energy was obtained using the method of Osborne and Vogt; (2000) [19]. This was calculated by multiply mg the value of crude protein, fat and carbohydrate by factors of 4, 9 and 4 respectively formed the sum of their products and expressed the result in kilo calories.

Mineral Analysis: Samples were dry – ashed according to AOAC (2005) [2]. Aliquots were analyzed for mineral components of potassium, sodium and iron using atomic absorption spectrophotometer (buck, 210 model) while phosphorus was determined calorimetrically (AOAC, 2005) [2].

Functional properties measurement

Water Absorption Capacity: Water absorption of the cocoyam and plantain flour blends were measured by the centrifugation method of AOAC (2005) [2]. The samples (1.0g each) were dispersed in 10ml of distilled water and placed in pre weighed centrifuge tubes. The dispersions were stirred occasionally held for 30mins, followed by centrifugation for 25mins at 3000rpm. The supernatant was decanted, excess moisture was removed by draining for 25mins at 50c and sample was reweighed.

Bulk Density: The bulk density was determined according to the method described by Okaka and Potter (1977) [15]. 50g of sample was weighed and transferred into a measuring cylinder and the volume occupied by the flour was recorded. The cylinder was tapped on the palm for 40 to 50 times and the bulk density was determined by reading the final volume. Bulk density was calculated as.

$$BD = \frac{\text{mass of materials}}{\text{Volume of materials after tapping}}$$

Determined of Least Gelation: The modified procedure of a AOAC (2005) [2]. Was used to determined gelation properties. Appropriate sample suspension of 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8g were prepared in 5ml of distilled water each to make 2 – 20% (w/v) suspensions were heated for one hour in boiling water (bath) followed by test tube were then cooled for one hour. The least gelation concentration was determined as concentration when the sample from the inverted test tube did not fall down or ship.

$$\%\ \text{least gelation} = \frac{\text{weight of sample x 100}}{5\text{(ml) of } H_2O}$$

Oil Absorption Capacity: Oil absorption of the cocoyam and plantain flour blends were measured by the centrifugation method of AOAC (2005) [2]. The samples (1.0g each) were dispersed in 10ml of soybean oil and placed in pre-weighed centrifuge tubes. The dispersions were stirred occasionally, held for 30mins. Followed by centrifugation for 25mins at 3000rpm. The supernatant was decanted excess oil was removed by draining for 25mins at 50c and sample was reweighed.

Sensory Evaluation of Product Simples

A ten- man panelist comprising of staff and student of Rufus Giwa Polytechnic, was used and selection was made on the basis of familiarity with "Amala". The sample were presented to panelist in a randomized order and were evaluated for colour taste, Aroma, Texture and general acceptability on a 7- point hedonic scale.

Statistical Analysis

Data was generated in triplicate and analysis was done one way analysis of variances (ANOVA) of the statistical package for social sciences (SPSS VERSION 100 FOR WINDOWS) and the means were separated using Duncan's multiple Range test.

Results and discussion

Table 1: Proximate Composition of Complementary Flour Blends and control

Properties	100:00	90:10	80:20	50:50
Moisture %	7.00	7.50	8.50	7.50
Ash content %	5.00	4.00	4.50	4.00
Crude fiber %	6.00	1.25	2.75	2.00
Fat %	8.50	11.50	8.00	6.50
Crude protein%	6.13	3.50	4.38	3.76
Carbohydrates %	67.37	72.25	71.87	76.24
Energy (kcal)	370.50	406.50	377.00	378.50

Table 2: Functional Properties of Complementary Flour Blends and Control

Properties	100:00	90:10	80:20	50:50
Bulk density	1.29	1.32	1.43	1.40
Water absorption	140.00	140.00	150.00	210.00
Oil absorption	140.00	130.00	100.00	120.00
Least generation	8.00	8.00	4.00	4.00

Table 3: Mineral Contents of Flour Blends and Control

Mineral	100:00	90:10	80:20	50:50
Sodium (Na)	13:30	14.70	12.80	14.50
Potassium (K)	30.50	35.30	28.90	38.30
Iron (fe)	0.73	0.61	0.74	0.84
Phosphonus (p)	3.01	2.63	2.39	2.94
Na/k	0.44	0.42	0.44	0.39

Table 4: Sensory Properties of Cooked Paste of Flour Blends and Control

Attributes	100:00	90:10	80:20	50:50
Colour	6.00 ± 1.24^a	6.10 ± 0.87^a	6.50 ± 0.53^a	6.00 ± 1.24^a
Taste	6.40 ± 0.69^a	6.10 ± 1.59^a	6.40 ± 0.69^a	6.30 ± 0.99^a
Aroma	6.70 ± 0.48^a	6.80 ± 0.42^a	6.70 ± 0.48^a	6.30 ± 0.675^a
Texture	6.10 ± 1.59^a	5.80 ± 0.63^a	6.60 ± 0.69^a	6.30 ± 0.67^a
General Acceptability	6.50 ± 0.70^a	6.30 ± 1.33^a	6.30 ± 0.94^a	6.50 ± 0.85^a

Values with same superscript in each row are not significantly different ($P>0.05$)
Key: 100:00: Cocoyam Flour, 90:10: Cocoyam Flour with Fermented Unripe Plantain Flour 80:20: Cocoyam Flour With, Fermented Unripe Plantain Flour, 50:50: Cocoyam Flour With, Fermented Unripe Plantain Flour.

Proximate Composition of Flour Samples

The proximate composition of blended flour samples and the control are shown in table 1. The moisture contents of the sample which ranged from 7.00% to 8.50% were generally low and suggested reduced chances of microbial spoilage with increased shelf life if properly packaged (NNAM, 2002) [13]. Cocoyam flour and the blends had moisture contents below 10% which agreed with the level recommended for safe keeping of flour samples (SON, 2007) [23]. Ash content of the blended flour decreased with increasing addition of fermented unripe plantain flour this may be due to the fermentation that has taken place on the plantain. However, these was no significant difference in the value obtained for 90:10 blend ratio and that of 50:50 blend ratio. The protein content of the cocoyam flour was found to be 6.13%; the protein content of water yam flour blends relatively decreased with the addition of fermented unripe plantain flour and reduced from 6.13 to 3.50%. This could be due to low protein content of the unripe plantain pulp as reported in research finding of Ogazi (1996) [14]. Fat content of cocoyam flour and the blend ranged from 6.50 to 11.50.the highest fat content was observed in the flour blends sample 90:10 (11.50%). The low fat content recorded in the samples will extend shelf life by decreasing the chances of rancidity. The fibre content of samples ranged from 1.25 to 6.00%. The control sample CF has the highest fibre content (6.00 %) and the other sample have 1.25%, and 2.00% respectively. The reduction in the unripe plantain all the value were with the range reported by Abiodun *et al*, (2012) [1].

Carbohydrate content for CF and the blends ranged from 67.37 to 76.24%. Flour blended with plantain had higher carbohydrate contents and this is evident in the sample with the highest plantain flour (50:50). The higher carbohydrate value may therefore be attributed to the higher content of the cocoyam and fermented unripe plantain blends (Abiodun *et al*. (2012) [1]. The total energy was 370.50kcal, 406.50kcal, 377.00kcal and 378.50kcal respectively. A low value was observed in total energy of the control sample (CF) which has the lowest energy (370.50kcal); and this may be due to the low carbohydrate content of the sample.

Functional Properties of Flour Samples

Results of functional properties of the composite of ours are shown in table 2. The mean values for blank density of the cocoyam flour and the blended samples that ranged from 1.29-1.43g/cm^3 did not have any significant difference apart from the positive control. However, values obtained were similar to that reported by Udensi and Okaka (2000) [15]. This would imply that the flour samples had similar packaging characteristics since bulk density is directly related to molecular size. Values for water absorption capacity of cocoyam flour was found to be 140.00% and flour blend ratio 90:10. Water absorption of the flour mainly depends upon protein, carbohydrates their interaction and nature (Abiodun *et al*., 2012) [1].

High water absorption capacity indicated loose structure of the polymeric starch molecules while low water absorption showed closeness or compactness of the starch polymers making up the flour samples (Mgbofung *et al*., 2006) [11]. Findings of Mepba *et al*. (2007) [10] submitted that unripe plantain flour had high water absorption capacity. This is obvious in the water absorption capacity of 50:50 flour blends having plantain flower with the highest value of 210%. High water absorption is desirable in flour as it enhances high affinity for water during reconstitution. Least gelation capacity ranged between 4.00-8.00. Gelation is an important property which influence the texture of various kinds of foods such as Amala.

Mineral Contents of Flour Blends

Table 3 presents the mineral contents (ppm) of the flour blends. The most abundant of the minerals was potassium (K) ranging between 28.90ppm and 38.30ppm followed by sodium (Na) and phosphorus (P) with values ranging from 12.80ppm to 14.70ppm and 2.39ppm to 3.01ppm respectively. The least abundant was iron (Fe) having values ranging from 0.61ppm to 0.84ppm. These results were in close agreement with the observation of Olaofe and Sanni (1998) [17].

Iron is required in hemoglobin for transportation of oxygen in human blood, blood detoxification and energy production in cells while phosphorus is an essential mineral primarily used for growth and repair of body cells and tissues including energy production and PH regulations

The ratio of sodium (Na) to potassium (K) (Na/K) in the body is a great concern for prevention of high blood pressure. Na/K ratio of less than one (<1) is recommended (Nieman *et al*., 1992) [12]. The Na/K ratio in this study ranging between 0.39 and 0.44 is an indication that consumption of the products from the flour blends would probably reduce high blood pressure disease.

Mean Sensory Evaluation Scores of Cocoyam and Fermented Plantain Flour Blends Pastes

Table 4 shows the mean sensory scores of pastes produced from the flour blends of cocoyam and fermented plantain. From the results, it was observed that there is no significant difference in all the sensory parameters (colour, taste, aroma, texture and general acceptability) evaluated in this study. The control sample (100.0) was ranked best in terms of aroma and general acceptability with mean scores of 6.40 and 6.50 respectively.

However, among the blends, sample blend (80:20) had the highest mean scores of 6.50 (taste) ; 4.40(aroma) and 6.60 (texture) while sample blend (90:10) had the highest value of 6.80 in terms of colour and sample blend (50:50) was the best accepted sample with the highest mean score of 6.50. The results obtained in the study showed that the panelists will accept any of the samples for consumption since there no significant difference in all the sensory properties assessed.

Conclusion

The present study had shown that the selected flour blends from cocoyam and fermented plantain products are fairly rich in source of potassium, carbohydrate and protein. Also control sample had higher fibre contents while 100.0 and 50:50 had no significant difference. Therefore, rated high in all the attributes and make it good for consumption. Further work should be carried out on the cocoyam and fermented unripe plantain flour blends in the area of microbial analysis, anti-nutrient and vitamins determinations. However, individuals under health management such as the Obese, Diabetes mellitus type among others could benefit more in using the blend in equal ration for amala consumption.

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