ISSN : 0974 - 7508 Volume 10 Issue 2

Natural Products

An Indian Journal

Full Paper

NPAIJ, 10(2), 2014 [37-43]

The effect of different pre-treatments on the functional properties of unripe mature green horn plantain flour (*Musa paradisiaca*)

Olawuni Ijeoma[1,2,3], Charles C.Osobie[1,2,3]*, Anthonia E.Uzoukwu[1,2,3], Onyeneke N.Esther[1,2,3], Nwokenkwo Emilia[1,2,3]

[1]Department of Food Science and Technology, Federal University of Technology, Owerri (FUTO), Imo State (NIGERIA)

[2]Department of Food Science and Technology, Imo State University, Owerri (NIGERIA)

[3]Central Laboratory Service Unit, National Root Crop Research Institute (NRCRI), Umudike, Umuahia, Abia State (NIGERIA)

E-mail: ccharles4@gmail.com

ABSTRACT

Flours were prepared from unripe matured green (horn) plantain subjected to different pre-treatments, and examined for functional properties. The flour samples had moisture content between 8.76-10.88%. The plantain flour pre-treated with citric acid had the highest Water Absorption Capacity and Bulk Density 5.54ml/g and 0.84g/ml respectively while pre-treatment with potassium metabisulphite (F) showed a high Oil Absorption Capacity of 7.36ml/g. The Wettability, Swelling Power and pH had values 1.33-2.33s, 2.07-5.20, and 6.24-6.88 respectively. Blanching increased the pH of the flour, however, no significant difference existed among the different samples ($P<0.05$). A considerable decrease in Swelling Power was observed with flour samples with citric acid (C) and potassium metabiusuphite (D). From the above results, unripe plantain flour had good functional properties and can function well in food systems.

INTRODUCTION

Plantain, cooking banana and banana (Musa species AAB, AAA and ABB group) are important staple crops that contribute to the calories and subsistence economics in Africa. It is one of the oldest cultivated fruits in West and central Africa[9]. The origin of plantain and its introduction to Africa have generated controversy among researchers and taxonomists. Although Simmonds[8] reported Plantain to have originated from south India, De-langhe[2] meted a remarkable diversity to exist in central Africa, thus suggesting plantain to be among the oldest cultivated crop in the region. Plantain is also the common name for herbaceous plant of genus MUSA. The fruit they produce for cooking in contrast to the soft sweet banana which is sometimes referred to as desert (banana). They are consumed both as energy yielding food and as desert, providing more than 200 calories (food energy) a day[13].

In Ghana, Plantian contributes about 13.1% of the Agriculture Gross Domestic products (AGDP) and its per capita annual consumption of 96.4kg per head, it is of great socio-economic and nutritional significance and generates considerable employment. Plantain cultivation is attractive to farmers due to the low labour requirements for production compared with cassava, maize, rice and yam[5]. Annual production in the country is about 1.8metric tones for plantain (AAB subgroup) of which only 0.5 tonnes is exported and 7.9 metric tonnes for banana of which 3.4 metric tones is exported. For production purposes, bunch type and plan size characteristics are used to differentiate between plantain cultivars. In general, the morphology of the bunch is used for classification. These include French

Plantain, French horn Plantain, false horn Plantain and horn Plantain. The plantain cultivar used for this project was fully matured unripe horn plantain composing of the false and true horn plantain. The reason for this choice of raw material being that it is suitable for making flour and that it is the commonest food item in West Africa requiring less man-hour of labour per hectare than cassava, maize and rice[11].

Nutritionally, horn plantain makes significant contribution to the diet in providing carbohydrate, the two main components of starch, amylase and amylopectin are present in a ratio of about 1:5[4]. Protein in unripe pulp is 3.0%, fat content was reported by Ketitu[6] to be 1% in unripe pulp while crude fiber in unripe pulp is 0.5%.

Some of the processed products from horn plantain are plantain flour, plantain fufu, plantain porridge, plantain beer.

The objective of this study therefore was to determine the effect of different pre-treatment on the functional properties of the matured green horn unripe plantain so as to ascertain its potential as ingredient for food products eg. Bakery products.

MATERIAL AND METHOD

Materials

Source of materials

The plantain fingers of the unripe matured plantain bunch in the processing of the plantain flour were purchased from Ihiagwa Owerri, Imo states. The plantain bunches were identified by a farm officer in school of Agriculture Technology, FUTO as Horn plantain.

Chemical and reagents

The chemical reagents of analytical grades used for the analysis of the work were obtained from FST laboratory and the chemicals include: citric acid and potassium metabisulphite.

Equipments used

The equipments used were obtained from the department of Food Science FUTO. They include: stainless steel kitchen knives, big bowls for washing, oven, measuring cylinder, slicer, blancher, trays.

Production of plantain flour

About thirty-four (34) good piece of wholesome unripe horn (green) plantain were selected from the bunch, thoroughly washed to remove sand and dirt, to remove spray (chemical) residues and also to reduce microbial load.

Peeling

The plantains were peeled to remove the plantain peels.

Slicing

The unripe plantain was sliced to 2mm, thickness using a slicing machine.

Methods

Preparation of the process reagents

Preparation of citric acid solution

Three grammes (3g) of citric acid was dissolved in 500ml of distilled water to form a solution.

Preparation of potassium metabisulphite

Five grammes of potassium metabisulphite was dissolved in 500ml of distilled water to form a solution.

Per-treatment

The pre-treatment given to these unripe (green) plantains includes

- Blanching
- Citric Acid
- Citric Acid and Blanching
- Potassium Metabisulphite
- Potassium Metabisulphite and Blanching

Generation of samples

The bunch of unripe mature plantain was harvested and the same day the fingers were separated from the bunch, washed and peeled. After peeling, the plantain pulps were sliced to 2mm, thickness. Five hundred grams of the sliced plantain was soaked in a solution containing 5g of potassium metabisulphite in 500ml of water. It was allowed to stay for five minutes before draining off.

Five hundred grams of sliced plantain was soaked in a solution containing three grammes of citric acid in 500ml of water for three minutes before draining off. Five hundred grammes of the sliced plantain was blanched for three minutes.

Two hundred and fifty grammes of sliced of plantain was blanched for five minutes and another two hundred and fifty was soaked in a solution containing five grammes of citric acid in 500ml of water for three minutes, it was drained and the both were added together.

Two hundred and fifty grammes of sliced plantain was blanched for five minutes and another two hundred and fifty was soaked in a solution containing five grammes of potassium metabisulphite in 500ml of water for five minutes. It was drained and the both were added together.

Another five hundred grammes of sliced plantain was removed as a control.

All these samples were oven dried as a temperature 60°C then milled into flour using milling machine. After milling the flour was packaged in air tight moisture-proof containers and stored at (27°C).

Determination of moisture content

The dish was washed and dried in an oven at 100°C for 10mins.

The dish was weighed and its weight noted. Then two grammes of the sample was weighed into the dish and placed in the oven at 105°c for one hour. After, the sample was removed from the oven, cooled in a desicator and weighed. The sample was returned to the oven and dried at intervals, cooled and weighed until a constant weight was obtained.

The percentage moisture was then calculated as follows

$$\% \text{ Moisture Content} = \frac{W1-W2}{W1-W} \times 100\%$$

W1 = Mass of container + sample before drying; W2 = Mass of container + sample after drying; W = Mass of container.

BULK DEN ITY DETRMINATION

Fifty grammes (50) of each sample were weighed into 100ml of measuring cylinder. The measuring cylinder was tapped continuously and the bulk density calculated thus: Bulk density =Mass of sample/volume at the end of tapping)

Wettabilty

One gramme of sample was added into a 25ml graduated cylinder with a diameter of 1cm. placing a finger over the open end of the cylinder invert and clamp at a height of 10cm from the surface of a 600ml beaker containing 500ml of distilled water. The finger was removed to allow the test material to be dumped. The wettability is the time required for the sample to become completely wet.

Determination

A 10% (m/v, dmb) suspension was prepared from the sample and allowed to settle at room temperature (27°C) for fifteen minutes while the pH electrode was switched on and allowed to stabilize chemically with buffer solution of pH 7, pH 4 and pH 9. The electrode was then inserted into the test dispersion and pH values for freshly prepared, process media as well as plain water were determined.

Swelling index determination

Three grammes (3g) portion of each dry sample was transferred into clean graduated (50ml) cylinders. The samples were gently leveled and the volume noted.

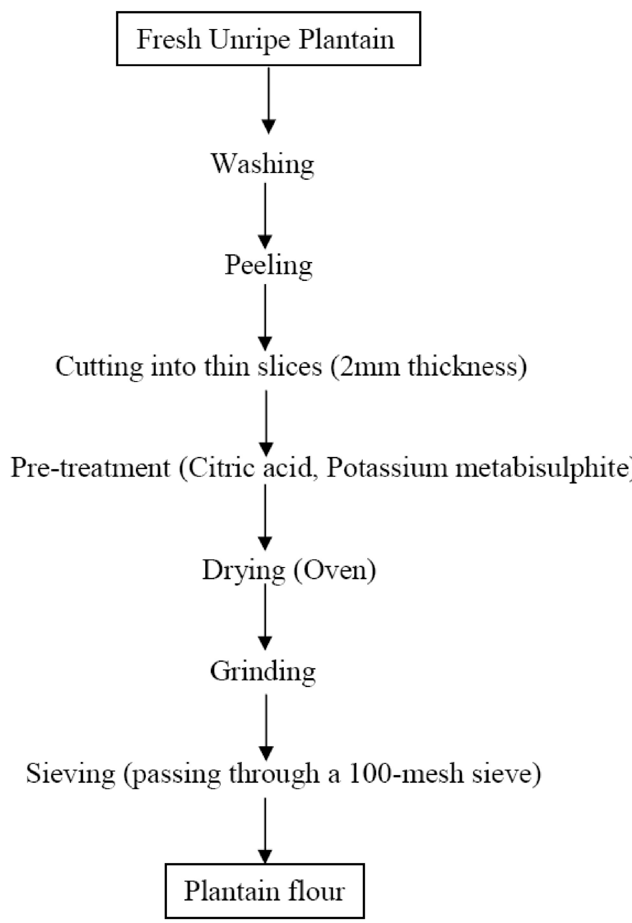

Figure 1 : Flow diagram for the production of plantain flour used for the analysis

30ml of plain water was added to each sample; the cylinder was swirled and allowed to stand for 60 minutes while the change in volume (swelling) was recorded every 15mins. The swelling power of each sample was calculated.

WATER ABSORPTION CAPACITY

Determination

The procedure described by Onwuka[3] was as follows:

One gramme of flour sample was weighed into a conical graduated centrifuge tube with a wiring whirl mixer. The sample was mixed thoroughly with 10ml distilled water for 30 seconds.

The sample was allowed to stand for 30minutes at room temperature and then centrifuged at 5000rpm for 30 minutes. The volume of free water (the supernatant) was read directly from the graduated centrifuge tube.

The amount of water absorbed (total minus free) was multiplied by its density for conversion to grammes.

OIL ABSORPTION CAPACITY DETERMINATION

The procedure described by Onwuka[3] was as followed:

One gramme of flour sample was weighed into a conical graduated centrifuge tube with a wiring whirl mixer. The sample was mixed thoroughly with 10ml oil for 30 seconds.

The sample was allowed to stand for 30 minutes at room temperature and then centrifuged at 5000rpm for 30 minutes. The volume of free oil (supernatant) was read directly from the graduated centrifuge tube.

The amount of oil absorbed (total minus free) was multiplied by its density for conversion to grammes.

Gelation

The flour sample (10g, dmb) was dispersed in distilled water in a 250ml beaker and made up to 100ml flour suspension. A thermometer was clamped on a retort stand with its bulb submerged in the suspension with a magnetic stirrer and the system heated and stirring continued until the suspension began to gel and the corresponding temperature was recorded. The temperature at boiling point was also recorded.

RESULTS AND DISCUSSION

TABLE 1 summarized the functional properties of the plantain flours. The moisture content of the flours obtained by oven drying showed sample F having the lowest moisture content of 8.75% while sample A had highest 10.88%. There values are acceptable for established goal, to reach a stable shelf life (<20.0% moisture) and agree with those previously reported[1,7,12]. The pH valves ranged from 6.24 to 6.88 and these values were in agreement with those of Pacheco et al.[10] who reported valves of 4.6-6.10 for plantain flours dried using four dehydration methods including oven drying. The flours had bulk densities ranging from 0.680 g/ml to 0.84 g/ml. sample B (blanching) showed that the lowest bulk density while a (control) had the highest bulk density. The results obtained were in agreement with that of Fagbemi[14] who reported unripe plantain flour bulk densities between 0.42-0.72 g/ml. The treatments given to the

TABLE 1 : Functional properties of unripe horn plantain given different pre – treatment

Sample	OAC	WAC	pH	SP	WET	BD	MOISTURE
A	$5.8060.04^{e}$	$3.7560.03^{f}$	6.5860.03	$3.7960.02^{c}$	1.3360.58	$0.7960.04^{a}$	$10.7660.04^{b}$
B	$5.8760.05^{e}$	$5.0660.05^{c}$	6.8860.04	$3.4460.02^{d}$	1.3360.58	$0.6660.03^{b}$	$10.8860.03^{a}$
C	$7.2560.03^{b}$	$5.5460.05^{a}$	6.4460.05	$2.0760.03^{f}$	1.3360.58	$0.8460.04^{a}$	$9.8860.03^{c}$
D	$7.3660.03^{a}$	$5.2560.03^{b}$	6.2461.12	$2.1460.04^{e}$	1.3360.58	$0.7660.05^{a}$	$9.1560.05^{e}$
E	$6.3260.03^{d}$	$4.0560.04^{e}$	6.5260.03	$5.2060.02^{a}$	2.3360.58	$0.7960.03^{a}$	$9.6460.06^{d}$
F	$6.9260.01^{c}$	$4.7360.04^{d}$	6.2860.02	$5.1160.02^{b}$	2.3360.58	$0.7660.03^{a}$	$8.7660.03^{f}$

Note : OAC - OIL ABORSORBING CAPACITIES; WAC- WATER ABSORPTION CAPACITIES; SP - SWELLING POWER; WET- WETTABILITY; BD - BULK DENSITY SAMPLES; A- Control; B- Blanching; C- Citric acid; D - Potassium metabisulphite; E - Blanching and Citric acid; F - Blanching and Potassium metabisulphite

TABLE 2 : Gelation capacities of unripe plantain flour in water at different concentration

Concentration g/100m	G C in H_2O
2	No gel
4	No gel
6	strong gel
8	strong gel
10	strong gel
12	strong gel
14	strong gel
16	strong gel
18	strong gel
20	strong gel

flour unripe plantain before conversion to flour increased the oil and water absorption capacities when compared to the control sample (A). This result obtained was in agreement with values obtained by Fagbemi[14] who reported that blanching considerably increased water and oil absorption capacities of unripe plantain flour. The swelling index showed sample (E) having the highest swelling power while sample (B) had the lowest value of 2.07. The unripe plantain flours had good swelling capacities which were in accordance with the range of values for flour samples.

In wettability, the time taken for the last particle of the sample to get wet was one to two seconds. This

Appendix 1

TABLE 3 : Way anova for named test parameter

Source of Variation	Sum of Squares (SS)	Degree of Freedom (DF)	Means Square (MS)	Variance ratio calculated (Fcal)	Variance ratio tabulated (Ftab) at p=0.05
Among Columns	SSC	(K-1)	MSC= SSC/ (K-1)	Fc=MSC /MSE	F= {K-1}, K(r-1)
Error (Within)	SSE	(K-1) (r-1)	MSE=SSE/ [(K-1) (r-1)]		
Total	SST	(n-1)			

Appendix 2

TABLE 4 : Anova for water absorption

Source of Variation	Sum of Squares (SS)	Degree of freedom (DF)	Means Square (MS)	Variance ratio Calculated (Fcal)	Variance ratio tabulated (Ftab) at p= 0.05	Remark
Among Columns	7.0737	5	1.4147	1430.64	3.11	Highly Significant
Error (Within)	0.0119	12	0.001			
Total	7.0856	17				

Appendix 3

TABLE 5 : Anova for oil absorption

Source of Variation	Sum of squares (SS)	Degree of freedom (DF)	Means Square (MS)	Variance ratio Calculated (Fcal)	Variance ratio tabulated (Ftab) at p=0.05	Remark
Among Columns	7.3839	5	1.4768	843.87	3.11	Highly Significant
Error (Within)	0.021	12	0.0018			
Total	7.4049	17				

showed that unripe plantain flour can be referred to as instant powder. Colour is an important physical parameter in flour quality.

Flour obtained from different pre-treatment showing, samples A, B, C and D having a light cream colour whereas E and F having a light yellow colour.

The least concentration of liquid of the dehulled plantain flours was 6-8 (g/100ml) according to TABLE 2. The value for the gelation capacity showed that plantain flours can be used in food formulation which re-

Full Paper

Appendix 4

TABLE 6 : Anova for wettability

Source of Variation	Sum of squares (SS)	Degree of freedom (DF)	Means Square (MS)	Variance ratio Calculated (Fcal)	Variance ratio tabulated (Ftab) at p= 0.05	Remark
Among Columns	4	5	0.80	2.4	3.11	Not Significant
Error	4	12	0.33			
Total	8	17				

Appendix 5

TABLE 7 : Anova for swelling power

Source of Variation	Sum of Squares (SS)	Degree of Freedom (DF)	Means Square (MS)	Variance ratio calculated (Fcal)	Variance ratio tabulated (Ftab) at p= 0.05	Remark
Among Columns	27.9656	5	5.5931	10169.32	3.11	Highly significant
Error	0.0066	12	0.0006			
Total	27.9722	17				

Appendix 6

TABLE 8 : Anova for pH

Source of Variation	Sum of squares (SS)	Degree of freedom (DF)	Means Square (MS)	Variance ratio calculated (Fcal)	Variance ratio tabulated (Ftab) at p= 0.05	Remark
Among Columns	0.5833	2.76	3.11	2.91655	0.2111	Not Significant
Error	2.5335	12				
Total	5.4410	17				

Appendix 7

TABLE 9 : Anova for bulk density

Source of Variation	Sum of squares (SS)	Degree of freedom (DF)	Means Square (MS)	Variance ratio calculated (Fcal)	Variance ratio tabulated (Ftab) at p= 0.05	Remark
Among Columns	0.0497	5	0.0010	7.72	3.11	Significant
Error	0.0155	12	0.0013			
Total	0.0652	17				

Appendix 8

TABLE 10 : Anova for moisture

Source of Variation	Sum of squares (SS)	Degree of freedom (DF)	Means Square (MS)	Variance ratio Calculated (Fcal)	Variance ratio tabulated (Ftab) at p= 0.05	Remark
Among Columns	10.8176	5	2.1635	1410.10	3.11	Highly Significant
Error	0.0184	12	0.0015			
Total	10.8360	17				

quire thickening.

CONCLUSION

The result obtained showed that the functional properties of the flours were affected by the different pretreatments. Heat treatment (blanching) increased the bulk density of plantain flour. Blanching also improve the Water and Oil Absorption Capacities. From the appreciable results obtained, it was concluded that green unripe matured plantain flour given different pre-treatments had good functionalities and so cultivation and application in food systems could be encouraged.

REFERENCES

[1] B.Daramola, S.A.Osanyinlusi; Production, Characterization and Application of Banana (*Musa Spp.*) Flour in Whole Maize. Afr.J.Biotechnol, **5**, 992-995 **(2006)**.

[2] E.De-Langhe; The Origin of Variation in the Plantain Banana. Meded Land Boow Hoge School, Kent, 44-45 **(1964)**.

[3] G.I.Onwuka; Food Analysis and Instrumentation. Naphthali Print, Lagos, Nigeria, 133-137 **(2005)**.

[4] H.T.Montcel; Basic Concept in Plantain Banana. Macmillan Publishers Ltd, London and Basing Stoke, 39-100 **(1987)**.

[5] J.Marriott, P.A.Lancaster; Banana and Plantain. Hand Book of Tropical Fruits.T.C.Harvey Jr. Marcel Dekker, Inc. (Ed), 85-142 **(1983)**.

[6] Ketiku; Composition of some Tropical Crops. J.Sci.Food and Agric., **24**, 703-706 **(1973)**.

[7] K Kayisu, I.F.Hood, P.J.Vansoest; Characterization of Starch and Fibre of Banana Fruits. J.Food Sci., **46**, 1885-1890 **(1981)**.

[8] N.Simmonds; Banana, 2nd Edition. Tropical Agriculture Syracuse. Longman Group Ltd. U.K., London, **(1966)**.

[9] O.P.Ogazi; Plantain: Production Processing and Utilization. Paman and Associates Ltd., Nigeria, **(1996)**.

[10] Pacheco, E.Delahaye; Nutritional Evaluation of Green Plantain (*Musa spp*) Chips and its Starch Digestibility. Rev.Fac.De Agron., **28**, 175-183 **(2002)**.

[11] P.Devos, G.F.Wilson, E.De-Langhe; Plantain Genetic Resources and Potential in Africa: Crop Genetic resources in Africa: Institute of Tropical Agriculture, Ibadan, Nigeria, **(1980)**.

[12] P.N.Gwanfogbe, J.B.Cherry, J.G.Simmons, C.James; Functionality and Nutritive Value of Composite Plantain (*Musa paradisiaca*) Fruit and Glandless Cotton Seed Flours. Tropic.Sci., **28**, 51-66 **(1988)**.

[13] R.H.Stover, N.W.Simmonds; The Eumusa Series of Cultivars. Longman Group Ltd. U.K., 125–126 **(1987)**.

[14] T.N.Fagbemi; Effect of Blanching and Ripening on Functional Properties of Plantain (*Musa AAB*) Flour. Plant Foods Hum.Nutr., **54(3)**, 261-269 **(1999)**.