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The Functional Properties of Plantain (*Musa sp*) Flour and Sensory Properties of Bread from Wheat – Plantain Flour as Influenced by Blanching Treatments

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ABSTRACT---- ***The effect of blanching treatments on the functional properties of plantain flour and sensory characteristics of bread made from wheat (80%) and plantain (20%) flour was investigated. The plantain flour was produced using different blanching treatments; blanching with ash infusion (A), blanching in hot water with peel (B), blanching in hot water without peel (C) and unblanched plantain (D). The functional properties analysis revealed that the pH of all the samples were significantly (p<0.05) different; sample C had the highest (6.15) pH value while sample D had lowest (5.48). The emulsion capacity (EC) of sample D was highest (2.78) while sample A had the least EC (1.89) and they were significantly (p<0.05) different. The oil absorption capacity (OAC) and water absorption capacity (WAC) ranged between (1.74 – 1.83) and (2.39 – 2.99) respectively. Samples B and C had the same OAC (1.47) and WAC (2.99). Sample C had the highest bulk density (BD) (0.81) while sample A had the least BD (0.72). The BD of all the samples were not significantly (p>0.05) different. The loaf characteristics result showed that sample C produced bread with highest loaf weight (180.18g), sample E with least loaf weight (93.53g). All the samples were significantly (p<0.05) different in loaf weight and loaf volume (250 - 420) cm^3. The sensory evaluation result revealed that bread produced from sample C was rated highest (6.95) and moderately accepted by the panelists. This suggests that plantain /wheat bread could be an alternative to the the regular and whole wheat bread for consumers.***

Keywords--- Blanching, Flour, Functional, Plantain, Sensory, Wheat

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1. INTRODUCTION

Plantain (*Musa spp*.) belongs to the family of plants referred to as *Musaceae*. It is an important staple crop that contributes to the calories and subsistence economies in Africa. It is a good source of carbohydrate; (Marriott *et.al.*, 1981). Nigeria is one of the largest plantain producing countries in the world (FAO, 1987) but despite its prominence, Nigeria does not feature among plantain exporting nations because it produces more for local consumption than for export. The consumption of plantain has risen tremendously in Nigeria in recent years because of the rapidly increasing urbanization and the great demand for easy and convenient foods by the non-farming urban populations.

Besides being the staple for many people in more humid regions, plantain is a delicacy and favoured snack for people even in other ecologies. A growing industry, mainly plantain chips, is believed to be responsible for the high demand being experienced now in the country (FAO, 1987).

Plantain flour for "fufu" is now popular to cater for the interest of diabetics, realizing its low glycaemic index. Plantain bread and biscuit have been reported by Ogazi (1996) but like its "fufu" product, the colour of the bread have not compared well with the present commercial bread including the cassava-blend bread, even after the normal blanching process. Thus acceptable plantain bread product to serve as breakfast for diabetics is still not available. Therefore the objectives of this study are to produce plantain flour through different blanching processes, produce bread with blends of wheat and plantain flour and evaluate the acceptability of the plantain/wheat bread in comparison to normal wheat bread.

It is hoped that the successful execution of this project may encourage a regular production of plantain/wheat bread which can serve the interest of the diabetic patients besides whole wheat bread. It will create another variety in the bread industry/ market.

2. MATERIALS AND METHODS

The plantain (*Musa spp*.) used for this project work were obtained from Ihiagwa market while the baking ingredients (wheat flour, granulated sugar, margarine, Salt and yeast) were obtained from Ekeukwu market both in Owerri, Imo state.

2.1 Material Preparation

Palm ash infusion: About 2litres of palm ash infusion was obtained by soaking up to 100g of palm ash ("Ngu") in 3litres of tap water for 20min, then decanted and filtered. The resulting infusion was used in blanching.

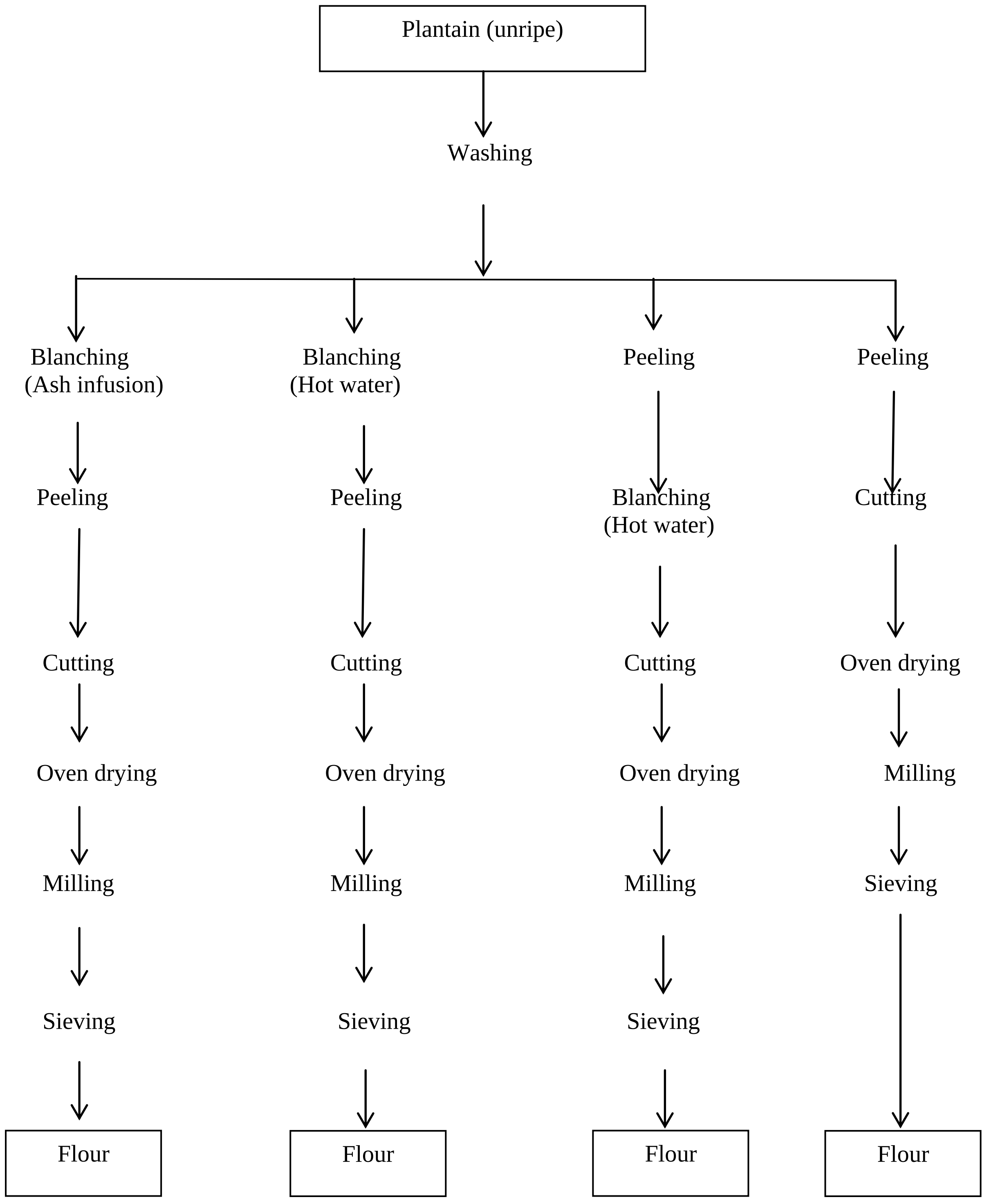

Fig. 1: Flow chart for Plantain flour Production

Plantain Flour Sample: The supply of mature green plantain bunches were cut into individual fingers, washed and weighed. The supply was divided into four portions and given different blanching treatments. These treatments were, blanching unpeeled fingers in boiling palm ash infusion, blanching unpeeled fingers in boiling water, blanching peeled fingers in boiling water and using some peeled finger without blanching. All blanching treatments were done for 5min. After the blanching operations, all unpeeled samples were peeled and were manually sliced with kitchen knife to chips of about 1.2cm thickness and oven dried at 60°C. The dried chips were separately milled and sieved into flour using a 60BSS standard sieve. The flow chat for the production of plantain flours is shown in Fig. 1.

2.2 Determination of the Functional Properties of Plantain Flour Samples

pH measurement : The method of AOAC (1984) modified by Onwuka (2005) was used. A 10% weight per volume suspension of the sample was prepared in distilled water and was mixed thoroughly in a warring blender and then the pH of the sample was measured by inserting the electrodes into the suspension, the result was recorded from a digital display and this was done with a martini (mi - 151) pH meter.

Emulsification capacity (EC): The method of AOAC (1984) was adapted as described by (Onwuka, 2005). Two gram (2g) of the flour sample was blended with 25ml of distilled water at room temperature for 30sec in a warring blender at 1,600rpm. After complete dispersion, 25ml of vegetable oil (groundnut oil) was added and blended again for another 30sec. The mixture was transferred into a centrifuge tube and centrifuged at 1,600rpm for 5min.The oil and water separated, with the oil at the upper part and the water at the bottom part of the centrifuge tube. The emulsion layer being in the middle of the separation was read and recorded using a ruler.

$$\text{Emulsification capacity (EC)} = \frac{X}{Y} x \frac{100}{1}$$

Where X = height of emulsified layer
Y = height of whole mixture in the centrifuge tube.

Foam capacity and stability: The method of AOAC (1984) was employed as described by Onwuka (2005). One gram (1g) of the sample was blended with 10ml of distilled water in a warring blender and whipped at 1600rpm for 5min. The mixture was poured into a 250ml measuring cylinder and the volume recorded after 30sec. Foaming capacity was then expressed as percentage increase in volume using the formula.

$$\text{Foam capacity} = \frac{\text{volume after whipping} - \text{volume before whipping}}{\text{Volume before whipping}} x \frac{100}{1}$$

After the determination of foaming capacity, the foam volume was recorded at 15, 30, 60 and 120 after whipping to determine the foam stability

$$\text{Foam stability} = \frac{\text{foam volume after time "t"}}{\text{Initial foam volume}} x \frac{100}{1}$$

Wettability: The method of AOAC (1984) was used as described by Onwuka (2005). One gram (1g) of each of the flour samples was weighed out using an analytical balance and was each added into a 25ml graduated measuring cylinder with a diameter of 1cm. The finger was then placed over the open end of the cylinder in each case, inverted and was clamped at a height of 10cm from the surface of a 600ml beaker containing 500ml of distilled water. The finger was then removed and the test sample was allowed to be dumped. The wettability was recorded as the time required for the sample to become completely wet using a stop watch.

Oil Absorption Capacity: This was determined as the weight of oil absorbed and held by 1gram of the sample. The procedure of AOAC (1984) was adapted as described by (Onwuka, 2005). One gram (1g) of the sample was weighed into a graduated centrifuge tube. A warring whirl mixer was used to mix the sample thoroughly with 10ml of oil for 30sec. The sample was allowed to stand for 30min at room temperature and was then centrifuged at 3,500rpm for 30min.The volume of oil (supernatant) was decanted, measured and recorded. Oil absorption capacity was calculated by subtracting volume of oil (supernatant) from the initial volume of oil (10ml).

$OAC = V_O - V_I$
OAC = Oil absorption capacity
V_O = Initial volume of oil (10ml)
V_I = Volume of oil (supernatant)

Water Absorption Capacity: This was determined as the weight of water absorbed and held by 1gram of the sample. The procedure of AOAC (1984) was adapted as described by (Onwuka, 2005). One gram (1g) of the sample was weighed into a graduated centrifuge tube. A warring whirl mixer was used to mix the sample thoroughly with 10ml of distilled water for 30sec. The sample was allowed to stand for 30min at room temperature and was then centrifuged at 3,500rpm for 30min. The volume of water (supernatant) was decanted, measured and recorded. Water absorption capacity was calculated by subtracting volume of water (supernatant) from the initial volume of water (10ml).

$WAC = V_O - V_I$
WAC = Water absorption capacity
V_O = Initial volume of water (10ml)
V_I = Volume of water (supernatant)

Bulk Density: The method of AOAC (1984) modified by Onwuka (2005) was employed. A 10ml capacity graduated measuring cylinder was weighed and the weight was recorded. The flour sample was gently placed in the cylinder to the 10ml mark. The cylinder was gently tapped on the laboratory table several times until there was no further diminution of the sample level.

The Bulk density was calculated thus

$$\text{Bulk density (g/ml)} = \frac{\text{weight of smaple (g)}}{\text{Final Volume of sample after tapping}}$$

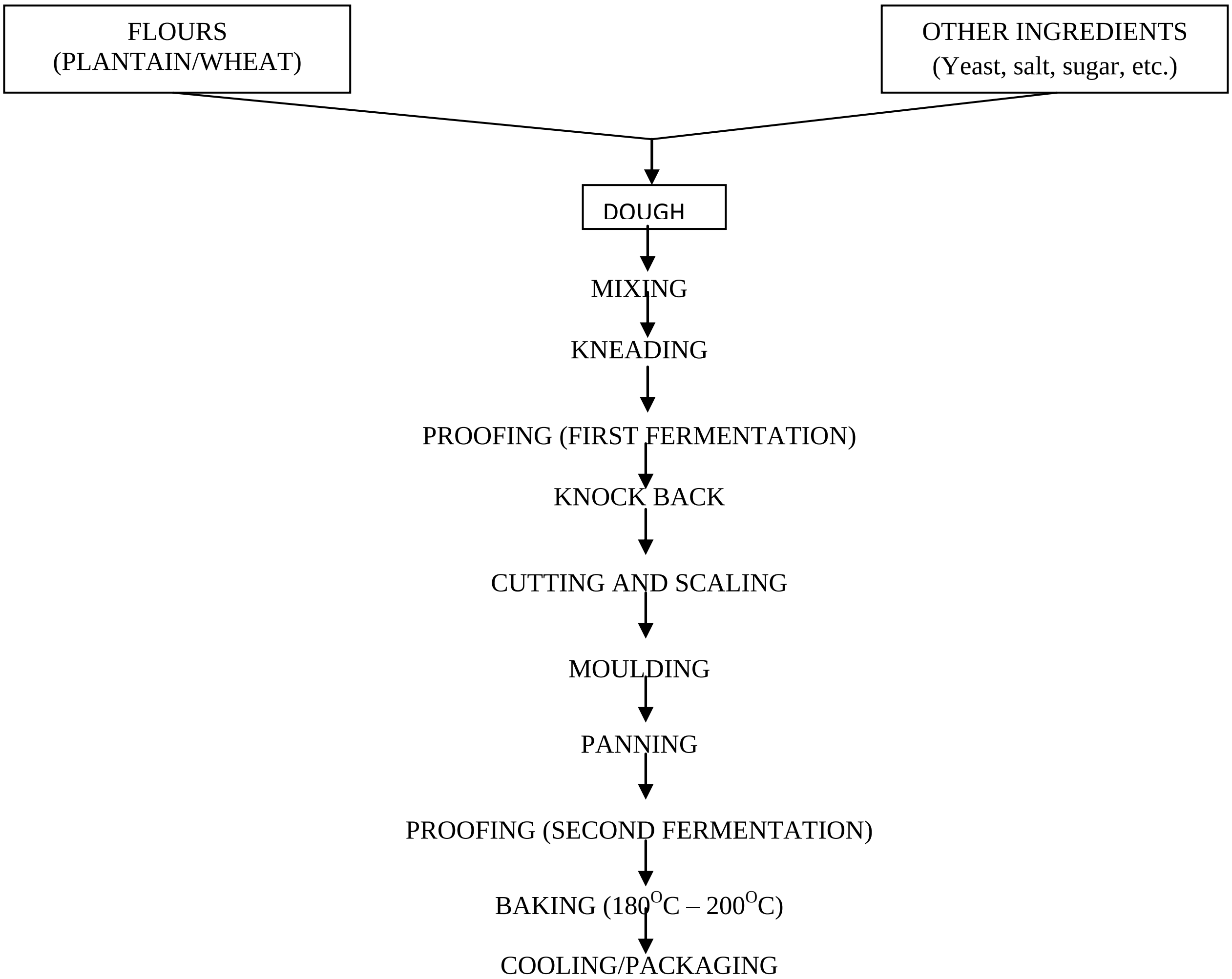

Fig 2: Flow diagram for bread production.

2.3 Production of Bread with Wheat/Plantain Composite Flour

Baking of the bread samples was done using 80% wheat flour and 20% plantain flour sample while the bread serving as the control was 100% wheat flour. The bread samples were prepared by mixing all the ingredients such as flour, yeast, sugar, fat and salt according to desired formulation. The quantities of products are shown in Table 1 (Recipe for Wheat/plantain Composite Bread) and Table 2 (Recipe for 100% Wheat Bread - Control). Mixing was done by hand, after which water was added and mixed to a desired consistency by hand kneading. The dough was allowed to proof for 40min after which it was knocked back (de-gas) and shaped into already greased baking pans and allowed to proof for the second time for 20min before it was loaded in the oven and baked at a temperature range of 180^{o}C – 200^{o}C for 45min. After baking, the bread was allowed to cool at room temperature and used for sensory evaluation. Flow diagram for bread production is shown in fig.2.

Table 1: Recipe for Wheat/plantain Composite Bread

Ingredients	Percentage	Quantity
Four (wheat)	80%	450g
Flour (sample)	20%	90g
Yeast	2%	10.8g
Salt	1%	5.4g
Fat	5%	27g
Sugar	3%	16.2g
Water	-	variable

Table 2: Recipe for 100% Wheat Bread (Control)

Ingredients	Percentage	Quantity
Flour (wheat)	100%	540g
Yeast	2%	10.8g
Salt	1%	5.4g
Fat	5%	27g
Sugar	3%	16.2g
Water	-	variable

Bread Quality Analysis

Loaf Weight and Loaf Volume Determination: After cooling, the bread samples were weighed using a digital analytical weighing balance. The volume of the bread samples was also measured according to the seed displacement method of AOAC (1984) described by Onwuka (2005) using millet grains. The bread sample was placed in an empty graduated volumeter and filled with the millet grains. The volumeter was slightly tapped on the laboratory bench to ensure that the millet grains were properly packed. The level of the packed millet grains containing the bread sample in the volumeter was noted and recorded. The bread sample was removed from the volumeter leading to a drop in the height of the millet grains. The new level of the millet grains was also noted and recorded. The loaf volume was determined by the difference between the level of the packed millet grains containing the bread sample and the level of millet grains after the bread sample has been removed.

Loaf Volume = H_o- H_1

Where;

H_o = height of millet grains with bread sample

H_1 = height of millet grains after the bread sample was removed

Specific Loaf Volume Determination

Specific loaf volume was obtained by dividing the loaf volume by its corresponding loaf weight.

Thus, specific loaf volume (ml/g) = V/W

Where, V = volume of loaf sample

W = weight of the loaf sample

Oven Spring: After moulding, the height of the dough was measured using a ruler and after baking, the bread samples' height were also measured and recorded. The oven spring was obtained by subtracting the differences between the height of bread samples after baking and the height of dough before baking. Oven spring = height of bread after baking –height of dough before baking.

2.4 Sensory Evaluation

The samples of the bread baked with wheat/plantain flour and the control sample were served to a 20-member untrained panelist selected from students of Federal University of Technology Owerri. The sensory panel was asked to determine the consumer preference and the quality parameters assessed includes taste, aroma, texture, crust colour, crumb colour as well as the general acceptability. The evaluation was conducted using a 9-point hedonic scale as described by Ihekoronye and Ngoddy (1985). Where, 1 represents dislike extremely and 9 represents like extremely.

2.5 Statistical Analysis

The experimental data obtained were analysed using analysis of variance (ANOVA) and Fisher's least Significant Difference (LSD) was used to establish significant differences among the mean at 0.05 level of confidence.

3. RESULT AND DISCUSSION

3.1 Functional Properties of Plantain Flour samples

The result of the statistical analysis on the functional properties of the flour samples is shown in table 3 and each value is a mean triplicate determination. The results obtained are discussed below.

The pH of the flour samples were within the range of 5.48 – 6.15 as shown in table 3. The pH values were significantly ($p< 0.05$) different from each flour sample, with sample C (6.15) having the highest pH value. High pH values for flour have been found to increase solubility due to increased hydrophilic character of the flour at these pH value (Adeboyega, 2006).

The emulsion capacity (EC) from table 3 showed that there sample B and C had no emulsion capacity, while sample D had the highest mean 2.78and was significantly different ($p>0.05$) from sample A (1.89). The EC of the blanched samples (A, B, C) were lower than that of the unblanched sample (D). This is consistent with the observation of Oluwatooyin *et al.* (2003).

The statistical data on the foaming capacity (FC) suggest that FC of sample B had the highest mean of 3.96% followed by sample D (3.91%), sample A (2.70%) while sample C (0.98%) had the least mean. There was significant ($p<0.05$) difference amongst the flour samples. Foam can be produced by whipping air into liquid as much and fast as possible (Sikorski, 2002). The reason why flours are capable of producing foams is that proteins in flours are surface active (Eltayeb *et al*., 2011). The flour samples foaming ability is related to the rate of decrease of the surface tension of air/water interface caused by absorption of protein molecules (Graham and Philip, 1976).

There was no result recorded for foam stability (FS) from the flours samples. Foam is a colloid of many gas bubbles trapped in a liquid or solid (Eltayeb *et al*., 2011). Small air bubbles are surrounded by thin liquid films. Soluble proteins can reduce surface tension at the interface between air bubbles and surrounded liquid. Thus, the coalescence of the bubbles is obstructed. In addition, protein molecules can unfold and interact with one another to form multilayer protein film with an increased flexibility at the air liquid interface (Eltayeb *et al*., 2011). As a result, it is more difficult for air bubbles to break, and the foams are more stabilized (Adebowale and Lawal, 2003). Data shows that FS was nil throughout the analysis. These air bubbles might be easier to collapse and consequently lowered the foaming stability (Jitngarmkusol et al., 2008).

The wettability (W) result clearly showed that sample D had the highest mean value of 50.51sec followed by sample B (39.29) sec, sample C (17.94) sec and sample A (11.30) sec. The wettability result implies that sample D required much longer time than the other flour samples before it became completely wet. There was significant ($p<0.05$) difference amongst the flour samples.

The oil absorption capacity (OAC) of the samples ranged between (1.47 – 1.83). Oil absorption capacity of samples A and D were lower than the water absorption capacity. Sample B (1.47) was not significantly ($p>0.05$) different from sample C (1.47) while samples (B and C) were significantly ($p<0.05$) different from sample A (1.74) and sample D (1.83). There was significant ($p>0.05$) difference between samples A and D. According to Oluwatooyin *et al.* (2003), good OAC of flour samples suggest that they may be useful in food preparations that involves oil mixing like in bakery products, where oil is important ingredient. The water/fat binding capacity of protein is an index of its ability to absorb and retain oil, which in turn influences the texture and mouth feel of food products like doughnut, pancakes, baked goods and soups. Oil absorption capacity is importance since oil acts as flavour retainer and increases the mouth feel of foods
(Aremu et al., 2007). It has been reported that variations in the presence of non-polar side chains, which might bind the hydrocarbon side chains of oil among the flours, explain differences in the oil binding (Adebowale and Lowal, 2004).

The result of the water absorption capacity (WAC) showed that samples B and C had the highest WAC (2.99 %) while sample D had the least value of 2.39 %. These were in accordance to the findings of Oluwatooyin *et al.* (2003) who observed that WAC could be enhanced by blanching. Although the values obtained are lower compared to those reported for Bambara groundnuts flour (281.35%) (Eltayeb *et al*., 2011), soybean flour (130%) and sunflower meal products (Padilla *et al*.,1996). African yam bean flour (118 to 179%) (Oshadi et al., 1997) and various lima bean flours (130 to 140%) (Adeyeye and Aye, 2005). There was no significant ($p > 0.05$) difference between sample B and sample C. Both samples (B and C) were significantly ($p<0.05$) different from sample A and sample D. There was also significant ($p< 0.05$) difference between sample A and sample D.

The bulk density (BD) of sample C had the highest mean (0.81)g/ml followed by that of sample B and sample D having the same mean (0.77)g/ml. Sample A had the least bulk density (0.72)g/ml. The bulk density result indicated that sample A had more moisture than the other flours. . There were no significant ($p > 0.05$) difference amongst samples A, B, C and D.

Table 3: Functional Properties of Plantain Flour samples

	PARAMETERS							
SAMPLES	pH	EC (%)	FC (%)	FS (%)	W(sec)	OAC(%)	WAC(%)	BD(g/ml)
A	5.90^b	1.89^b	2.97^c	0	11.30^d	1.74^b	2.79^b	0.72^a
B	5.71^c	0.00	3.96^a	0	39.29^b	1.47^c	2.99^a	0.77^a
C	6.15^a	0.00	0.98^d	0	17.94^c	1.47^c	2.99^a	0.81^a
D	5.48^d	2.78^a	3.91^b	0	50.51^a	1.83^a	2.39^c	0.77^a
LSD	0.05	0.01	0.02	-	0.24	0.08	0.12	0.09

Mean values in the column followed by different superscript are significantly ($P< 0.05$) different.

KEY:

SAMPLE A = Flour from blanched plantain with ash infusion

SAMPLE B = Flour from blanched plantain with peel

SAMPLE C = Flour from blanched plantain without peel

SAMPLE D = Flour from unblanched plantain

EC = Emulsion capacity, FC = Foam capacity, FS = Foam stability, W = Wettability, OAC = Oil absorption capacity, WAC = Water absorption capacity, BD = Bulk density

3.2 Bread Quality Analysis

The statistical analysis result of the loaf weight in table 4 showed that sample C had the highest loaf weight (180.18g) while sample E (100% wheat bread) had the least loaf weight (93.53g); there was significant ($p<0.05$) difference amongst the bread samples except sample B and sample D.

From table 4, sample E (100% wheat bread) had the highest loaf volume (420) $cm^{3.}$ There was significant ($p<0.05$) difference in the loaf volume amongst the bread samples of B, C and E while sample A and sample D were not significantly ($p>0.05$) different. The loaf volume is a good indicator of the crumb; how light and airy the interior of the bread loaves are. The lesser values indicate a dense and compact crumb.

The specific loaf volume of the bread samples were within the range of 1.39cm^3/g -4.49cm^3/g. Sample E had the highest specific loaf volume (4.49cm^3/g). There was no significant ($p>0.05$) difference between sample B and sample D but both samples were significantly ($p<0.05$) different from sample A, sample C and sample E.

The result of the oven spring of the bread sample shown in table 4 showed that sample C had the least mean of 2.70cm against the control (sample E) that had the highest mean value of 4.00cm, this could be as result of the high ratio of gluten content (protein) present in the sample E (100% wheat flour). There was significant ($p<0.05$) difference between sample E and sample C. There was no significant ($p>0.05$) difference between the bread samples of A and E. Also, there was no significant ($p>0.05$) difference between the bread samples of 'A and D', 'sample B and C' and 'sample B and D'. Oven spring also is a good indicator of the crumb; how light and airy the interior of the bread loaves are.

Table 4: Mean Scores of the Bread Quality Analysis

SAMPLES	PARAMETERS			
	LOAF WEIGHT(g)	LOAF VOLUME(cm^3)	SPECIFIC LOAF VOLUME(cm^3/g)	OVEN SPRING(cm)
A	112.15^{c}	390^{b}	3.49^{b}	3.60^{ab}
B	130.43^{b}	325^{c}	2.50^{c}	3.10^{cd}
C	180.18^{a}	250^{d}	1.39^{d}	2.70^{d}
D	137.67^{b}	382^{b}	2.78^{c}	3.4^{bc}
E	93.53^{d}	420^{a}	4.49^{a}	4.00^{a}
LSD	8.72	11.04	0.26	0.42

Mean values in the column followed by different superscript are significantly ($P<0.05$) different.

KEY:
SAMPLE A = Wheat flour 80% + Flour from blanched plantain with ash infusion 20% bread (80:20)
SAMPLE B = Wheat flour 80% + Flour from blanched plantain with peel 20% bread (80:20)
SAMPLE C = Wheat flour 80% + Flour from blanched plantain without peel 20% bread (80:20)
SAMPLE D = Wheat flour 80% + Flour from unblanched plantain 20% bread (80:20)
SAMPLE E = 100% wheat flour bread

3.3 Sensory Evaluation of the bread samples

The crust colour result in table 5 showed sample E had the highest mean value 7.00 (moderately liked) while sample A had the least mean value of 5.90 (slightly liked). The crust colour of sample A may have been affected by the use of ash infusion in blanching the plantain fingers. There was no significant difference in the crust colour of the bread samples amongst sample B, sample C and sample D at ($p>0.05$). Also, there was no significant ($p> 0.05$) difference amongst sample B, sample C and sample E. Sample E was significantly ($P< 0.05$) different from sample A and sample D. There was no significant ($p>0.05$) difference amongst sample A, sample B and sample D.

The result on table 5 showed that sample C had the highest mean of 6.85 (moderately liked) for aroma while sample D had the least mean of 6.15 (slightly liked). There were no significant ($p>0.05$) difference in the aroma of the bread samples of sample A, sample B, sample C and sample E. There were also no significant ($p > 0.05$) difference amongst sample A, sample B, sample D and sample E. Though, their mean score varied slightly. There was significant difference ($p<0.05$) between sample C and sample D. The panelists liked the aroma of all the bread samples.

Sample A (5.65) (slightly liked) had the least mean for taste, this may be attributed to blanching with ash infusion while sample C had the highest mean value of 6.85 (moderately liked).There was no significant ($p>0.05$) difference in the taste of the bread samples amongst sample A, sample D and sample E. There was also no significant (p>0.05) difference amongst sample B, sample C. Sample C and sample B were significantly (p<0.05) different from sample A.

The crumb colour of sample A had the least mean value of 5.90 (slightly liked) and this could be as a result of ash infusion blanching while sample E had the highest mean value of 7.2 (moderately liked). Sample E was significantly (p<0.05) different form sample A, sample B and sample D. There was no significant (p> 0.05) difference amongst sample A, sample B, sample C and sample D. Also, sample C was not significantly (p>0.05) different from sample E.

For texture, table 5 showed that sample C had highest mean 7.40 (moderately liked) while sample D had the least mean (6.00). Sample C was significantly (p<0.05) different from other bread samples. There were no significant (p>0.05) difference amongst sample A, sample B, sample D and sample E.

The general acceptance result from table 5 clearly showed that sample C had the highest mean of 6.95 (moderately liked) while sample A had the least mean value of 5.85 (slightly liked) and there was no significant (p>0.05) difference amongst sample A, sample B and sample D. Also, there was no significant (p>0.05) difference amongst sample B, sample C and sample E. There was significant (p< 0.05) difference between sample A and sample C. There was no significant (p>0.05) difference amongst sample B, sample D and sample E.

TABLE 5: Mean Scores of the Sensory Properties of the bread samples

	PARAMETERS					
SAMPLES	CRUST COLOUR	AROMA	TASTE	CRUMB COLUR	TEXTURE	GENERAL ACCEPTANCE
A	5.90^{c}	6.30^{ab}	5.65^{b}	5.90^{b}	6.45^{b}	5.85^{c}
B	6.45^{abc}	6.60^{ab}	6.55^{a}	6.15^{b}	6.45^{b}	6.50^{abc}
C	6.85^{ab}	6.85^{a}	6.85^{a}	6.50^{ab}	7.40^{a}	6.95^{a}
D	6.30^{bc}	6.15^{b}	6.10^{b}	5.8^{b}	6.00^{b}	6.15^{bc}
E	7.00^{a}	6.70^{ab}	6.10^{b}	7.2^{a}	6.10^{b}	6.80^{ab}
LSD	0.58	0.55	0.68	0.63	0.62	0.66

Mean values in the column followed by different superscript are significantly (p<0.05) different.

KEY:

SAMPLE A = Wheat flour 80% + Flour from blanched plantain with ash infusion 20% bread (80:20)
SAMPLE B = Wheat flour 80% + Flour from blanched plantain with peel 20% bread (80:20)
SAMPLE C = Wheat flour 80% + Flour from blanched plantain without peel 20% bread (80:20)
SAMPLE D = Wheat flour 80% + Flour from unblanched plantain 20% bread (80:20)
SAMPLE E = 100% wheat flour bread

4. CONCLUSION

The blanching treatments had effect on the functional properties of the plantain flour samples. Flour from blanched plantain with peel (sample B) and flour from blanched plantain without peel (sample C) had the highest water absorption capacity and this gave it higher affinity to absorb water during production. The absorbent nature of the said flour has quantitative advantage and can be regarded as being economical. From the results obtained, it is quite evident that up to 20% substitution of wheat flour with plantain flour in bread production could be achieved. The result of sensory evaluation showed that sample C had the highest overall acceptability and could be compared with bread produced from 100% wheat flour.

5. RECOMMENDATION

Based on these findings, the use of wheat-plantain composite flour in bread making and other baked products for diabetic patients and other consumers is recommended. This will help to create variety and improve the utilization of plantain flour in Nigeria.

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APPENDIX

SENSORY EVALUATION FORM

NAME: ....

DATE: ....

You are provided with bread samples of plantain composite given treatment. You are requested to access the sensory quality of the samples on the given parameters using the hedonic scale provided. You are also provided with a glass of portable water, empty cup and serviette (paper napkin).

Please rinse your mouth after toasting each before tasting another.

9 -----   LIKE EXTREMELY

8------   LIKE VERY MUCH

7------   LIKE MODERATELY

6------   LIKE SLIGHTLY

5------   NEITHER LIKE OR DISLIKE

4------   DISLIKE SLIGHTLY

3------   DISLIKE MODERATELY

2------   DISLIKE VERY MUCH

1------   DISLIKE EXTREMELY

SAMPLES	**A**	**B**	**C**	**D**	**E**
AROMA					
TASTE					
TEXTURE					
CRUST COLOR					
CRUMB COLOR					
GENERAL ACCEPTANCE					

Please, briefly comment on the samples based on your rating score above;

COMMENTS:

Sample A:

……
……………………………………………………………………………

Sample B:

……
…………………………………………………………………………

Sample C:

……
…………………………………………………………………………

Sample D:

……
…………………………………………………………………………

Sample E:

……
…………………………………………………………………………