

# Performance of Ripped and Unripped Plantain-Wheat Flour Blend in Biscuit production

Idoko J. O., Nwajiaku I.

**Abstract**—Unripe and ripe plantain were dried and milled into flour and used with wheat flour in biscuit production to determine the best plantain-wheat composite flour for biscuit production. The blends as follows: 100% wheat flour, 100% ripe plantain flour, 100% unripe plantain flour, 50% wheat flour and 50% ripe plantain flour and 50% wheat flour and 50% unripe plantain flour. The Biscuit samples were stored at ambient temperature for 8 weeks after which the equilibrium moisture content and water activity were determined. The sensory evaluation of the biscuit samples was also determined. The results of these analyses showed 100% unripe plantain flour as the most stable of the BISCUIT samples judging from its equilibrium moisture content level of 0.32% and water activity of 0.62. The sensory evaluation results showed Biscuit made from 150:50 ripe plantain and wheat flour as most generally accepted at 5% level of significance.

**Keywords**—Biscuit, equilibrium moisture content, performance, plantain, water activity.

## I. INTRODUCTION

PLANTAIN (*Musa* sp.) is an important food crop in Nigeria as in all humid tropical zones of Africa. Over 80% of the harvest of the plantain is obtained during the period of September to February and there is much wastage of this crop during the period of peak supply. Most of the plantain products do not store for a long period, resulting in seasonal availability and limitations of use [1].

The interest of research scientist in production of suitable flours from local raw materials is growing to include all possible oil seeds, cereals and tubers. FAO promoted and sponsored a composite flour technology programme to overcome the technical restraints on the utilization of local grain and starchy flours in the production of bakery products [2]. Plantain flour could be used to replace wheat flour for the production of baked foods such as biscuits and cakes [2].

Biscuits are recognized as cereal based product baked to moisture content less than 6.0 percent. Thus biscuits are regarded as dried products. Generally, biscuits can be classified into hard dough biscuits and soft dough biscuits. Hard dough biscuits contain relatively low levels of fat and sugars with large amount of water added during dough stage. Soft dough biscuits on the other hand contain relatively high levels of fat and sugar with little amount of water added during the dough stage. Biscuits as dried foods contain oil and fat, sugar and other ingredients subject to certain chemical

changes that may result in their becoming undesirable upon storage. Such changes include oxidative rancidity, Mallard reaction or non-enzymatic browning and mold growth.

This experiment was undertaken to produce soft biscuits from plantain-wheat composite flours, to ascertain the influence of ripe and unripe plantain flour on the water uptake by biscuits when packaged in cellulose films and stored under ambient temperature.

## II. MATERIALS AND METHODS

### A. Sources and Preparation of Plantain Flour

The horn unripe plantain samples used in this experiment were bought in one lot from Ogbete Main market, Enugu. The samples were divided into two for the experiment. The first sample was used unripe while the second was stored for 4 days for firm ripening using traditional ripening method for plantains.

The plantain samples were converted into flour following the method described by [1].

### B. Chemical Analysis

The produced plantain flour samples were subjected to proximate analyses using [3] methods.

Functional properties of the flour samples were also determined.

- Relative viscosity was determined by [4] method
- Swelling capacity by [5] method
- Oil absorption capacity by [6] method
- Emulsion capacity [7] method
- Whippability and foam stability [5] method

### C. Biscuit Recipe and Production

Biscuit production with unripe and firm ripe plantain-wheat composite flour using recipe shown in Table I was carried out. The ingredients were added at the same level in all the samples.

Creaming method of biscuit production was used [8], [9]. Fat and sugar were creamed together to a fluffy consistency. A solution of whipped egg was added, the sieved flour samples added along with baking powder and milk powder and a smooth dough was obtained. The dough was allowed to proof for 15 minutes then rolled out with a rollers pin to an even thickness. The dough was allowed again to proof for another 5 minutes and cut out into shapes using biscuit cutter, placed on greased pan and allowed to proof for about 10 minutes and baked at 180°C until light brown [10]. The products were cooled, removed from pans, packaged in cellulose bags and labelled according to the type of flour composition.

J. O. Idoko is with the Department of Food Technology, Institute of Management and Technology (I. M. T) Enugu. Enugu State Nigeria (e-mail: Idoko.justina@yahoo.com)

I. Nwajiaku is with the Department of Food Technology, Institute of Management and Technology (I. M. T) Enugu. Enugu State Nigeria.

#### *D. Storage Stability Studies*

The fresh biscuits were analysed for equilibrium moisture content and water activity. The biscuit samples were then stored at ambient temperature for 8 weeks after which the equilibrium moisture content and water activity were determined [11].

#### *E. Sensory Evaluation*

This was carried out on a 9-point hedonic scale using 20 judges all drawn from students and staff of Food Technology Department (I.M.T.) Enugu. The results were analysed by ANOVA at 5% level of significance [13].

### III. RESULTS AND DISCUSSION

#### *A. Proximate Composition*

Results of the proximate composition of the unripe and firm ripe plantain samples are presented in Table II. Results for unripe plantain as reported by [14] gave 49.40% moisture, 3.09% total carbohydrate, 2.0% ash, and 0.5% crude fibre. Also [15] reported 62.0%, 2.53%, 0.02%, 29.42%, 2.21%, and 3.85% moisture, crude protein, fat, total carbohydrate, ash and crude fibre for unripe plantain. Again [16] reported 64.7% moisture, 3.14% crude protein, 0.02% fat, 21.96% total carbohydrate, 2.22% ash, and 6.45% crude fibre for ripe plantain. The results in this experiment showed an increase in the moisture content of plantain flour from 61.60% in the unripe stage to 62.06% at firm ripe stage. This increase could be as a result of hydrolysis of complex organic compounds, accumulation of sugar and osmotic withdrawals of moisture from the peel to the pulp [16]. The results also showed an increase from 2.80% at the unripe stage to 3.50% at the firm ripe stage in the protein content of the plantain flour. This is associated with amino acid uptake and incorporation into the protein during fruit ripening [16]. Fat content decreased in the samples from 2.30% in the unripe stage to 2.10% in the firm ripe stage. The decrease is due to fat hydrolysis, during ripening to fatty acids and glycerol. The variation in the total carbohydrates is attributed to polysaccharides conversion into simple sugars [17].

#### *B. Effect of Ripening on the Functional Properties of the Plantain Flour Samples*

Results of functional properties determinations on the unripe and firm ripe plantain flour samples are presented in Table III. The viscosity of the unripe flour sample was higher than the value obtained for the firm ripe plantain flour sample. This is attributed to higher content of bulk and undegraded poly molecules in the unripe plantain flour sample. The lower viscosity values for the firm ripe plantain sample suggest its suitability in the formulation of complementary foods. Water absorption capacity was higher in the unripe plantain flour sample than the firm ripe plantain. The higher water absorption capacity of the unripe plantain flour suggested high amount of hydrophilic carbohydrates in the samples. This also suggests the sample's suitability in product formulation such as in bakery products where hydration to improve handling characteristics is required [18]. The oil absorption capacity of

the firm ripe plantain sample was higher than the value obtained for the unripe plantain sample. This may be due to the presence of high amount of non-polar amino acid side chain in the sample, which tends to bind fat. This higher oil absorption capacity of the ripe plantain sample suggests its possible use in the preparation of doughnut, ground meat formulation, pancake or soft dough biscuit where oil holding capacity is of primary importance [18]. The firm ripe plantain flour exhibited higher foam capacity.

This may be due to its higher proteins (Table II). Foams are used to improve texture consistency and appearance of foods. The least gelation capacity for unripe plantain sample was 30% while that for the firm ripe plantain was 24%. Values of 8 – 10% were obtained for *Treculia Africana* maize blends [18]. Gelation is an important physical characteristic of starch. Degree of gelation, the extent of solubilization, the increase in paste viscosity and the pasting temperature are close relationship. The gelation capacities of the samples studied showed they would be useful in bakery products like cake and biscuits.

The emulsion capacities of the samples studied were 40% for unripe plantain and 50% for the firm ripe plantain flour. The emulsion activity of food product depends on the protein content which is the most reactive molecules and facilitates formation of emulsion by lowering surface tension [19]. The presence of polysaccharides in the unripe plantain sample may have affected its emulsion capacity.

#### *C. Effect of Storage Time on the Moisture Content and Water Activity of Biscuit Samples*

The results of the moisture content and water activity determinations on biscuit samples are presented in Table IV. The percentage equilibrium moisture contents of the samples were in the range of 3.1 – 3.4%, while water activity ( $a_w$ ) varied from 0.62 – 0.65. Biscuit samples made with 100% unripe plantain flour had lowest  $a_w$  of 0.62 probably due to presence of reducing sugars competing for moisture. Equilibrium moisture content and water activity for the samples fall within the standard values for biscuits given by Standard Organization of Nigeria (SON). These values depict the packaging material used for the biscuits as effective in preventing permeability of moisture and oxygen and this implies the products are stable against microbial spoilage. Mold which is the largest organism in baked products are inhibited at  $a_w$  of 0.65, Peroxidation of lipid leading to their reaction with the protein components of the biscuit samples is also prevented by the low equilibrium moisture content and water activity. This implies that hydroperoxides cannot be accumulated or decomposed in the packaged samples, and there will be no formation of soluble, insoluble or sparsely soluble compounds or end products such as aldehydes or ketones.

#### *D. Sensory Evaluation of Biscuit Samples from Different Plantain-Wheat Composite Flour*

The values of results obtained from the sensory evaluation of the biscuits samples are presented in Table V.

It was shown that samples [produced using 100% wheat flour and that made using 50% wheat flour and 50% unripe plantain flour were significantly different from sample produced using 100% ripe plantain flour in terms of crust colour. The variation in the crust colour of samples is mainly due to the effects of the pigment in the plantain flour and the reaction of sugars and amino group in the plantain which is more pronounced in the ripe samples.

Texture of the sample made with 50% wheat flour and 50% unripe plantain flour was significantly different from all the other samples. The differences in texture are related to the quantity of oil absorbed during mixing.

#### IV. CONCLUSION

The result of this research show that biscuit of high quality can be produced from the composite flour of plantain and wheat. Using moisture content and water activity as index for storage studies, the results obtained show that low moisture foods are stable at low water activity. The sample made with 100% unripe plantain flour will store longer than other samples because it has lowest water activity in terms of sensory quality, the 50% substituted samples were better accepted.

#### APPENDIX

TABLE I  
RECIPE FOR BISCUIT PRODUCTION USING PLANTAIN-WHEAT COMPOSITE FLOUR

Sample	% Wheat Flour	% Firm ripe plantain flour	% unripe plantain flour	Other ingredients
A	100	-	-	Fat, sugar, egg, baking powder, milk powder, salt and water
B	-	100	-	Fat, sugar, egg, baking powder, milk powder, salt and water
C	-	-	100	Fat, sugar, egg, baking powder, milk powder, salt and water
D	50	50	-	Fat, sugar, egg, baking powder, milk powder, salt and water
E	50	-	50	Fat, sugar, egg, baking powder, milk powder, salt and water

TABLE II  
PROXIMATE CONTENT OF UNRIPE AND FIRM RIPE PLANTAIN SAMPLES

Sample	Moisture content %	Crude protein %	Fat %	Total carbohydrate %	Ash %	Crude Fibre %
Unripe plantain	61.62	2.80	2.30	31.53	1.06	0.75
Firm ripe plantain	62.06	3.50	2.10	29.69	2.00	0.65

TABLE III  
RESULTS OF THE FUNCTIONAL PROPERTIES DETERMINATION ON THE PLANTAIN FLOUR SAMPLES

Sample	Viscosity mpa/s	Water absorption capacity %	Oil absorption capacity %	Gelling capacity %	Emulsion capacity %	Foam capacity %
Unripe plantain flour	80	75	40	30	40	74
Firm ripe plantain flour	70	60	60	24	50	81

TABLE IV  
EFFECT OF STORAGE TIME ON THE MOISTURE CONTENT AND WATER ACTIVITY OF BISCUIT SAMPLES AFTER 8 WEEKS OF STORAGE

Samples	Equilibrium moisture content %	Water activity $a_w$
100% wheat flour biscuit	3.4	0.63
100% ripe plantain flour biscuit	3.2	0.64
100% unripe plantain flour biscuit	3.2	0.62
50% wheat flour and 50% ripe plantain flour blend biscuit	3.3	0.65
50% wheat flour and 50% unripe plantain flour blend biscuit	3.1	0.63

TABLE V  
SENSORY EVALUATION MEAN SCORES OF BISCUITS PRODUCED FROM PLANTAIN-WHEAT COMPOSITE FLOUR

Sample	Crust colour	Texture	Crisp homo-geneity	Flavour	Overall acceptability
100% wheat flour biscuit	a 5.00	b 2.80	b 3.80	ab 5.80	b 5.30
100% ripe plantain flour biscuit	b 7.00	b 3.30	b 4.30	ab 5.50	b 5.50
100% unripe plantain flour biscuit	bc 2.80	bc 5.00	c 4.50	ab 5.80	b 6.00
50% wheat flour and 50% ripe plantain flour blend biscuit	bc 2.80	bc 5.80	a 5.50	a 6.00	b 5.50
50% wheat flour and 50% unripe plantain flour blend biscuit	a 2.30	b 2.30	b 3.00	ab 5.00	ab 5.80

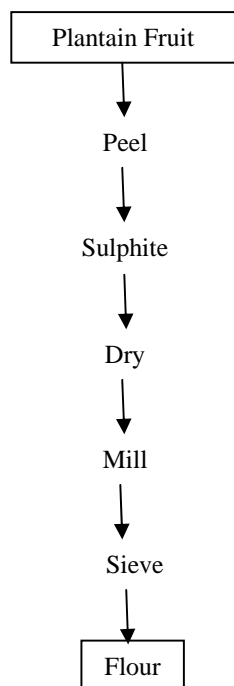


Fig. 1 Stages in plantain flour production [12]

#### ACKNOWLEDGMENT

The authors deeply appreciate the financial support of their family and friends. To the staff and students of Food Technology Department (I.M.T), Enugu, we say a big thank you.

#### REFERENCES

[1] P.O. Ogazi Plantain Utilization and Nutrition. In Food Crops Production, Utilization and. 1988. Ed B.N. Mbah and D.O Nnayelugo Dotam Publishers Ibadan. Pp 125-144

[2] P.O Ogazi. Plantain as a raw material for Baking Industry 1986. 8th Annual Conference of National Horticultural Research Institute (NIHORT) Ibadan.

[3] D. Pearson Chemical Analysis of Foods. 1976. H. Egan R.S Kirks and R. Sawyer edition. Longman Scientific Technical London pp 230-235

[4] S.K Sathe and D. K. Salunkle. Functional Properties of the Great Northern Bean (*Phaseolus vulgaris*) Proteins Emulsion, Foaming, Viscosity and Gelation Properties 1991. Journal of Food Science 16 pp 71- 74

[5] D.R. Lineback and C.H. Ke. Starches and Low Molecular Weight Carbohydrates from Chickpea and Horsebean Flours. 1974. Cereal Chemistry 53(3). pp 1334-1347.

[6] F.W Sosulki, M. A Gernal and A. E . Slinkard. Functional Properties of Ten-Legume Flours. 1976. Food Science and Technology Journal 9. Pp 66-69.

[7] K. Yasumatsu, I. Sawada, s. Moritaka, M, Misaki, j. Tocla. T. Wada, K. Ishii. Whipping and emulsifying properties of soybean products 1972. Agric and Boil. Chemistry 36(5) pp 716-727

[8] P.O. Ogazi. Invited lecture at the workshop on Post Harvest Food Losses and their control. 1986. Organized by CRD, the University of Nigeria Nsukka

[9] J.C Okaka. Cereals and Legumes Storage and Processing Technology 1997. Data and Microsystems Publishers' Ogui Enugu pp 20-55.

[10] D. Sutherlands, Pastry Work and Confectionary Handbook. 1995. Bats for Academic and Educational Pub. London pp 60- 62.

[11] A OAC., Standard Official methods of analysis of the association of Analytical Chemists. 13th Edn. Washington D.C 1980.

[12] P.O. Ogazi Plantain flour production and potentials 1982. Conference on plantain and cooking banana pp 28- 31.

[13] A.I Ihekoronye and P.O Ngoddy. Integrated Food Science and technology for the tropics. 1985. Macmillan Education Ltd. London. PP 296 -298.

[14] A.O. Ketiku chemical composition of unripe (green) and ripe plantain (musa parasidica) 1973. Journal of Science of Food and Agriculture 24. pp 703-709.

[15] J.J. Asiedu. Some physico-chemical changes during ripening and storage of plantain 1987. Tropical Science 27(4) pp 249-260.

[16] J. Brady, J.K.O. Palmer, P.B.H. Connel, R.M Smile, An Increase in Protein Synthesis During Ripening of Banana Fruit. 1970. Phytochemistry 9(5). Pp 1037 - 1047.

[17] T. Marriot, M. Robinson, S.K Karikari. Starch and Sugar Transformation During ripening of plantain and bananas. 1981. Journal of the Science of Food and Agriculture 32(10) pp 1021 – 1026.

[18] P.I Akubor, E. A. Obeta. Chemical and functional properties of African bread fruit (*Treculia african*) meal and Maine flour blends 1999. Journal of management technology 1(1). Pp 19 – 24.

[19] G. Ramantham, L.H. Ram and S.L. Ur. Emulsification properties of peanut protein. 1978. Journal of Food Science 13. pp 1270 – 1273.