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Statistical Analysis of the Effects of Drying Temperature and Pretreatment on the Proximate Composition of Dried Matured Green Plantain (Musa Paradisiaca)

Drying has been identified as the efficient means of ensuring continuous food supply to the growing population of any country and to enable the farmers produce more high quality marketable products. In this study, the effects of drying temperature and pretreatment on the quality of dried mature green plantain (Musa paradisiaca) were studied using an electrically-powered cabinet dryer. The product was dried from an initial moisture content of 62% (w.b) to a moisture content of 11.9% (w.b). A factorial experiment in a Randomized Complete Block Design (RCBD) involving three levels of temperature (50, 60 and 70^{0}C); three levels of pretreatment (blanching, boiling and control) and three replications were used. The quality analysis of the dried samples at different level of drying temperatures and pre-treatments was carried out for protein, fat, ash and fibre content and the data obtained were statistically analyzed using SPSS 16.0 software to determine the level of significance among the treatment factors on the dried samples. The protein, fat and fibre content decreased with increase in temperature but the ash content increased with increase in temperature. In pre-treatments, control had the highest protein content of 4.27% at 60^{0}C, lowest fat content of 2.26% at 70^{0}C and moderate fibre and ash contents of 0.68% and 1.82% respectively at 60^{0}C. Boiled sample also had the highest fat content of 4.27% at 50^{0}C, lowest fat content 2.26% at 70^{0}C and moderate fibre and ash contents of 0.88% and 1.73% respectively at 60^{0}C. lastly, blanched sample had the highest fat content of 4.11% at 50^{0}C, lowest fat content 2.54% at 70^{0}C and moderate fibre and ash contents of 0.83% and 1.45% respectively at 60^{0}C.

***Keywords**: plantain, pre-treatment, drying, temperature*

1. Introduction

Drying is an important unit operation in the preservation and processing of food and agricultural materials. It decreases the water activity of a high moisture food product thereby inhibiting microbial and fungal deterioration. Drying improves storability, reduces packaging and haulage costs, enhances appearance, retains flavor and maintains nutritional value (Saeed *et al.*, 2008). The maintenance of the freshness of fruits and vegetables is one of the most difficult aspects of fruits and vegetables production in the tropics. Physiological deterioration which results during storage due to natural reactions lead to significant loss of nutritional value and in many cases, loss of the whole fruits or vegetable. It also arises from actions of biological or microbiological agents such as insects, rodents and other animals, bacteria, mould, yeast and viruses (William *et al.,* 1991).

Plantain (*Musa paradisiaca*) belongs to the family of plants referred to as *Musaceae*. It is a carbohydrate staple in humid tropical zone of Africa, Asia, Central and Southern America. Most of the production of plantain occurs in Central and West Africa, with Uganda and Rwanda together accounting for 41% of all plantain production worldwide (Robinson, 1996). It was reported by Danso *et* al. (2006) that chromium (Cr), zinc (Zn), selenium (Se), iron (Fe), cobalt (Co), manganese (Mn), and copper (Cu) are present in plantain as micronutrients. These micronutrients are very essential to human life. Their presence in plantain therefore makes it suitable for food, particularly in areas where micronutrient deficiencies may be prevalent. Plantain and banana are among the most important staple food crops in humid forest zone of west and central African. This is due to the crops contribution to food security, employment, diversification of income resources in rural and urban areas and contribution to the gross national products (GNP) (Nkendah and Akyeampong, 2003).

Plantains are of great nutritional importance. The proximate analysis reported for plantain by USDA (2005) shows that per 100g edible portion, plantains contain 67.30 g water, 116 kcal of energy, and 31.15 g of carbohydrate. The report also shows that plantains are rich in some minerals, notably phosphorus (28 mg per 100g edible portion) which is good for bone development, and potassium (45 mg per 100 g). It is reported that plantain composes of mainly water, 60% and 27-31% carbohydrate with only 2-3%, protein about 1% fat (Oyenuga, 1968). Therefore, the objective of this study is to investigate the effects of drying temperature and pre-treatment on the proximate composition of the dried green plantain.

2. Materials and methods

The dryer used for the study was designed and fabricated by Omodara (2011). The dryer consists of heating chamber having three electrical heating coils of 1.8 kW each, connected directly to a centrifugal fan of 0.5 hp and drying chamber as

shown in figure (1a) and (1b) below. The heating coils are connected in series and the whole unit connected to the temperature regulator (0-400°C) which controls the temperature of the heaters. The drying cabinet measures 500 mm long, 500 mm wide and 800 mm high (with external dimension of 560 mm x 560 mm x 860 mm) consisting of three set of trays separated by 150 mm clearance. The drying chamber is double walled insulated with fibre glass with a thickness of 3 mm. The drying trays with an area of 500 mm x 500 mm were made from one inch square pipe with expanded metal having an aperture wide enough to allow free flow of heated air. Other apparatus included an infrared moisture meter (Model AD-4714A), plantain slicer, sensitive weighing balance, grinder (Polymix-PX-MFC90D), stainless steel knife, thermo-hygrometer, and distilled water.

Figure.1.a. Pictorial front view of the dryer Showing temperature regulator

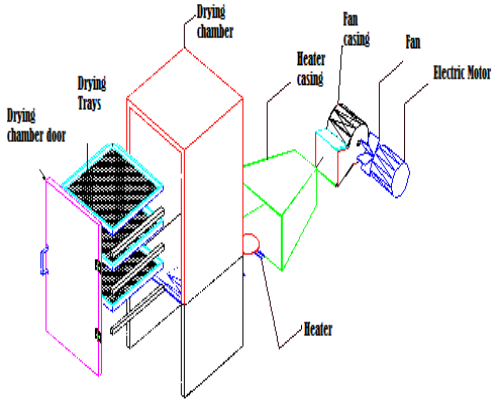

Figure 1.b. Exploded view of the dryer

2.1. Sample Preparation for Analysis

Green, mature, healthy and freshly-harvested plantain bunches '*Agbagba*' (false horn) which were free from any form of mechanical injuries was purchased from a produce merchant within Ilorin metropolis. Samples were weighed using a top loading balance—Snowrex Counting Scale (Model SRC 5001, Saint Engineering Ltd., London, UK) with an accuracy of 1 g and range 0 - 5000 g.

The fruits were rinsed in clean water at room temperature and cut with the plantain slicer to a thickness of 5 mm. 1000g of the samples were blanched in 2000 mls of boiling water at 90 ^{0}C for three minutes. A second set of the samples were left unpeeled, cut into half and put into 4000 mls of boiling water for five (5)

minutes. All samples subjected to hydrothermal treatment (blanching and boiling) were drained, weighed and checked for sample weight and moisture content before drying commenced. A third sample was also prepared which served as the control sample.

2.2. Drying Procedure

The dryer was pre-heated to a temperature of 40^0C by means of a thermostat while the samples were being prepared to ensure stability of the condition of the drying chamber. After arranging the trays in the dryer, the fan was switched on and set to a velocity of 0.5 m/s using the fan regulator with the speed measured with the anemometer. The initial condition of the environment and the drying chamber were recorded immediately after loading. 100g samples of green plantain were cut into slices with slicer, pretreated at three levels (Control, Blanched, and Boiled) and dried at three levels of drying temperature (50, 60 and 70°C) with each experiment carried out in triplicates. The drying samples were weighed at 1 hour intervals as the drying continued from an initial moisture content of 62% (wb) until the desirable moisture content of 11 % (wb) was reached.

3. Result and discussion

3.1 Quality Analysis of the Dried Plantain

The quality analyses of dried plantain were determined at the Biochemistry Laboratory of the Nigerian Stored Products Research Institute (NSPRI) Ilorin Kwara State Nigeria, using the AOAC (1990) standards. The parameters considered include the crude protein; crude fat; crude fibre; and ash contents of the dried samples at different level of drying temperature as shown in table 1.

Table 1. Quality Characteristics of the Dried Plantain

	Temperature	Protein*	Fat*	Fibre*	Ash*
Control	50	4.11 ± 0.021	3.02 ± 0.031	0.69 ± 0.017	1.63± 0.062
	60	4.26 ± 0.024	2.83 ± 0.181	0.69 ± 0.050	1.81 ± 0.081
	70	4.09 ± 0.133	3.19 ± 0.198	0.82±0.096	2.15 ± 0.137
Boiled	50	4.26 ± 0.051	4.05 ± 0.237	0.97 ± 0.073	1.62 ± 0.094
	60	3.96 ± 0.084	3.76 ± 0.073	0.88 ± 0.025	1.73 ± 0.057
	70	4.02 ± 0.055	2.28 ± 0.082	0.77 ± 0.026	1.89 ± 0.075
Blanched	50	4.11 ± 0.062	2.79 ± 0.156	0.94±0.054	1.29 ± 0.128
	60	3.75 ± 0.054	2.63 ± 0.100	0.83 ± 0.048	1.45 ± 0.152
	70	3.78 ± 0.048	2.55 ± 0.064	0.83 ± 0.056	1.56 ± 0.062

**Each value is the mean of triplicates ± standard deviation of proximate composition of protein, fat, fibre and ash content of dried plantain.*

The results of the statistical analysis of variance (ANOVA) for the effects of pretreatment on the proximate composition of dried plantain are shown in Table 2.

Table 2. ANOVA for the Effects of Pretreatment and Temperature on the proximate composition of dried plantain.

S.V	D.F	S.S	M.S	F	P>F
a. Crude Protein Content					
Pre- treatment (P)	2	0.698	0.349	77.206*	0.000
Temperature (T)	2	0.608	0.304	67.197*	0.000
P × T	4	0.111	0.028	6.122*	0.001
Error	18	0.163	0.005		
Total	26	2.465			
b. Crude Fat Content					
Pre- treatment (P)	2	3.816	1.908	78.477*	0.000
Temperature (T)	2	2.548	1.274	52.408*	0.000
P × T	4	3.347	0.837	34.414*	0.000
Error	18	0.875	0.024		
Total	26	20.239			
c. Crude Fibre Content					
Pre- treatment (P)	2	0.041	0.021	1.430	0.253
Temperature (T)	2	0.200	0.100	6.9138*	0.003
P × T	4	0.105	0.026	1.808	0.149
Error	18	0.520	0.014		
Total	26	2.465			
d. Crude Ash Content					
Pre- treatment (P)	2	1.286	0.643	30.833*	0.000
Temperature (T)	2	0.404	0.202	9.679*	0.000
P × T	4	0.194	0.011	0.510	0.729
Error	18	0.751	0.021		
Total	26	2.906			

*significantly different at $p \leq 0.05$

It can be observed from the table that the Pretreatment and drying temperature are significant factors on the proximate composition of the dried plantain except for crude fibre that the pretreatment is not significant. The interaction between the pretreatment and temperature is also significant factor that affect the crude protein content and crude fat content but has no effect on the crude fibre content and crude ash content of the dried plantain.

3.2. Effect of drying temperature on the proximate composition of dried plantain

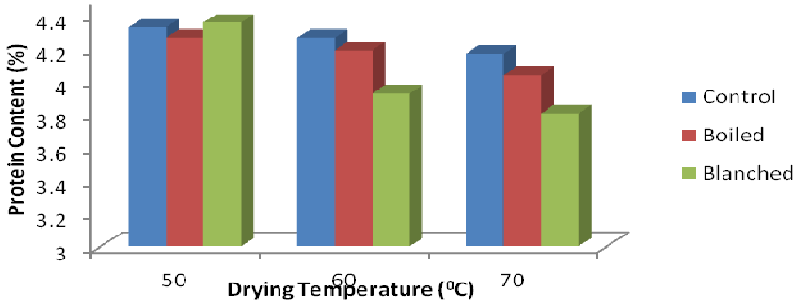

Figure 2. Effect of drying temperature on the protein content of dried plantain.

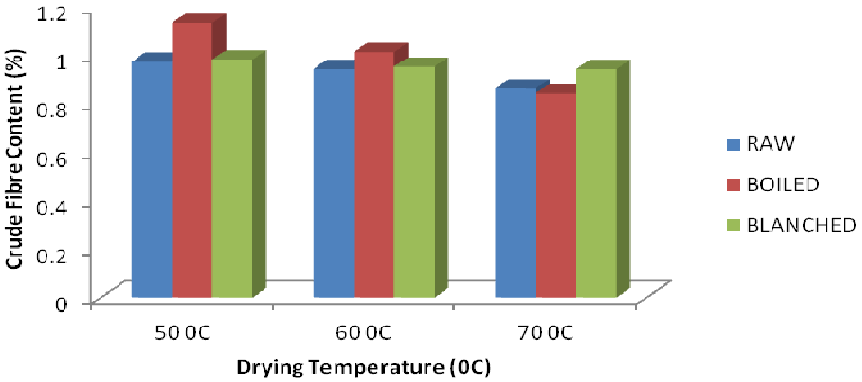

Figure 3. Effect of drying temperature on the crude fibre content of the dried plantain.

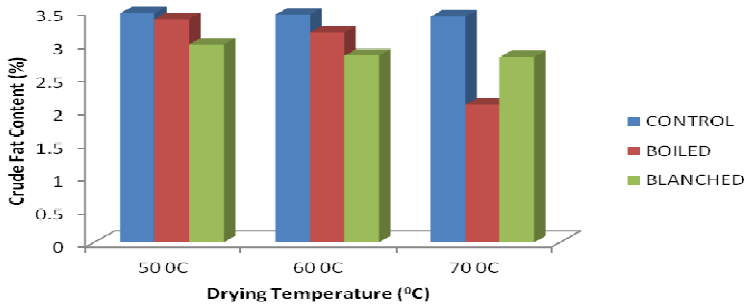

Figure 4. Effect of drying temperature on the crude fat content of dried plantain

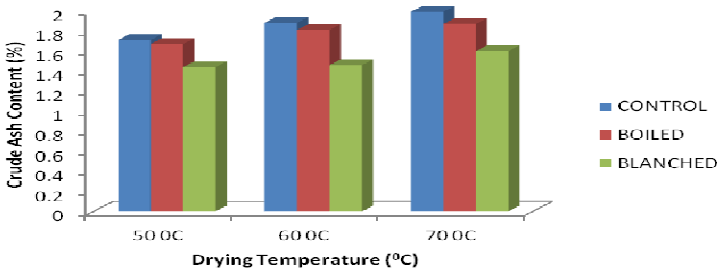

Figure 5. Effect of Drying Temperature on the Crude Ash Content of the Dried Plantain.

3.3. Effect of drying temperature on the proximate composition of dried plantain

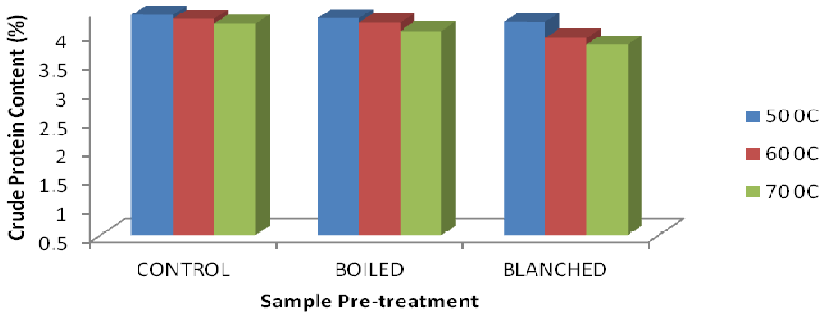

Figure 6. Effect of pre-treatment on the protain content of the dried plantain

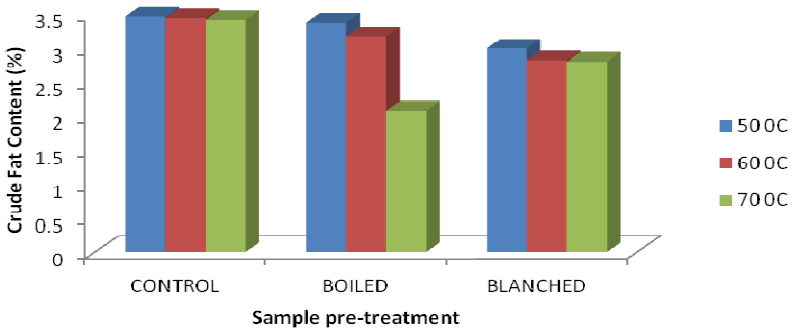

Figure 7. Effect of pretreatment on the crude fat content of dried plantain

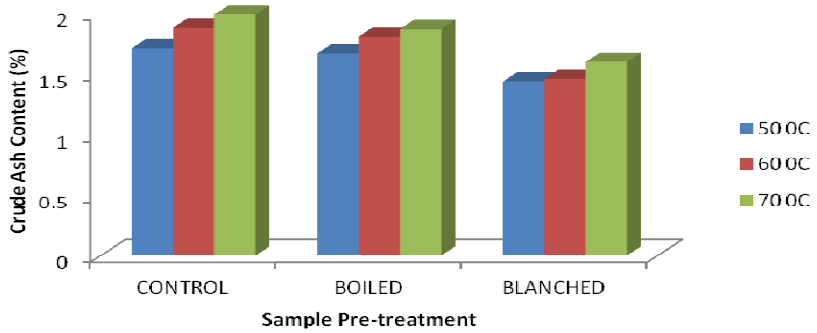

Figure 8. Effect of pretreatment on the crude ash content of dried plantain

4. Conclusion

Generally, the higher the drying temperature the lower the proximate composition retained by the dried plantain. The protein, fat and fibre content of green plantain reduced with increase in drying temperature while the ash content increased with increase in drying temperature irrespective of the pre-treatments.

The controlled and boiled pre-treatment has the highest protein content. Lower fat content was observed in the boiled samples as compared to the controlled and also the boiled sample dried at low temperature of 50^0C. Blenched sample has lower protein content when compared with controlled and boiled samples and high fat content as compared with boiled samples.

References

[1] ***** AOAC, *Official Methods of Analysis of the Association of Official Analytical Chemists*, 15th ed., Arlington, Virginia, USA, 1990.

[2] Danso K.E., Adomako D.; Dampare S.B., Oduro V., *Nutrient Status of Edible Plantains (Musa spp) as Determined by Instrumental Neutron Activation Analysis*., Journal of Radioanalytical and Nuclear Chemistry, 2006, 270(2): 407-411.

[3] Nkendah R., Akyeampong E., *Socio-economic Data on the Plantain Commodity in West and Central Africa*. Info Musa, 2003, 12 (1).

[4] Oyenuga V.A., *Nigeria's Food and Feeding Stuffs, their Chemical and Nutritive Value*, Ibadan University Press. University of Ibadan, Nigeria, 1968.

[5] Robinson J.C., *Bananas and Plantains. Crop Production Science*, Horticulture Series. CAB International, Wallingford, UK, 1996, pp5.

[6] Saeed I.E., Sopian K., Abidin Z.Z., *Drying Characteristics of Roselle (1): Mathematical Modeling and Drying Experiments*, Agricultural Engineering International: the CIGR Ejournal. Manuscript FP 08 015. Vol. X, 2008.
[7] USDA. Plantains. National Nutrient Database for Standard Reference, 2005, Release 18. http://www.everynutrient.com/files/Health_Benefits_of_Plantains.mht Accessed on 06/02/2010
[8] William C.N., Uzo J.O., Peregrine W.T., (1991). *Vegetable Production in the Tropics*. Longman Publishing Ltd. pp. 70-71.
[9] In Mukhtar F.B., *Effect of Storage Temperature on Post-Harvest Deterioration of Banana and Plantain*, International Journal of Pure and Applied Science. 2009, Vol. 3:28-38.

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