International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 5 Issue 3, March-April 2021 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Effect of Different Drying Methods on Chemical Composition of Unripe Plantain Flour

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ABSTRACT

Food processing is often thought to bring about changes in nutrients content, thus decreasing its patronage. To investigate this in a Nigerian staple, unripe plantain (*Musa paradisiaca*) flours were prepared following sun drying and oven drying methods. These were compared against fresh plantain for their nutritional composition. Proximate composition and minerals contents were determined using standard AOAC methods. The results showed that the unripe plantains pulp contained 59.77%, 1.42%, 1.51%, 1.40%, 7.65%, 28.23%, 40.22% and 38.80% of moisture, ash, fat/oils, crude fibre, crude protein, carbohydrates, dry matter and organic matter respectively. Calcium, sodium, potassium, iron, and nitrogen were determined to be 0.1534 ppm, 0.2613 ppm, 0.3034 ppm, 0.7808 ppm and 0.2240 ppm respectively. The processing methods produced flour with similar nutritional composition. However, oven drying gave the lowest moisture content in the flour, suggesting a higher capacity to prevent microbial growth and decay in the dried sample, hence prolonging storage life.

KEYWORDS*: Flour, Plantain, Nutritional, Drying, Processing, Storage*

How to cite this paper*:* Segilola, V. O | Amodu, S. O | Olatunji, C. A "Effect of Different Drying Methods on Chemical Composition of Unripe Plantain Flour" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-5 | Issue-3, April 2021, pp.397-400, URL: www.ijtsrd.com/papers/ijtsrd38725.pdf

IJTSRD38725

INTRODUCTION

Plantains (*Musa parasidiaca*) is one of the important staple food crops consumed in the tropics behind rice, wheat and maize and are obtainable in about 120-130 tropical countries in the world (Mephaet *al.,* 2007). It is an essential food crop in sub-Sahara Africa that serves as source of nutrient and household income for many people around the world (Mephaet *al.,* 2007). The aggregated world production is put at over 76 million metric tons (Salawuet *al.,* 2015), out of which over 12 million metric tons are harvested yearly in Africa (Agoyeroet *al.,* 2011). Sizeable tons of plantains are harvested in Nigeria annually and Nigeria is the biggest producer of plantains in West Africa with an estimated production of about 2.7 million metric tons, majority of which are produced and harvested from the southern part of the country (FAO, 2009).

In spite of large tons of plantains harvested yearly in Nigeria, Abiodunet *al*., (2012) reported that over 50% of plantains harvested are lost due to the unavailability of appropriate storage facilities to prevent postharvest losses. These large productions and post-harvest losses necessitate the need to develop new and suitable technologies for processing and preservation of plantain flour for time to come. Usually harvested at matured but unripe stage, plantains undergo rapid respiration after harvest, making it a short-lived agricultural product that requires urgent attention immediately after harvest. Plantain may therefore be processed into flour when it is matured but not ripe. Traditionally, sun drying is the common method used in processing plantains into flour. However, there are some problems associated with sun drying such as slowness of the process, the uncertainty of the weather and uneven drying (Abiodunet *al.,* 2012)). Baiyiriet *al.* (2011) reported that drying is one of the best methods in terms of cost efficiency to preserve plantain flour in other to have plantain products with considerable shelf stability. Drying serves as a suitable and cheap means for removing water from plantain which adds value to plantain and this result in the production of convenience product having suitable shelf life (Adepojuet *al.,* 2011).

Drying is one of the best techniques used in the processing of agricultural produce and many kinds of researches have been done on the drying of different agricultural produce. It is done to reduce moisture below levels required for microbial and enzymatic reactions (Baiyiriet *al.,* 2011). According to Abiodunet *al.* (2012), different drying methods can be used for drying plantain fruits. Microwave, oven and freeze-drying have been previously used to dry plantain flour (Emperatrizet *al.,* 2008). The effects of freeze-drying, drum drying, microwave and oven drying on quality attributes of plantain flour have been reported. The need for a hygienic, effective drying method is apparent. The end use of plantain flour in food depends on the attractiveness of its colour. Enzymatic browning reaction is one of the problems encountered during plantain processing and this reaction often affects the colour of the flour produced from plantain.

The browning reactions usually occur during processing because of the activity of polyphenol oxidase that is also known as tyrosinase (Adeniyi*et al.,* 2009). It is therefore essential to pretreat plantain slices during processing to arrest the browning, which if not arrested may affect the colour of the final product. Therefore, to intensify the use of plantain flour in food products, it is necessary to establish the best drying method to produce plantain flour of good quality. The objectives of the study were to determine the effect of drying methods on the chemical composition of unripe plantain flours.

Materials and methods

Collection of Plantain: The matured unripe plantain fruits for this work were purchased from the Teaching and Research Farm of Rufus Giwa Polytechnic, Owo, Ondo State, Nigeria. Plantain of the same variety and maturity level were carefully selected.

Preparation of Plantain flour: The selected plantains fruits were processed in the Department of Food Science and Technology Laboratory, Rufus Giwa Polytechnic, Owo, Ondo State. The plantain fruits were washed, hand-peeled and sliced using a plantain slicer in other to obtain slices of the same thickness. The sliced plantain was divided into three portions, two of the samples were then dried using solar and oven drying methods while the last one was used as control (fresh). They were then milled and stored in ziplock bags for further analysis (Zakpaa*et al.*, 2010).

Proximate Composition of the Plantain Flour samples: The proximate composition of the samples were done using the methods describe by AOAC (2005).

Mineral Composition of Plantain Flour Samples: Minerals in the samples were determined using AOAC (2005) methods. Into a digestion tube 1 g of the sample was weighed, 15 ml of concentrated Nitric acid (HNO_3) added to each sample and digested for 30 min at 150 °C in a digester in a fume chamber. The sample was digested until the solution was pale yellow, and allowed to cool. 10 mL of concentrated perchloric acid (70 % $HClO_4$) was added and the digestion continued at 200 °C until the solution was colourless. After complete digestion, the solution was cooled slightly and 80 ml of distilled water added. The mixture was boiled for about 10 min and filtered through Whatman No. 42 filter paper into 250 ml volumetric flask. The solution was then made to the mark with distilled water.

Determination of Ca, Na, K and Fe: The concentrations of Ca, Na, K and Fe were determined using Atomic Absorption Spectrophotometer (Spectra AA220FS Model). The mineral contents in the samples were then calculated and results expressed in part per million (ppm).

Results and Discussion

Table1: Proximate composition of fresh plantain, sundried and oven dried unripe plantain flours

Parameter	Fresh	Oven-dried Sun-dried	Sun-dried
Moisture	9.77±0.03^{a}	9.09±0.01^{c}	15.00±0.01^{b}
Ash	1.42±0.01^{b}	5.44±0.01^{a}	4.80±0.01^{a}
Fat	1.51±0.02^{a}	1.55±0.01^{a}	1.37±0.01^{b}
Crude fibre	1.40±0.02^{b}	10.11±0.01^{a}	10.43±0.01^{a}
Crude protein	7.65±0.01^{a}	3.60±0.01^{b}	3.34±0.01^{b}
Carbohydrates	28.23±0.06^{c}	70.19±0.01^{a}	65.04±0.03^{b}
Dry matter	40.22±0.03^{c}	90.90±0.01^{a}	84.99±0.01^{b}
Organic matter	38.80±0.02^{b}	85.46±0.01^{a}	80.19±0.00^{a}

Values are means± standard deviation. The values in a row followed by the same superscripts are not statistically significantly different at a significance level of 5%

Table 2: Mineral composition of fresh unripe plantain, sundried and oven dried unripe plantain flours.

Parameter	Fresh	Oven-dried	Sun-dried
Calcium (ppm)	0.1534	0.4229	0.5385
Sodium (ppm)	0.2613	0.7955	0.9108
Potassium (ppm)	0.3034	1.8905	0.8170
Iron (ppm)	0.7808	0.7963	0.0239

The results of proximate analysis of fresh, sundried and oven-dried samples are given below (Table 1). The result showed that plantain contained appreciable amounts of carbohydrates, whether fresh or processed. Moisture and the protein content of plantain were lowered by the two drying methods tested in this study. Crude fibre, carbohydrates, dry matter, ash content and organic matter contents were higher in the drying methods employed here. Decrease in these macronutrients may be attributed to the application of heat. Similar losses of these macronutrients after heat treatment have been reported (Onuoha*et al.*, 2014; Enomfon-Akpan and Umoh, 2004; Morris *et al.*, 2004). The application of heat can be both beneficial and detrimental to nutrients. Heat improves the digestibility of food, promotes palatability and improves the keeping quality of food, making them safe to eat. The heating process also results in nutrients' losses by inducing biochemical and nutritional variation in food composition.

The apparent increase in carbohydrate, dry matter, organic matter, ash and fibre contents observed in this study following drying treatments could be because of the removal of moisture that tends to increase the concentration of nutrients (Morris *et al.*, 2004). Processing has been reported to increase carbohydrates availability in a more digestible form (Emperatriz*et al.*, 2008). These could explain the significant difference ($P<0.05$) observed in the carbohydrates content of processed samples (oven-dried and sundried plantain flour).

The moisture content for the fresh plantain was determined to be 9.77% in agreement with 9.4% and 9.612% reported by Adepoju*et al.* (2012) and Agoyero*et al.* (2011) respectively. The moisture content of flour was determined to be 9.09% (oven-dried) 15.01% (sundried) as compared to 11.03% (oven dried) and 13.00% (sundried) reported by Agoyero*et al.* (2011). These values were all significantly different ($P<0.05$) from each other. Moisture content of food or processed products gives an indication of its anticipated shelf life. Low moisture content is a requirement for long storage life. During storage, fungal growth is bound to be observed on moist food samples. Fungal food contamination could be a predisposing factor to food poisoning such as aspergillosis. Since a well-dried food sample withstands fungal and other microbial infestation better during storage, oven dried flour gave lower residual moisture content, hence should be preferred.

Fat, indicating the total lipid content of the plantain was shown to be 1.51% (fresh), 1.37% (sundried) and 1.55% (oven dried) (Table 1). Agoyero*et al.* (2011) reported unripe plantain fruit gives values as 2.75% (fresh), 1.38% (sundried) and 1.57% (oven dried) while Adepoju*et al.* (2012) reported 1.50% (fresh) and 3.90% (sundried). The fresh and oven dried samples are not significantly different

(P>0.05), but these are significantly different (P<0.05) from the sun dried sample. These results agree. Variations could be due to intensity of sunlight during the drying process, extent of dryness because sun drying has no objective way of assessment. The difference observed between sundried and oven dried samples could be as a result of solar radiations mediated oxidation of the composite lipids, especially the unsaturated fatty acids thereby decreasing the overall crude lipids content and quality. Nutrients have been reported to be lost because of chemical changes such as oxidation. Lipid oxidation is known to be increased by many factors such as heat, sun light and radiations (Savage *et al*., 2002).

Minerals, being inorganic are not destroyed by heating. They have low volatility compared to other food components. The increased ash (Table 1) consequently calcium, sodium, potassium (Table 2) observed in this study could be as a result of the removal of moisture which tends to increase concentration of nutrients per 100g of a food sample (Morris, *et al*., 2004). This is evident by the percentage organic matter content as it significantly differs (P<0.05) between the different methods of treatment studied. Since sun drying proceed slower than oven drying, it is obvious that this prolonged drying period leaves room for several biochemical reactions to occur freely under atmospheric oxygen conditions (Wiriya*et al.,* 2009). This holds many prospects in reducing the availability of the nutrient. The decrease in the iron content of the sundried sample suggests the anti-nutritional factors; oxalate and phytate (unfortunately these were not determined in the present study) could be present in the sample, thereby making the mineral unavailable by forming complexes with them, as reported by Enonfon-Akpan and Umoh, (2004).

The highest calcium value of 0.5385 ppm was observed from the sundried sample while the fresh sample had the least value, 0.1534 ppm (table 2). This is less than the 7566.53±0.93 mg/100kg reported by Salawu*et al*. 2015. While the 0.44±0.00 ppm reposted by Onuoha*et al*. (2014) is more than the fresh sample but less than the sundried sample. Sodium followed a similar trend, being highest in sundried sample (0.9108) and least (0.2613 ppm) in the fresh sample. Potassium was highest in the oven dried sample (1.8905 ppm), and lowest in the fresh sample (0.3034 ppm). These values are all less than those reported by Onuoha*et al*. (2014) and Salawu*et al*. (2015) for both sodium and potassium. Iron had a similar pattern as potassium. It was highest in the oven dried sample (0.7963 ppm) and lowest in the sundried sample (0.0239 ppm). The rich content of calcium, sodium, iron and potassium in the unripe plantain pulp could be attributed to factors such as soil mineralization and fertilization. Variations in mineral content in crops tend to be high, owing to varying degree of ripeness, geographic and soil factors (Gibbon and Pain, 1985; Morel *et al*., 1985; Zakpaa*et al*., 2010). These are thought to play a role here as well. These show unripe plantain to be a rich source of these minerals, especially potassium, sodium and iron. Processing does not eliminate the mineral contents.

There was a significant (P<0.05) decrease in crude protein content between the fresh sample and the dried ones. This implies drying does not conserve proteins in plantain. The crude protein content of fresh sample was determined to be 7.65% while 3.35% and 3.61% for the sundried and oven dried samples respectively. These agree with the 3.6% and 3.86 protein in unripe plantain powder reported by Salawu*et al*. (2015). In the presence of atmospheric oxygen, proteins contained in exposed tissues tend to react, forming several intermediates which make the amino group of the amino acids non bio-available. Decrease in protein content probably occurred because of Millard reaction; which results between carbohydrates and protein (Morris*et al*., 2004). It could also be due to drying under elevated temperatures. Similar losses of crude protein by the application of heat have been reported (Hassan *et al*., 2007; Enonfon-Akpan and Umoh, 2004; Morris *et al*., 2004). Application of heat can be both beneficial and detrimental to nutrients. Heating improves the digestibility of food, promotes palatability and improves the keeping quality of food, making them safe to eat.

Conversely, the heating process also result in nutritional losses by inducing biochemical and nutritional variations in food composition, especially sun heating. Since plantain are consumed majorly for its energy content, this significant decrease in crude protein due to processing does not invalidate the need for food security by processing nor the acceptance of this food sample in its processed form. Moreover, the gain from energy seems to appreciate significantly (P<0.05) (table 1).

The crude fibre was significantly different (P<0.05) between the fresh sample and the processed samples (table 1). It was determined to be 1.41% in agreement with the 1.40% reported by Adepoju*et al*. (2012). Values for sundried and oven dried were 10.43% and 10.12% respectively. These are in agreement with the 10.43% and 10.11% reported for sundried and oven dried respectively by Agoyero*et al*. (2011). Crude fibre represents the content of the non-digestible components of food, such as lignin, cellulose and hemicelluloses. These are essential in animal nutrition, since they enhance the transit time through the bowels, facilitates bowels movement thus reducing the risk of colon cancer.

Ash is the inorganic residue after the water and organic matter have been removed by burning a food sample. Ash was significantly different (P<0.05) between the fresh sample and the processed samples (table 1). It was determined to be 1.43% from the fresh sample, which is in agreement with the 1.40% reported by Adepoju*et al*. (2012). The dry matter content was 40.23%, 90.91% and 84.99% for fresh, oven dried and sundried samples respectively. Organic matter content was 38.80%, 85.47%, and 80.19% for fresh, sundried and oven dried samples respectively.

Conclusion and Recommendation

Based on the results obtained from the study, the two drying methods were all good as they all yielded nutritional constituents with minimal differences from the fresh sample. However, to obtain fast drying, conserve protein and iron content, the oven drying method though likely to be more expensive is recommended, while the sun-drying method is cheaply executed, takes a longer time and may be prone to contaminations from microorganisms due to unhygienic exposures.

Further studies could focus on the microbial contamination of the flours from respective processing methods, fatty acids profile and amino acid profile analysis. Moreover, the reducing sugars content and the glycemic index of the flours need to be examined. This will provide the necessary information to adopt this food sample as a dietary source for special nutritional cases, such as diabetics, depending on the results obtained.

References

[1] Morris, A. A., and Barnett, B. (2004). Effects of processing on nutrient content of foods. *Cajarticles*, 37:160-164.

[2] Savage, G. P., Dutta, P. C. and Rodriguez-Estrada, M. T. (2002). Cholesterol oxides: Their occurrence and methods to prevent their generation in foods. *Asian Practical J. Clin. Nutri*. 11:72-78

[3] Zakpaa, H. D., Mak-Mensah, E. E., and Adubofour, J. (2010). Production and characterization of flour produced from ripe "apam" plantain (*Musa sapientum L. var. paradisiaca* French horn) grown in Ghana. *J. Agric. Biotech. Sus. Deve.* 2(6):92-99

[4] Wiriya, P., Paiboon, T., and Somchart, S. (2009). Effect of drying air temperature and chemical pretreatments on quality of dried chilli. *Intern. Food Res. J.* 16:4 – 7

[5] Salawu, S. O., Shaibu, R., Afolabi, A. A., Boligo, A. A. and Athayde, M. L. (2015). Nutraceutical potential and sensory acceptability of unripe plantain-millet Composite Flour Blends. *Food Sci. Qual. Mngt*., 39:84-97

[6] Emperatriz, P. D., Ronald, M., Elvina, P., and Mily, S. (2008). Production and Characterization of unripe plantain (*Musa paradisiaca*) flours *Interciencia*, 33:290 – 296

[7] Baiyeri, K. P., Aba, S. C., Otitoju, G. T. and Mbah, O. B. (2011). The effects of ripening and cooking methid on minerial and proximate composition of plantain (*Musa*sp AAB cv "Agbagba") fruit pulp. *Afric. J.Biotech.* 10(36): 6979 – 6984

[8] AOAC (2005). Official Methods of Analysis, Association of Official and Analytical Chemists, Washington, D. C. USA 17thEdnpp 807 – 928

[9] Adepoju, O. T., Sunday, B. E. and Folarami, O. A. (2012). Nutrient composition and contributions of plantain, (*Musa paradisiaca*) products to dietary diversity of Nigerian consumers. *Afric. J. Biotech.* 11(71):13601-13605

[10] Agoyero, B. O., Akpiroroh, O. O., Osaweren, O. R. and Owabor, C. N. (2011). The effect of various drying methods on the nutritional composition of *Musa paradisiacal Dioscorearotundata* and *Colocasiaesculenta*. *Asian J. Biochem*. 6:458-464

[11] Enomfon-Akpan, J. and Umoh, I. B. (2004). Effects of heat and tretracycline treatments on the food quality and acridity factors in cocoyam *Xanthosomasagittifolium* (L) Schott. *Pakistan J. Nutri*. 3:240-243

[12] FAO (2002). Human Vitamins and Mineral requirements. United Nations Vaile DelleTerme di Carcalla, 00100 Rome, Italy.

[13] Gibbon, D. and Pain, A. (1985). Crops of the drier regions of the Tropics. ECBS, pp 221 - 235

[14] Morel, C., Blaskewitz, J., Fardeau, J.C. (1985). Phosphorus supply to plants by soils with variable phosphorus exchange. *J. Soil Sc.* 160 (6), 423-430

[15] Onuoha, O. N., Eme, P. E., and Ekpo, U. E. (2014). Chemical evaluation of unripe plantain dishes commonly consumed by type 2 diabetics attending the University of Uyo Teaching Hospital in AkwaIbom State, Nigeria. *Pak. J. Nutri.* 13(6):331-334.

[16] Adeniji, T. A., Sani, L. O., Barimalaa, I. S., and Hart, A. D. (2009). Nutritional and antinutritional composition of flour made from plantain and banana hybrid pulp and peel mixture. *Nig. Food J.* 25(2): 234-241

[17] Abiodun, A. A., Bolanle, O. O., and Sola, O. (2012). Preliminary study on the development and evaluation of instant pounded yam from *Dicscoreaalata*. *Journal of Applied Science Environmental Manage*. 16(3): 287-290.

[18] Mepba, H. D., Eboh, L., and Nwaojigwa, S. U. (2007). Chemical composition, functional and baking properties of wheat-plantain composite flours. *Afric. J. Food Agric. Nutri. Dev.* 7(1):1-22