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# Proximate and Mineral Composition of Plantain (*Musa Paradisiaca*) Flour obtained through Different Processing Methods

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**Abstract**
The study was conducted to determine the proximate and mineral composition of plantain (*Musa paradisiaca*) flour produced using different processing methods. The experimental design was 2x2 factorial fitted into Randomized Complete Block Design (RCBD). In investigating the proximate and mineral composition of plantain flour, 4 samples of plantain flour were prepared using direct and blanching methods of processing. The plantain chips gotten from the blanched plantain fingers and those that were not blanched (direct) were subjected to sun drying and oven drying. The four samples were coded as SDD (Sun Dry Direct), ODD (Oven Dry Direct), SDB (Sun Dry Blanching) and ODB (Oven Dry Blanching). The results showed that moisture content was low in all the samples which ranged between 9.6% - 10.24%, crude fat content was within the range of 0.45% - 0.84%, ash content was between 1.89% - 2.32%, crude protein was between 1.78% - 2.15%. Carbohydrates, dry matter, phosphorus, magnesium, calcium and potassium contents were high ranging from 83.82% - 88.45%, 89.68% - 90.37%, 125.62mg/100g – 153.40 mg/100g, 56.75mg/100g – 74.92mg/100g and 73.60mg/100g – 87.30mg/100g respectively. The apparent increase in these nutrients is as a result of the removal of moisture which tends to increase the concentration of food nutrients. Though, all the processing methods gave rise to flour with similar proximate and mineral composition, there was significant difference ($p<0.05$) in proximate analysis among different methods of processing. However, to achieve a fast drying and conserve more nutrients, the direct method of processing for both sun drying and oven drying is recommended.

***Keywords: Plantain flour, Proximate and Mineral composition and processing methods***

## Introduction

Plantain is a tree-like perennial crop with an underground rhizome and fibrous roots. It belongs to the family Musaceae and the genus Musa. Records have shown that plantain originated from Southeast Asia (IITA, 2009). Investigation results of scientists recorded sixty-eight species of plantain in the world with two hybrids (FAO, 1990). The most important parts of the plant are the fruits which are 3-10 inches or more in length depending on the cultivar. Plantain is a major starchy staple food in the Sub-Saharan Africa both for rural and urban populace, producing more than 25% of the carbohydrates and 10% of the daily calorie intake for more than 70 million people in the continent (Kayode, Ajiboye, Babayeju and Kayode, 2011). Ndayambaje, Dusengemungu and Bahati (2019) also stated that plantain (*Musa paradisiaca*) is one of the staple food crops consumed in the tropics behind rice, wheat and maize and are obtained in about 120 – 130 tropical countries worldwide. About 63 million tonnes of the crop are produced annually in the producing countries, allowing only a meager 10% for foreign financial earning through exportation (Awodoyin, 2003; Baiyeri, Aba, Otitoju and Mbah, 2011). Nigeria is one of the largest plantain producing countries in Sub-Sahara Africa but does not feature among plantain exporting nations because it produces more for local consumption than for exportation (FAO, 2010). This may be attributed to the perishability nature of the fruits and inadequate storage facilities as well as poor processing technology.

Plantain, though available all year round has its season of peak production. At the peak period of production there is more availability of the crop at affordable prices. Its abundance at the peak of harvest season is hardly contained (Yarkwan and Uvir, 2015). This leads to inadequate supply of plantain and plantain products during the off season of the crop. Since the storage life span of plantain is very short, plantain products can only be made available in sufficient amount during the off season if the fruits are processed within the shortest

period of time after harvest. Processing of plantain into flour is limited as most plantain food are eaten as boiled, fried and roasted (Oluwalana and Oluwamukomi, 2011). In Nigeria, plantain is commonly processed into flour traditionally and sun drying is the method used for plantain processing. The area where plantain is produced in large quantities is the rainforest belt where there is short period of dry season in a year. Depending on the sun as the source of heat for drying plantain during the raining season may expose the product to microbial infection that can reduce the quality of the flour. Conventional sun drying is the most common method applied in processing plantain into flour but there are a number of problems associated with it such as weather unpredictability, uneven drying, slowness of the process and possible damage of plantain flour by bacteria and insects (Ndayambaje *et al*, 2019). Thus the need for another method of drying other than sun-drying to make plantain flour available at all seasons. The consumption of plantain flour has risen tremendously in Nigeria in recent years because of rapidly increasing urbanization and the great demand for easy and convenient food by the non-farming urban population (Akinyemi, Aiyelaagbe and Akyeampong, 2010). Consumers may also want to know which method of drying plantain produces plantain flour of high nutritional value. There is paucity of information on the proximate and mineral composition of plantain flour produced using different drying methods especially blanching method. Hence, this study is designed to make such information available to both consumers and producers.

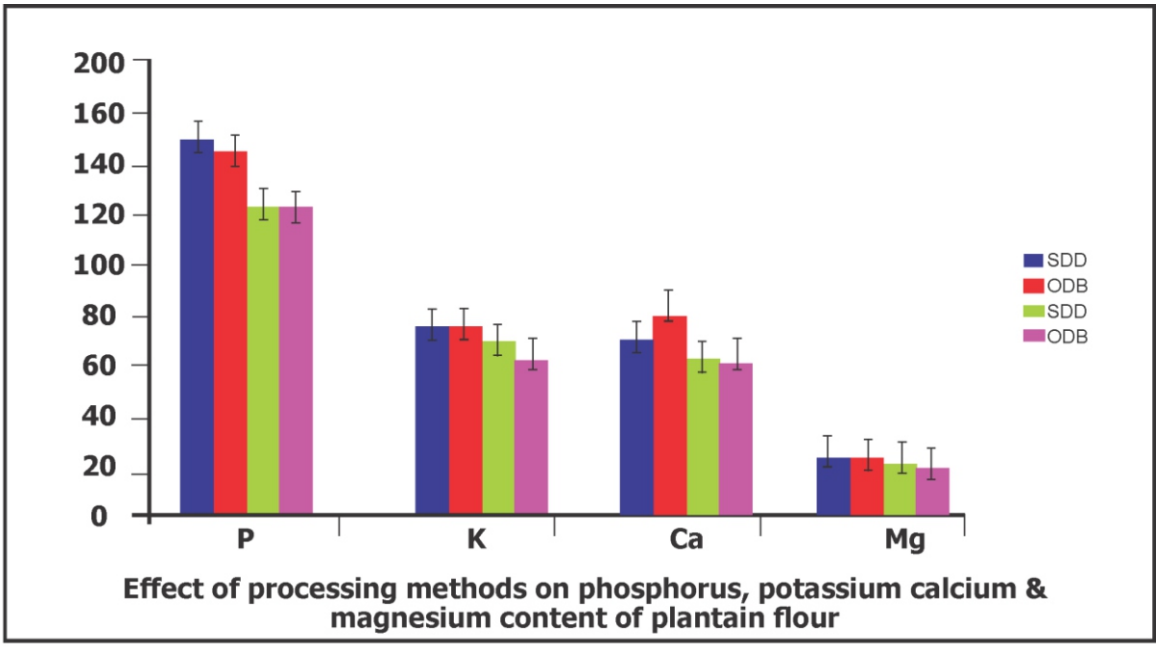
Plantain flour producers have always applied the direct methods of drying plantain chips whether it is sun-drying or oven drying. Little or nothing has been done about blanching plantain with its peels before drying. Plantain peels have been shown to contain considerable amount of nutrients. According to Happi-Emaga, Herenavalona – Adrianaivo, Wathelet, Tchango-Tchango and Paquot, (2007) peel from unripe fruit presents (on dry basis) 6 – 10% protein, 6 – 12% ash, 2 – 6% lipids, 11 – 39% is soluble dietary fibre (SDF) and 7 – 30% insoluble dietary fibre (IDF). Therefore some of the fingers were blanched with the peels before they were subjected to oven or sun drying while others were oven dried and sun dried directly.

**Materials and Methods**

The processing of the plantain flour was carried out during the dry season at Federal College of Education (Technical), Omoku, Ogba/Egbema/Ndoni Local Government Area of Rivers State. A big bunch of unripe plantain was shared into two parts. One part representing 'Direct' was washed, peeled and cut into chips. The chips were divided into two (2) parts and one part was oven dried at 60°c while the other was sun-dried. Again, the second part representing 'Blanching' was washed, blanched for five minutes, peeled and cut into chips. The chips were again divided into two (2) parts which were subjected to oven drying at 60°c and sun drying respectively. The four samples were dried until they became crispy and were milled into flour. The milled samples were sieved to produce very fine flour using a mesh size of 0.2mm.The samples were used for proximate and mineral composition determination. The laboratory analysis was carried out in agronomy laboratory of Federal University of Agriculture, Umudike. Parameters used for proximate composition were percentage moisture content, dry matter, ash, crude protein, crude fibre, fat and carbohydrate while parameters used for determination of mineral composition were nitrogen (%) phosphorus (mg/100g) calcium (mg/100g), potassium (mg/100g), carbon:nitrogen ratio (mg/kg) and minerals salt (mg/100g). Data were subjected to statistical analysis using analysis of variance, means were separated using fishers Least Significant Difference (LSD) and treatment effects and response trend were presented graphically using bar chart.

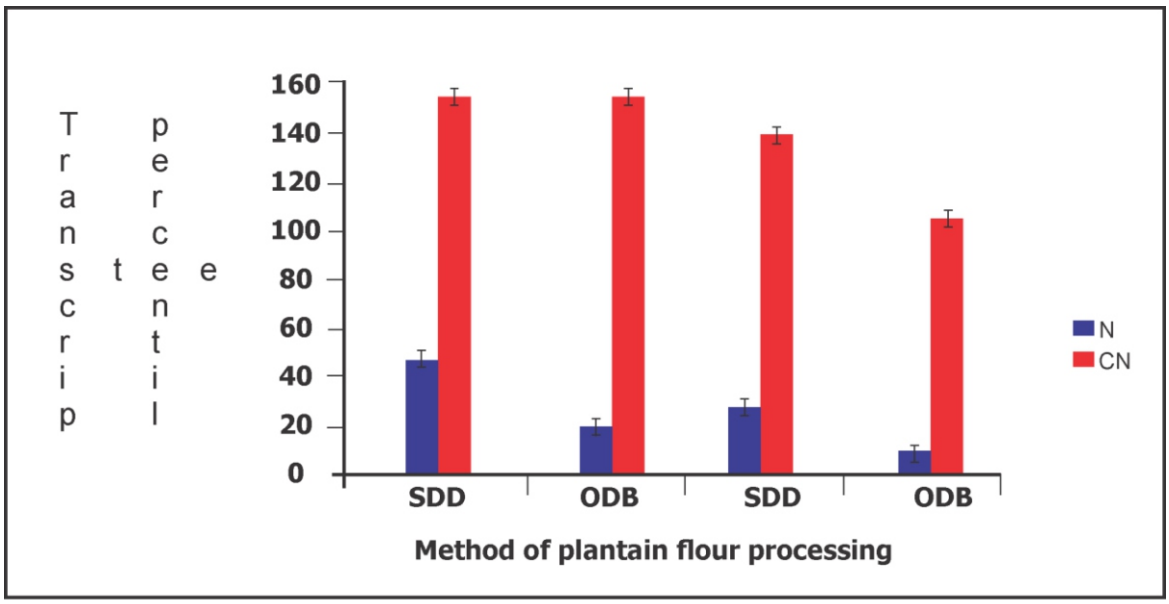
**Result and Discussion**

The results of proximate analysis and mineral composition of plantain flour produced using oven dry direct method; sun dry direct method, oven dry blanching method and sun-dry blanching method are presented in figures 1 – 4. The result of the mineral composition indicated that the content of mineral considered were lowest in samples obtained through oven dry blanching method (Nitrogen - 0.28%, Phosphorus - 125.60mg/100g, Potassium - 73.60mg/100g, Calcium - 56.75mg/100g, Carbon:Nitrogen ratio – 10.60mg/100g and Magnesium - 24.92mg/100g) while they were highest in sample produced from sun direct method (Nitrogen - 0.37%, Phosphorus - 153.40mg/100g, Potassium - 87.30mg/100g, Calcium – 74.92mg/100g,) except in Carbon:Nitrogen ratio and Magnesium contents in which sample from oven dry direct method were highest (Carbon:Nitrogen ratio – 16.45mg/100g and Magnesium - 29.62mg/100g) as seen in figures 1 and 2.




*SDD; OD; SDB & ODB means sun dried direct, oven dried direct, sun dried blanching, oven dried blanching: P, K, Ca, Mg means phosphorus, potassium, Calcium & Magnesium respectively*

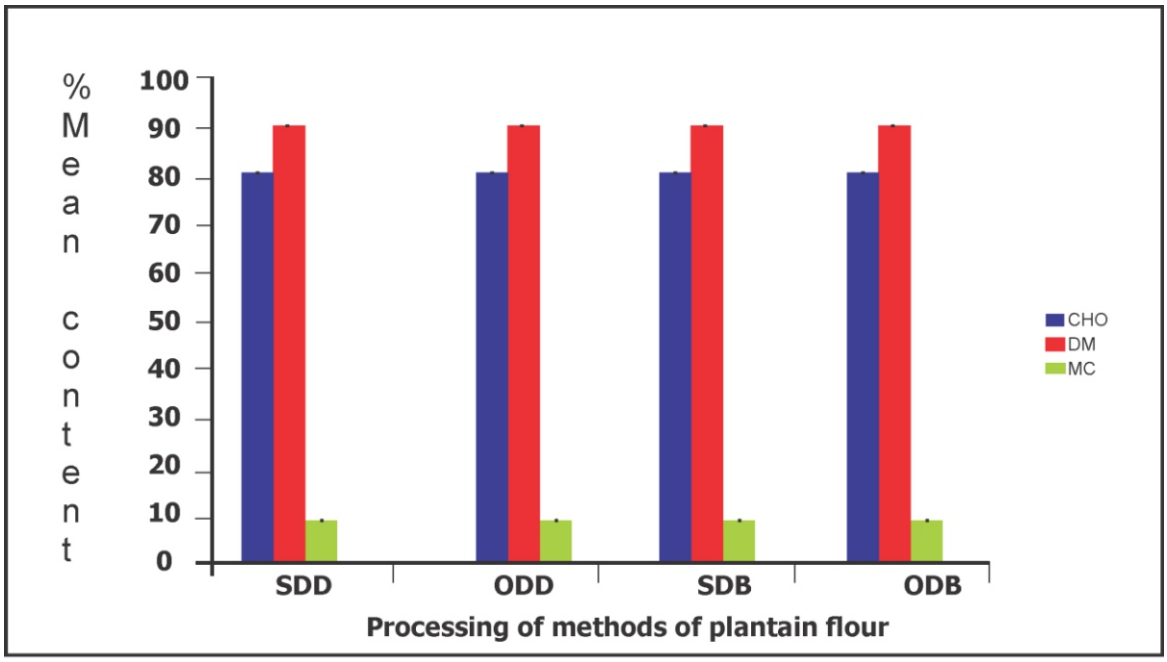
***Fig. 1: Effect of processing methods on some minerals content of plantain flour***




*SDD; OD; SDB & ODB means sun dried direct, oven dried direct, sun dried blanching, oven dried blanching: N Means nitrogen, CN carbon-Nitrogen ratio*

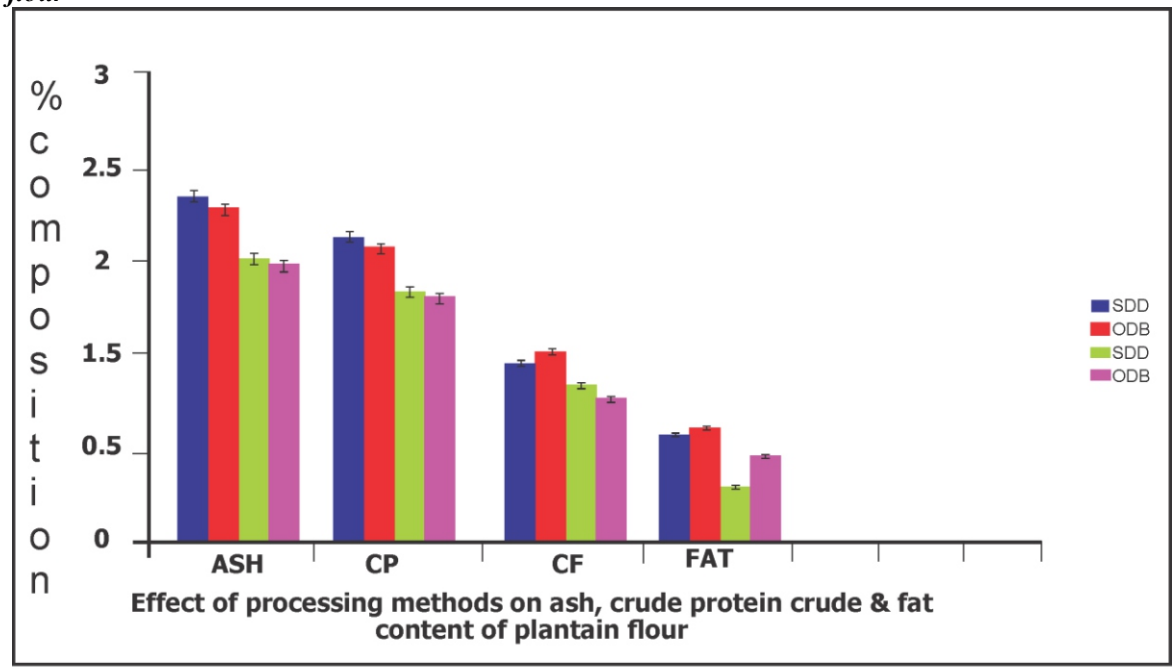
***Fig. 2: Effect of processing methods on nitrogen and carbon-nitrogen ratio of plantain flour***

The moisture content ranged from 9.65% in direct method – 10.32% in blanching while dry matter content ranged from 89.68% in blanching method – 90.37% in direct method as shown in figure 3. The range of percentage ash was from 1.89% in blanching method – 2.32% in direct method, crude protein was slightly higher in direct method (2.15%) than in blanching method (1. 78%), the range of crude fibre was 0.98% in blanching method – 1. 12% in direct method while fat content for all the samples were very low ranging from 0.45% in sundried, blanching method 0. 34% in oven dried direct method as indicated in figure 4. Carbohydrate level was highest in the sample from oven dried direct method (88.45%) and it was lowest in the sample obtained from sun-dried direct (88.82%) (figure 3).




*SDD; OD; SDB & ODB means sun dried direct, oven dried direct, sun dried blanching, oven dried blanching: CHO, means carbohydrate, dry matter & moisture contents respectively*

***Fig. 3: Effect of processing methods on carbohydrate dry matter and moisture content of plantain flour***




*SDD; OD; SDB & ODB means sun dried direct, oven dried direct, sun dried blanching, oven dried blanching: CP, CF, FAT means ash crude protein crude fibre & fat content respectively*

***Fig. 4: effect of processing methods on ash crude protein crude fibre and fat content of plantain flour***

Moisture and crude protein contents of plantain produced through the 4 processing methods were low compared to those of fresh plantain (Moisture Content - 59.77% and 7.65%) as reported by Yarkwan and Uvir, 2015. Plantain pulp is low in protein with estimated values of 4g/kg in unripe plantain and 9g/kg in fully ripe plantain (Adegunwa, Atamu and Fasanya, 2011). Carbohydrates, dry matter, phosphorus, calcium, carbon:nitrogen ratio, magnesium and potassium contents were higher than those of fresh plantain. The low and high nutrient values could be as a result of heat application during drying process. Heat application can improve or reduce nutrient value of food material. Heat improves the digestibility of food, promotes palatability and extends the shelf life of food. Application of heat also enhances food preservation by removing the moisture in the food in order to prevent the growth of microorganisms that can cause deterioration. Drying processes can lead to nutrients losses by inducing biochemical nutritional variation.

The increase in carbohydrates, dry matter, crude fibre, carbon:nitrogen ratio, phosphorus and potassium contents could be due to the removal of moisture which tends to increase the concentration of nutrients (Moris and Barnett, 2004). Processing has been reported to increase carbohydrates availability in a more digestible form (Emperatriz, Ronald, Elvina and Mily, 2008). This could be explained by the results obtained from the four drying methods ranging from 83.82% - 88.45% compared to that of fresh plantain (28.23%) as reported by Yarkwan and Uvir, 2015.

The moisture contents of plantain flour obtained from oven dry direct method (9.69%), sun dry direct method (9.85%), oven dry blanching method (10.32%) and sundry blanching method (10.24%) fall within of 9.09% (oven dried) and 13.00% (sun dried) as reported by Agoreyo, Akpiroroh, Osaweren and Owabor, 2011. The flour from the blanched plantain had higher moisture content (10.24% and 10.32%) than the flour obtained through direct drying (9.63% and 9.85%). The moisture content of processed food gives an indication of its anticipated shelf life. Food with low moisture contents remains in good condition for a longer time than the one with high moisture content. During storage, food with high moisture content is prone to microbial growth which could affect the colour, taste and aroma of the food. A well dried food withstands microbial infestation better during storage; therefore, direct drying method should be preferred to blanching.

Fat contents of plantain flour obtained from the four processing methods, oven dry direct (0.84%), oven dry blanching (0.63%), sun dry direct (0.45%) and sundry blanching (0.78%) are lower than the fat content of fresh plantain (2.75%) as reported by Agoyero*et al* (2011).Fat contents of blanched samples (0.45% and 0.63%) were lower than fat contents of direct samples (0.78% and 0.84%) as shown in figure 4. The fat contents of plantain flour from sun drying method for both blanching and direct (0.45% and 0.78%) respectively are lower than those obtained from oven dried flour for both blanching and direct (0.65% and 0.84%) respectively (figure 4). The difference observed between oven dried and sun 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 (Yarkwan and Uvir, 2015). Lipid oxidation is known to be increased by many factors such as heat, sunlight and radiation (Savage, Dutta, Rodriguez-Estrada, 2002).

Ash is the inorganic residue after the water and organic matter have been removed by burning a food sample. The ash contents of plantain flour obtained from the four processing methods, oven dry direct (2.16%), sun dry direct (2.32%), oven dry blanching (1.89%) and sundry blanching (1.94%) were higher than the fresh fruit ash content as reported by Okareh, Adeolu and Adepoju (2015). The ash contents of blanched samples for both sun dry and oven dry methods (1.94% and 1.89%) respectively were lower than those of the direct samples for both sun dry and oven dry methods (2.32% and 2.16%) respectively as shown in figure 4.

The crude protein contents of the four samples which range from 1.78% - 2.15% is lower than that of fresh plantain (7.65%) as reported by Yarkwan and Uvir (2015). The protein contents of flour produced through direct method for both oven dry and sundry (2.12% and 2.15%) respectively were higher than those obtained from blanching method for both sun dry and oven dry (1.86% and 1.78%) respectively as seen in figure 4. The direct method conserved protein than the blanching method. Decrease in protein content of plantain flour probably occurred as a result of Millard reaction which result between carbohydrates and protein (Wiriya, Paiboon and Somchart, 2004). Since plantain is eaten majorly for its carbohydrates content, the decrease in protein due to processing method does not render the product unfit for consumption rather it has appreciably increased the value of carbohydrates for which the food is needed.

**Conclusion**

The results obtained from the study showed that the four drying methods were good as they yielded nutritional constituents with minimal differences. However, to achieve fast drying and conserve more nutrients, the direct method of processing for both sun drying and oven drying is recommended. This is because there was significant difference ($P<0.05$) in proximate analysis among the different methods of processing. The result is in agreement with report of Savage *et al* (2002) which stated that the values for proximate composition of plantain flour processed with different drying methods differ significantly ($P<0.05$) from each other. Comparing the oven drying and sun drying, oven drying though more expensive is recommended because it allows for quick drying, neat product and could be used during the raining season while sun drying method though cheap, takes a long time and product may be prone to contamination from dust and micro-organisms.

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