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A Comparative Study on The Effect of Cooking Methods on The Nutritional Contents of Ripe and Unripe Plantain (*Musa Paradisiaca*)

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ABSTRACT: Plantains unlike bananas which are conventionally consumed raw as dessert are mostly eaten either after boiling, steaming, roasting or frying which are there major cooking methods employed in plantain fruit utilization in Nigeria. However, studies have revealed that the method of preparation and cooking can either reduce or improve the nutrition quality of foods. Thus, the objective of the present study was to investigate the effect of cooking methods on the nutritional content of ripe and unripe plantain. Ripe and unripe plantain was obtained and divided into four (4) portions; raw which served as the control, boiled, fried and roasted. Analysis of the proximate, vitamin and mineral content of the samples were carried out using standard methods and our result revealed that boiling as a cooking method significantly retained the levels of minerals, vitamins and proximate composition of ripe and unripe plantain relative to frying and roasting. In conclusion we recommend that boiling should be predominately employed during cooking of neither ripe nor unripe plantain.

Keywords: plantain, cooking method, vitamins, mineral, proximate composition

INTRODUCTION

One of the most significant crops grown in tropical regions is plantain. It belongs to the genus *Musa* and family *Musaceae*. The tropical plant *Musa paradisiaca*, often known as plantain in English, "*Ogede agbagba*" in Yoruba, "*Ayaba*" in Hausa, and "*Ogadejioke*" in Igbo, is indigenous to India (Okareh et al., 2015). It can grow to be up to 9 meters long, with a strong pseudostem like a tree and a crown of enormous, long, oval, deep-green leaves that can reach lengths of 365 cm and 65 cm (Auta and Kumurya, 2015). Each plantain in a cluster of fruits has a diameter of about an inch and is slightly longer than a banana fruit. The fruits are borne in clusters. Two and a half to four months after shooting, or a total of eight to twelve months from planting, are needed for plantain fruit to be ready for harvest (Okareh et al., 2015; Swennen, 1990). Plantains play a significant economic and dietary role in West, Central, and the Caribbean. Smallholders who grow them in compound farms, either in mixtures or solitary plots, get a sizable revenue from them. Only 10% of the 63 million tons of plantains produced worldwide are exported; the majority are consumed locally in the countries where they are grown (Awodoyin, 2003; Agbemafle et al., 2017). Plantains have remained a major starchy staple in sub-Saharan Africa for both rural and urban populations, contributing more than 25% of the continent's daily caloric intake and 10% of its daily calorie intake for more than 70 million people (IITA, 2000). Unripe plantains have been identified as hypoglycemic plants because of their low sugar content, which makes them useful in the treatment of diabetes problems. The fruits are starch-rich when unripe, but when they develop, the starch transforms into simple sugars (sucrose, glucose, and fructose) (Uzama et al., 2015).

Unripe plantain consumption may provide significant non-pharmacological health benefits in the dietary management of type 2 diabetes mellitus because mature unripened plantain pulp has high levels of amylose and low glycemic indices and is also very rich in iron, potassium, vitamin A, and ascorbic acid (Adegboyega, 2006; Oko et al., 2015). Both unripe and ripened plantain contain considerable amounts of phytochemical constituents, dietary bioflavonoids, and high levels of in-vitro antioxidant scavenging activities, according to Uzama et al. (2015). As a result of several health issues linked to food intake, such as diabetes and coronary heart disease, the field of human nutrition has expanded its advocacy for the use of functional foods (WHO/FAO, 2003; Ibeanu et al., 2016).

It is well known that depending on the cooking or processing method employed, meals are frequently processed or cooked to the point that vitamins and other nutritional components are lost, with vitamin losses reaching up to 90% (Penelope and Ritu, 2003). In Nigeria, plantains are often eaten after being cooked, in contrast to bananas, which are typically enjoyed raw as dessert. The main culinary techniques used for preparing plantain fruit are boiling, roasting, and frying. It has been shown that cooking meals enhances their microbiological and organoleptic properties, removes toxins and anti-nutritional elements, increases digestibility, and increases the bioavailability of minerals (Omotosho, 2015). In contrast, these practices simultaneously result in a significant loss of several minerals and vital vitamins in food (Yang and Gadi, 2008). Despite the fact that there is already information on how different cooking methods affect the nutritional components of plantains, most people choose a cooking method based more on flavor than on its nutritional effects. As a result, further research is still needed to support, expand upon, and update the body of existing literature. The goal of the current study was to ascertain how different cooking techniques affected the nutritional value and proximate composition of ripe and unripe plantains.

MATERIALS AND METHOD

Sample collection and Preparation

The samples were collected from the University of Ibadan Agriculture Farm and were divided into two (2) groups. One group served as unripe and the other was left to ripen for one week. The samples were further divided into four (4) portions; raw, boiled, fried and roasted.

Boiling of Plantain:

Six (6) Fingers of plantain were selected randomly from each set (unripe and ripe), peeled, washed, sliced into a cooking pot containing 1 liter of water each and was cooked for 15 minutes at cooking temperature. After cooking, the water was drained, plantain was allowed to cool for 20 minutes, further sliced into finer pieces, mashed and used for analysis.

Roasting of Plantain:

Six (6) fingers of plantain were randomly selected from each set (unripe and ripe), peeled and the pulp was placed on a smokeless charcoal for 10 minutes, the traditional method of preparation in Nigeria. The pulp was allowed to cool for 20 minutes further sliced into finer pieces, mashed and used for analysis.

Frying of Plantain:

Six (6) Fingers of plantain were selected randomly from each set (unripe and ripe), peeled, washed and sliced into a frying pan containing 1 liters of King cooking oil each and then fried for 5 minutes at frying temperature. After frying, each set was allowed to cool for 20 minutes and the pulp was further sliced into finer pieces, mashed and used for analysis.

Control Plantain:

The control sample was randomly selected from each set (unripe and ripe), peeled, washed, sliced, mashed and used for further analysis.

Proximate Analysis

The proximate parameters (moisture, ash, crude fat, crude determined using the procedure described by AOAC (1990). The moisture content was determined using an AND-MF-50 moisture analyzer at 105 °C. The moisture content in each of the samples was determined by weighing 3g sample were dried to a constant weight in the oven at 105 °C. The ash content was determined for all the samples by the incineration of the samples placed in a muffle furnace maintained at 550 °C for 5 – 8 hours while the crude fibre obtained by digesting 2g of the samples with H_2SO_4 and NaOH and incineration the residue in a muffle furnace maintain at 550 °C for 5 – 8 hours. The crude protein (% total nitrogen x 6.25) was determined by

Table 1. Proximate composition (%) of Ripe and Unripe Plantain

Samples	Protein	Fat	Ash	Moisture	Fibre	CHO
			RIPE PLANTAIN			
Control	15.50±0.50[d]	7.33±0.57[b]	5.33±0.57[a]	0.54±0.01[b]	0.45±0.02[c]	70.84±0.77[a]
Fried P	9.33±0.57[b]	10.33±0.57[c]	6.67±0.57[b]	0.48±0.46[ab]	0.19±0.01[a]	72.85±1.19[a]
Roasted P	6.60±0.52[a]	4.33±0.57[a]	8.33±0.57[c]	0.42±0.16[a]	0.14±0.02[a]	80.11±1.59[b]
Boiled P	11.67±0.57[c]	4.67±0.50[a]	4.33±0.57[a]	0.63±0.36[c]	0.28±0.02[b]	78.63±0.58[b]
			UNRIPE PLANTAIN			
Control	1.60±0.02[d]	7.17±0.28[b]	5.57±0.23[a]	0.54±0.00[c]	3.20±0.02[c]	81.93±0.03[ab]
Fried P	1.15±0.01[b]	9.33±0.57[a]	6.17±0.28[b]	0.38±0.01[a]	1.40±0.17[a]	81.56±0.68[a]
Roasted P	1.10±0.00[a]	6.17±0.28[a]	6.77±0.25[c]	0.47±0.01[b]	1.97±0.11[b]	83.53±0.43[c]
Boiled P	1.43±0.01[c]	6.33±0.57[a]	5.53±0.05[a]	0.62±0.00[d]	2.97±0.57[c]	83.12±0.58[bc]

n=3. Data are expressed as means ± SD: Mean values in the same column with different superscripts are significantly different at $p < 0.05$. Abbreviations denote P: Plantain, CHO: Carbohydrate.

Kjeldahl method, using 2g of each sample. The crude lipid content was also determined by exhaustively extracting 10g of each sample in a Soxhlet apparatus using n-hexane and the carbohydrate content was determined by deducting the total percentage of moisture, ash, fibre, fat and protein from 100.

Mineral Analysis

The mineral analysis was carried out using standard methods. Samples were ashed at 550 °C to constant weight, the ash dissolved into volumetric flasks using de-ionized water and mineral content was analyzed using

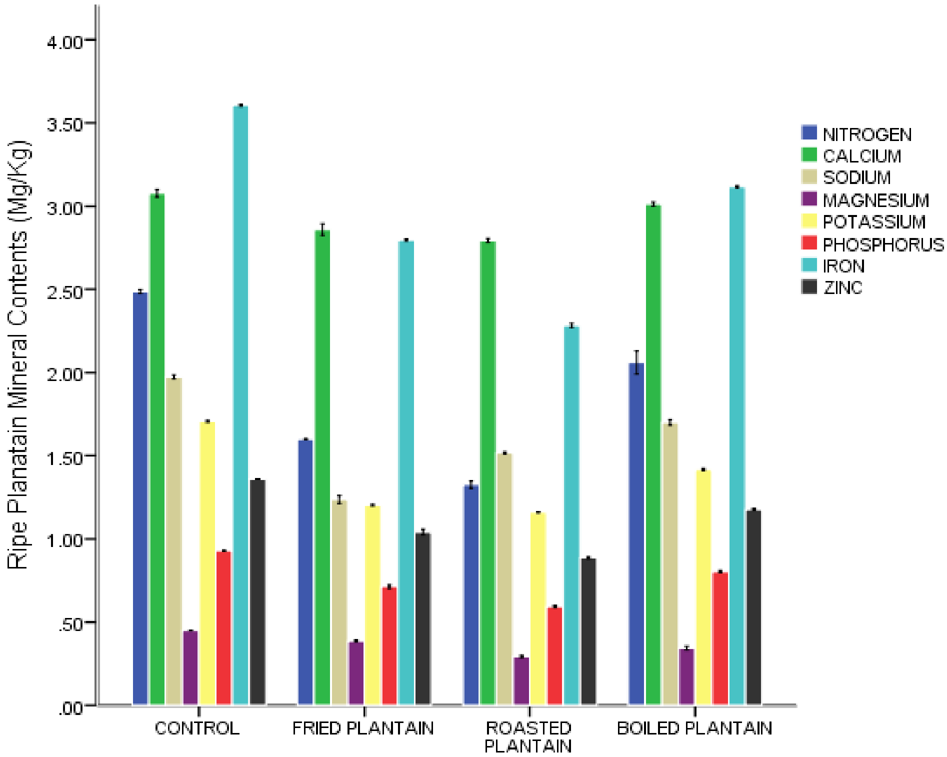

Figure 1: Effect of cooking methods on mineral composition of ripe plantain

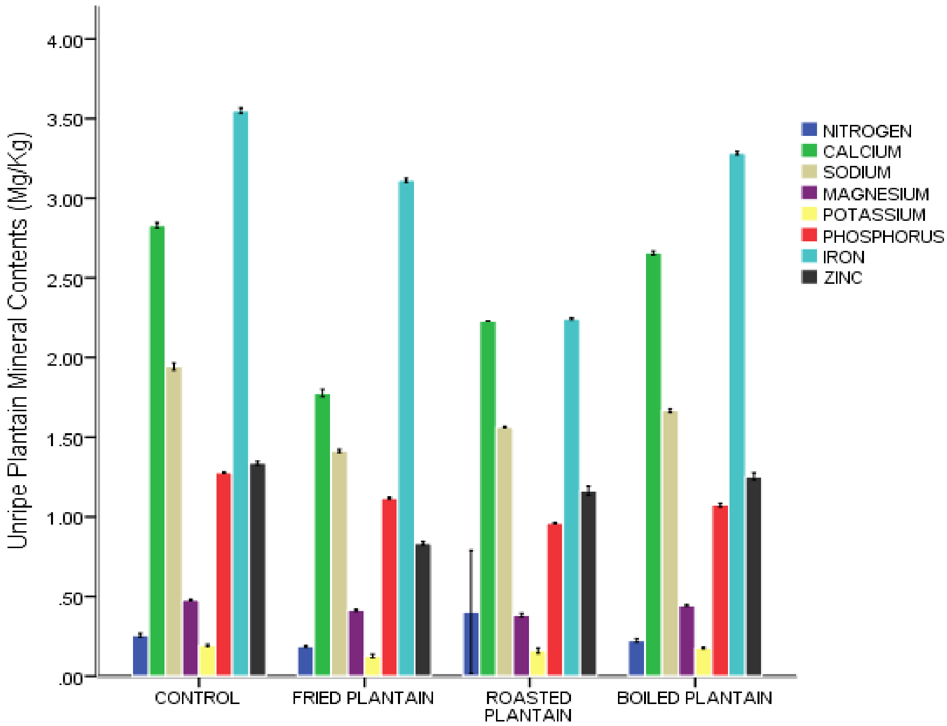

Figure 2: Effect of cooking methods on mineral composition of unripe plantain

Atomic Absorption Spectrophotometer (Nwozo and Nwawuba, 2018).

Determination of Vitamins

The separation and detection of the vitamins were performed using atomic absorption spectrophotometer (AAS) according to method described by Ruales and Nour (1993). Samples were analyzed for vitamin A, D, E, K, C, B1, B2, B6, and B12.

Statistical analysis

Data were treated by ANOVA (analysis of variance) and mean separation was done using Turkey HSD. $p<0.05$ was considered significant. Data were expressed as means±standard deviation. All statistical analysis was done using IBM SPSS Version 22 and Microsoft Excel.

RESULT

Proximate composition

Table 1 shows the effect of cooking methods on the proximate composition of ripe and unripe plantain. For ripe plantain the normal levels of proximate contents are; protein (15.50 ± 0.50%), fat (7.33 ± 0.57%), ash (5.33 ± 0.57%), moisture (0.54 ± 0.01%), crude fibre (0.45 ± 0.02%), carbohydrate (70.84 ± 0.77%) and for unripe plantain; protein (1.60 ± 0.02%), fat (7.17 ± 0.28%), ash (5.57 ± 0.23%), moisture (0.54 ± 0.00%), crude fibre (3.20 ± 0.02%), and carbohydrate (81.93 ± 0.58%) respectively. however, after adopting varying method of cooking (frying, roasting and boiling) on ripe and unripe plantain. Ripe and unripe plantain had a significant higher $p<0.05$ levels of percentage protein, moisture, crude fibre and carbohydrate relative to fried and roasted plantain. The percentage fat content of fried ripe plantain was significantly higher $p<0.05$ compared to the boiled and roasted plantain meanwhile the unripe plantain had no significant $p>0.05$ between the cooking methods. Percentage ash content of roasted plantain was significantly higher $p<0.05$ for both ripe and unripe plantain relative to the fried and boiled plantain.

Mineral Composition

Figure 1 and 2 shows the effect of cooking methods on mineral composition of ripe and unripe plantain. For ripe plantain the normal levels of mineral compositions in this study are; nitrogen (2.49±0.01), calcium (3.08±0.02), sodium (1.97±0.01), magnesium (0.45±0.00), potassium (1.71±0.00), phosphorus (0.93±0.00), iron (3.61±0.00), zinc (1.36±0.00) and for unripe plantain; nitrogen (0.26±0.01), calcium (2.83±0.02), sodium (1.94±0.02), magnesium (0.48±0.00), potassium (0.19±0.00), phosphorus (1.28±0.00), iron (3.55±0.02) and zinc (1.34±0.01). After subjecting the ripe and the unripe plantain to the various method of cooking, boiled plantain predominantly had a significant higher $p<0.05$ levels of mineral compositions relative to the fried and roasted plantain.

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DISCUSSION

Unlike bananas, which are typically taken raw as dessert, plantains are typically consumed either after boiling, steaming, roasting, or frying, which are the main culinary methods used when utilizing plantain fruit (Agbemafle et al., 2017). The biochemical and nutritional content of foods is subsequently affected by the cooking methods used (Baiyeri et al., 2011), and it goes without saying that the various cooking methods used in this study significantly ($p<0.05$) changed the nutritional quality of both ripe and unripe plantains. Table 1 of the current study's proximate analysis of ripe and unripe plantains showed that boiling, roasting, and frying both types of plantains resulted in changes to their proximate composition. The boiled plantain sample, however, revealed a significant increase in the amount of crude protein present compared to the fried and roasted plantain samples. Protein is a crucial dietary component needed for the survival of animals and humans, and its primary role in nutrition is to provide an adequate amount of the necessary amino acids (Nwozo et al., 2019; Nwawuba and Okechukwu, 2018). A considerable increase in fat content was found in the sample of fried plantains, which may have been caused by oil absorption during frying. Furthermore, the increased fat content in the fried plantain samples can be attributed to the oil coating the food after some water has been lost through evaporation (Saguy and Dana, 2003). As a result, the moisture content was significantly lower in the fried plantain samples compared to the other cooking techniques used in this study. For both ripe and unripe plantains, the crude fiber content was reduced considerably when processed using the frying and roasting methods compared to the control sample. However, the sample of boiled plantains had a higher significant amount of crude fiber, and research has shown the value of high-fibre meals in enhancing and maintaining health status. Ash content considerably increased in the roasted plantain sample compared to the fried, boiled, and control plantain samples; this can be a hint that the sample was directly exposed to smoke during the cooking process. Interestingly, compared to the control plantain sample, the amount of carbohydrate, a source of energy for everyday activities in humans (Ibeanu et al., 2016), was much higher in the roasted and boiled plantain sample. Our finding on the effect of cooking methods on the proximate composition of plantain corresponds to the findings (Agbemafle et al., 2017; Baiyeri et al., 2011).

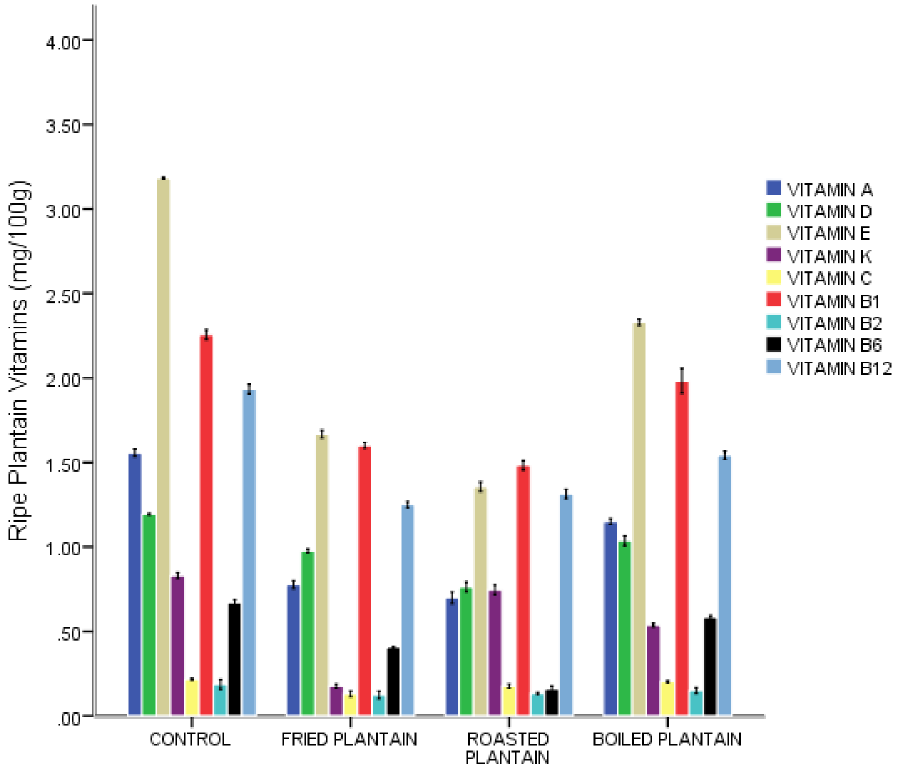

Figure 3: Effect of cooking methods on vitamin composition of ripe plantain

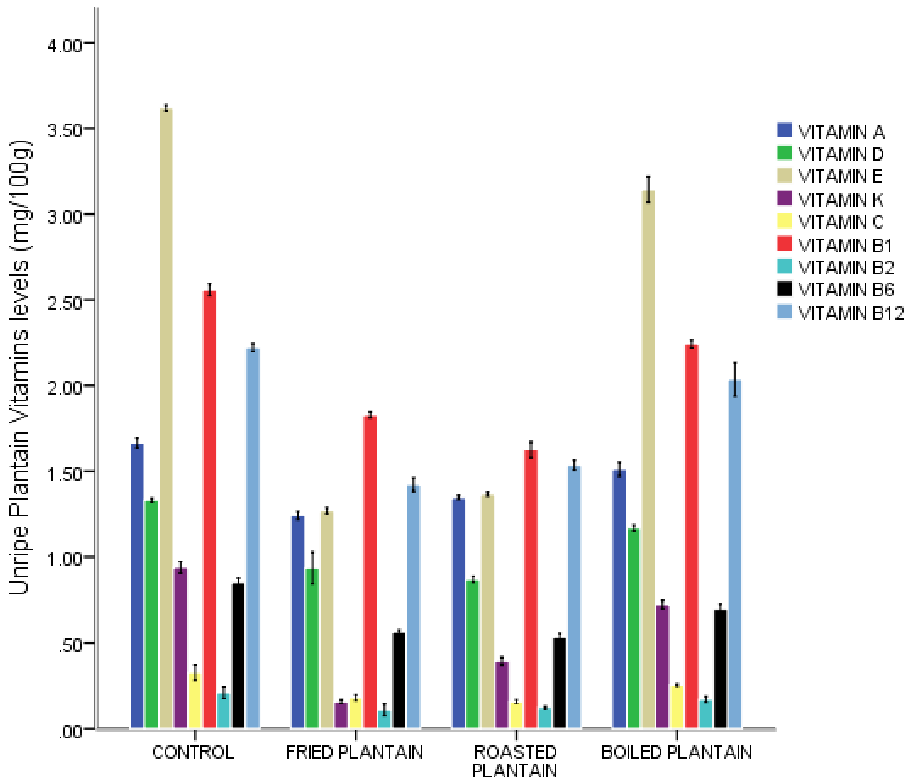

Figure 4: Effect of cooking methods on vitamin composition of unripe plantain

Plantains are classified among the main tropical staple foods because they contain a variety of macronutrients that are crucial for human nutrition and, thus, help maintain excellent health (Dzomeku et al., 2007). But cooking techniques cause a pronounced loss of nutritious properties (Miglio et al., 2008). In this context, it should come as no surprise that our study found that the techniques of cooking used had a substantial impact on the mineral content of both ripe and unripe plantains (Figure 1 & 2). The amount of minerals in the control plantain was, in fact, substantially higher $p<0.05$ than the plantain cooked using the different procedures used in the present study. Though the effect of heating was less noticeable for plantains that were boiled because there were more minerals present than for plantains that were fried or roasted, our findings are in line with the study of Karimian-Khosroshahi et al. (2016) who found that boiling was the optimum cooking method.

It is a well-known fact that depending on the cooking or processing method utilized, foods are frequently processed or cooked in a way that results in vitamin and other nutritional component losses of up to 90% (Penelope and Ritu, 2003). Unlike bananas, which are typically eaten raw for dessert in Nigeria, plantains are more commonly enjoyed after being cooked. However, there is a knowledge gap on how much different cooking methods alter the vitamin content of plantains, and as a result, research findings to determine a suitable cooking method that enables the optimal utilization of the vitamin content of plantains is highly necessary. Thus, our study identified boiling as a suitable cooking method for plantain either ripe or unripe. In tandem with the result findings in the present study on other nutritional indices, the vitamin content of ripe and unripe plantain (Figure 3 & 4) was significantly higher in boiled plantain in comparison with fried and roasted plantain and the amount of fat soluble vitamins (A, D, E & K) present were within the recommended daily intake limits by U.S Food and Drug Administration according to (Nwozo and Nwawuba, 2018). It's interesting that there has not yet been a scientific study on the comparison of how cooking affects the vitamin contents of ripe and unripe plantains. In this sense, presenting our findings as a pioneer.

CONCLUSION

The value of any food is in it nutritional content and employing a suitable cooking method invariably maintains the nutritional advantage of the food. The result of the present study indicates that boiling as a cooking method significantly maintained the levels of minerals, vitamins and proximate composition of ripe and unripe plantain and as such the nutritional value of the plantain used in this study was retained. In conclusion we recommend that boiling should be predominately employed during cooking of neither ripe nor unripe plantain.

CONFLICT OF INTEREST STATEMENT

The authors declare that there is no conflict of interest regarding the publication of this manuscript.

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