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Original article

Effect of fertilizer treatments on fruit nutritional quality of plantain cultivars and derived hybrids

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Summary

Introduction – **The effect of fertilizer-use on fruit nutritional qualities of four plantain genotypes were determined.** *Materials and methods* – **Proximate composition, minerals, heavy metals and vitamin contents of two cultivars ('Agbagba' and 'Mbi-Egome') and two bred-hybrids ('PITA 14' and 'PITA 24') were evaluated across three fertilizer treatments – organic (20 t ha^{-1} $year^{-1}$ of poultry manure), inorganic (400 kg N + 600 kg K_2O + 100 kg P_2O_5 ha^{-1} $year^{-1}$), and the combined half doses of organic + inorganic on split plot arrangement in randomized complete block design.** *Results* – **Analysis of variance showed that most of their proximate quality was not influenced by genotype or fertilizer treatment. However, ash, fibre, Mg and Ca contents were significantly ($P<0.05$) higher and similar in the organic and combined (inorganic + organic) plots. The hybrids had the highest mineral content particularly in the organic plot, while 'Mbi-Egome' had the lowest mineral content. Heavy metals (Pb and Cd) were present in negligible amounts across the treatments. All the vitamins (A, B1, B2, B3, B6 and C) were highest in fruits from the combined plot. The four genotypes were similar in vitamin content except for vitamins A and B6. 'PITA 24' had the highest vitamin A, whereas 'PITA 14' was noted for high vitamin B6.** *Conclusion* – **For optimum nutrients derivable in plantain fruits, organic or the combined application of organic and mineral fertilizers is recommended. The hybrids are recommended for adoption since they possess similar nutritional qualities with the cultivars.**

Keywords
fertilizer-use, bred-hybrids, nutrient content, plantain fruit, soil amendments

Significance of this study

What is already known on this subject?

- Soil amendments using both organic and inorganic sources support the best crop performance, but there is a growing preference for pure organic foods in the world market due to the envisaged health and environmental benefits.

What are the new findings?

- Fruit nutritional qualities were similar for the landrace and hybrid genotypes. The hybrids however had higher mineral and vitamin contents, particularly in the sole organic and combined (organic + inorganic) plots. Heavy metals were very negligible across the fertilizer treatments.

What is the expected impact on horticulture?

- Improved human nutrition, enhanced soil fertility and sustainable farm income would be achieved with the adoption of the high yielding nutrient-rich hybrid genotypes and organic fertilization or the combined application of organic and mineral fertilizers in plantain-based systems.

Introduction

Plantain (*Musa* spp. AAB) is an important starchy staple that contributes significantly to subsistence economies in West and Central Africa (Ortiz and Vuylsteke, 1996). It generates considerable income for the smallholder farmers who produce the fruits in compound farms. Plantain is a rich source of dietary energy, vitamins (A, B6 and C) and minerals such as calcium, potassium, phosphorus, iron and zinc (Tenkouano *et al.*, 2002). Plantain and bananas are among the cheapest crops to produce (Adesope *et al.*, 2004). In humid tropics, they mature and bear fruits within one year of cropping unlike other fruit trees that take between 3 to 5 years before bearing, hence offering a quick return on investment.

Besides the production in heavily manured compound farms where the productivity is sustained for several years, banana and plantain are also cultivated on large-scale commercial farms often under sole cropping, where the yields tend to decline after a few production cycles (Wilson *et al.*, 1987). This yield decline syndrome is a major hindrance to plantain cultivation, due to low levels of soil organic matter and increased susceptibility of traditional cultivars to pests and diseases (Braide and Wilson, 1980), particularly the black leaf streak (caused by the fungus *Pseudocercospora fijiensis*) and plant-parasitic nematodes.

The use of resistant cultivars is considered the most appropriate measure in controlling pathogens and pests affecting crops. It is economical and eco-friendly, and most farmers readily adopt improved cultivars (Vuylsteke *et al.*, 1994). Consequently plantain hybrids were bred and disseminated to farmers in sub-Saharan Africa that are resistant to pathogens and pests, and are high yielding with alluring postharvest quality, *e.g.*, 'PITA 14'. Sustaining the yield of improved cultivars in farmers' fields requires, however, appropriate soil fertility management and sound agronomic practices.

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Soil nutrient inputs could be supplied in organic form (*e.g.*, crop residues, green manure, kitchen waste, municipal waste, livestock manure, compost, faecal sludge, among others) or inorganic form (chemical fertilizers and lime) and in combinations. A continuous use of chemical fertilizers alone cannot, however, sustain crop yields on the strongly weathered soils of the tropics (Kang and Balasubramanian, 1990). Thus, organic soil amendments are needed on such soils to replenish the lost nutrients and improve the physicochemical and biological properties for sustained crop production.

It has been established that soil amendments using both organic and inorganic sources (otherwise known as integrated plant nutrition system) supports the best crop performance (Shiyam *et al.*, 2010; Osundare *et al.*, 2015). Furthermore, there is a growing preference for organic foods in the world market due to the envisaged health and environmental benefits (Lundegardh and Martensson, 2003). Manure is a slow-release fertilizer, and a valuable source of nutrients and organic matter, which can improve soil biological and physicochemical conditions for improved productivity and sustainable crop production (Mugwira, 1979; Baiyeri and Tenkouano, 2007). The combined application of manure with mineral fertilizers supports the prompt release of applied nutrients to satisfy crop nutrient demand (Mohammed, 2002).

Meanwhile, the quality of any agricultural produce is predetermined by the prevailing growth environment of which soil fertility variables are major determinants (Wills *et al.*, 1998; Lundegardh and Martensson, 2003). Among factors like cultivar type, prevailing climate, crop growth or harvest season, and the fruit physiological stage at harvest, plant nutrition is a critical element for fruit quality at harvest (Mattheis and Fellman, 1999; Ani and Baiyeri, 2008; Benkeblia *et al.*, 2011).

This study aims to evaluate the effect of different fertilizer regimes (organic, inorganic, and the combined application of organic and mineral fertilizers) on the proximate composition, minerals and vitamin contents of plantain flour. Four test genotypes comprising two cultivars ('Mbi-Egome' and 'Agbagba') and two bred-hybrids ('PITA 14' and 'PITA 24') were used. The hybrids were derived from 'Mbi-Egome'. 'Agbagba' is the most predominant plantain cultivar in Nigeria.

Materials and methods

Experimental site

The field experiment was conducted at the Department of Crop Science Teaching and Research Farm, University of Nigeria, Nsukka (07°29'N, 06°51'E, 400 m a.s.l.), Enugu State, Nigeria from August, 2011 to April, 2015. The processed fruits harvested during the third crop cycle were analyzed for the flour nutritional quality at SMO Consult Laboratory, Ibadan (Nigeria).

Treatment application

Three fertilizer nutrient sources (organic, inorganic and a combination of the organic and inorganic fertilizers) were evaluated with four plantain genotypes on split-plots in a randomized complete block design with three replications. The fertilizer treatments were applied on the main plots whereas the four plantain genotypes ('PITA 24', 'PITA 14', 'Mbi-Egome' and 'Agbagba') were grown on the sub-plots in single rows of five plants spaced 3 m × 2 m (inter × intra-row). The inorganic fertilizer plot received an annual application of 400 kg N + 600 kg K_2O + 100 kg P_2O_5 ha^{-1} as previously recommended (Aba and Baiyeri, 2015); the organic plot received 20 t ha^{-1} of poultry manure per annum following Aba *et al.* (2011); while the combined half doses involved the application of 200 kg N + 300 kg K_2O + 50 kg P_2O_5 + 10 t ha^{-1} of poultry manure. All fertilizer application was done in two split doses per annum for three consecutive crop cycles.

Plant materials used

The four plantain genotypes comprised two cultivars ('Mbi-Egome' and 'Agbagba') and two bred-hybrids ('PITA 14' and 'PITA 24'). The hybrids were derived from hybridization of 'Mbi-Egome' (as female parent) and the wild banana 'Calcutta 4' (as male parent); see Figure 1 for the pedigree description of the hybrid genotypes. 'Agbagba' is the predominant plantain cultivar in Nigeria. 'Mbi-Egome', 'Agbagba', and 'PITA 24' are triploids, but 'PITA 14' is a tetraploid (Table 1).

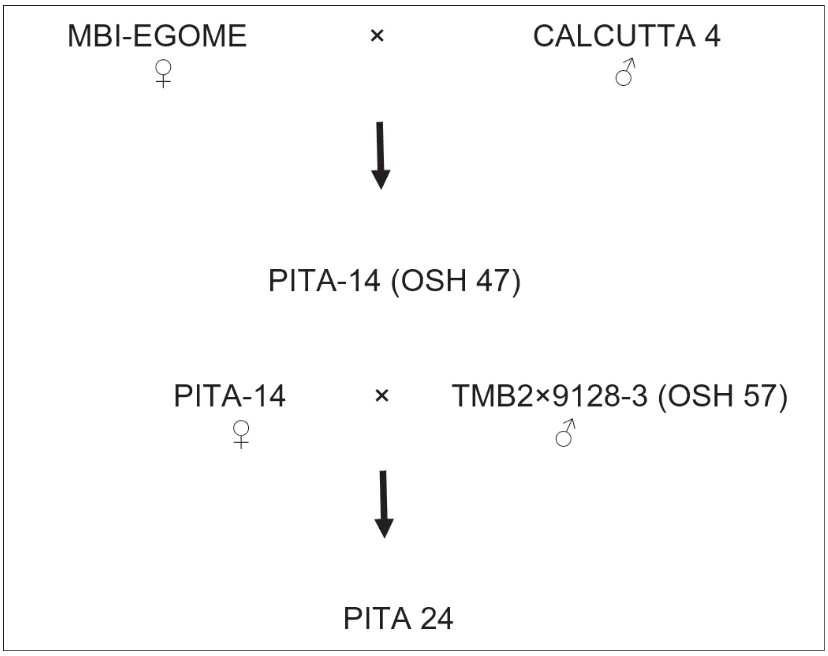

Figure 1. The pedigree of 'PITA 14' and 'PITA 24' plantain hybrids.

Data collection

To compare the nutritional quality of plantain fruits produced under different soil fertility management systems (organic, inorganic and the combination), plantain fruit pulp (harvested during the third crop cycle) was processed into flour after oven drying (65 °C, 4 days) to constant weight and assayed for bioavailable nutrients. The fruit samples were collected from the four middle fingers of the second proximal hand of each bunch. For each genotype, dry fruit pulp samples were bulked across the fertilizer treatments on each of the treatment plots across the three blocks. The samples were ground and prepared into triplicate samples (representing the three blocks of fields) for laboratory analysis. Dry samples were ground to pass through one millimeter mesh sieve using a Thomas Wiley laboratory mill (model 4). The processed flour samples were analyzed for proximate composition (fat, protein, carbohydrate, ash, moisture and fibre), minerals (P, K, Mg, Ca, Mn, Fe and Zn), vitamins (β-Carotene – vitamin A precursor, thiamin – B_1, riboflavin – B_2, niacin – B_3, pyridoxine – B_6 and ascorbic acid – C), and heavy metals (lead, cadmium) following standard analytical procedures. Proximate analysis of vitamins A, B_2, B_3, and B_6 were assayed following the procedures outlined by the Association of Official Analytical Chemist (AOAC, 2005). Vitamins B_1 and C were analyzed following the methodology of Eitenmiller and Landen (1999), while minerals and the heavy metals were determined after Isaac and Korber (1971) using Model 210 VGP of the Buck Scientific Atomic Absorption Spectrophotometer series with air-acetylene gas mixture.

Statistical analysis

Analysis of variance was performed on the generated data using GenStat Release 10.3 DE (2011). Comparison of treatment means was done using Fisher's least significant difference (F-LSD) at 5% probability level.

Results

Except for fat and fibre content, most of the proximate qualities across the four genotypes were not significantly ($P>0.05$) influenced by the fertilizer treatment (Table 2). The fat content was highest (0.54%) in the fruit harvested from the inorganic fertilizer treated plot, whereas flour samples from the organic fertilizer plot had the highest fibre (1.05%), followed by the inorganic (0.96%) and lastly the combined plot (0.92%). Likewise, the flour proximate quality of the four genotypes did not vary significantly ($P>0.05$) across the fertilizer treatments (Table 3). However, there was a significant ($P<0.05$) fertilizer-by-genotype interaction effect on carbohydrate, ash and fibre contents of the fruits (Table 4). Ash and fibre contents were highest in the organic plot across the genotypes.

Among the minerals studied, only the Mg and Mn contents of the plantain fruits were significantly ($P<0.05$) influenced by fertilizer treatments (Table 5). The fruit Mg content was significantly ($P<0.05$) higher in the organic and the combined (inorganic + organic) plots, whereas Mn was highest in the inorganic followed by the combined, and least in the organic plot. K, Ca and Mg were the most prominent minerals in the plantain samples (Table 5), and were seem-

Table 1. Description of the four plantain genotypes used in the study.

Genotype	Ploidy level	Type
Agbagba	Triploid (AAB)	False-horn landrace plantain
Mbi-Egome	Triploid (AAB)	French type landrace plantain
PITA 14	Tetraploid (AAAB)	French type hybrid plantain
PITA 24	Triploid (AAB)	French type hybrid plantain

Table 2. Effect of different fertilizer treatments on proximate qualities of plantain flour samples.

Fertilizer treatment	Protein	Carbohydrate	Fat	Ash	Fibre	Moisture
	%					
Inorganic plot	2.90	80.83	0.54	1.26	0.96	13.51
Organic plot	2.86	80.89	0.49	1.31	1.04	13.41
(In)organic combination	2.84	81.03	0.47	1.34	0.92	13.41
$F\text{-}LSD_{(0.05)}$	n.s.	n.s.	0.06	n.s.	0.06	n.s.

Table 3. Proximate qualities of plantain flour samples derived from two cultivars and two hybrid genotypes.

Plantain genotype	Protein	Carbohydrate	Fat	Ash	Fibre	Moisture
	%					
Agbagba	2.93	80.77	0.50	1.35	0.95	13.49
Mbi-Egome	2.87	81.03	0.54	1.25	1.00	13.30
PITA 14	2.95	80.85	0.46	1.29	1.00	13.45
PITA 24	2.71	81.00	0.51	1.32	0.93	13.53
$F\text{-}LSD_{(0.05)}$	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

TABLE 4. Effect of different fertilizer treatments on proximate qualities of plantain flour samples derived from two cultivars and two hybrid genotypes.

Fertilizer treatment	Plantain genotype	Protein	Carbohydrate	Fat	Ash	Fibre	Moisture
		%					
Inorganic plot	Agbagba	2.88	80.67	0.58	1.34	0.91	13.62
	Mbi-Egome	2.96	81.30	0.51	1.07	1.04	13.13
	PITA 14	3.21	80.33	0.47	1.30	1.01	13.67
	PITA 24	2.56	81.01	0.61	1.35	0.89	13.62
Organic plot	Agbagba	3.00	80.56	0.46	1.36	1.08	13.54
	Mbi-Egome	2.81	80.90	0.57	1.26	1.10	13.36
	PITA 14	2.79	81.23	0.49	1.25	0.95	13.30
	PITA 24	2.85	80.88	0.45	1.36	1.02	13.45
In(organic) combined plot	Agbagba	2.92	81.10	0.44	1.35	0.87	13.32
	Mbi-Egome	2.85	80.89	0.55	1.44	0.87	13.41
	PITA 14	2.84	80.99	0.42	1.32	1.05	13.38
	PITA 24	2.74	81.12	0.49	1.27	0.87	13.52
$F\text{-}LSD_{(0.05)}$ for interaction effect		n.s.	0.59	n.s.	0.15	0.12	n.s.

TABLE 5. Effect of different fertilizer treatments on minerals and heavy metal contents of plantain flour samples.

Fertilizer treatment	Minerals							Heavy metals	
	Ca	Mg	K	P	Mn	Fe	Zn	Pb	Cd
	(mg kg^{-1} flour sample)								
Inorganic plot	40,308	8,637	64,602	3,519	52.6	471	74.3	< 0.05	< 0.002
Organic plot	40,734	12,769	66,770	3,267	43.6	465	80.9	< 0.05	< 0.002
(In)organic combination	39,604	12,219	67,380	3,079	50.9	539	71.4	< 0.05	< 0.002
$F\text{-}LSD_{(0.05)}$	n.s.	1,532	n.s.	n.s.	4.0	n.s.	n.s.	–	–

TABLE 6. Minerals and heavy metal contents of plantain flour samples derived from two cultivars and two hybrid genotypes.

Plantain genotype	Minerals							Heavy metals	
	Ca	Mg	K	P	Mn	Fe	Zn	Pb	Cd
	(mg kg^{-1} flour sample)								
Agbagba	37,582	11,576	67,137	2,569	52.4	509	81.5	< 0.05	< 0.002
Mbi-Egome	38,383	10,511	63,190	3,341	44.1	486	70.0	< 0.05	< 0.002
PITA 14	40,961	10,673	67,610	3,467	47.5	464	80.5	< 0.05	< 0.002
PITA 24	43,936	12,073	67,066	3,776	52.2	508	70.1	< 0.05	< 0.002
$F\text{-}LSD_{(0.05)}$	2,833	n.s.	n.s.	n.s.	4.6	n.s.	n.s.	–	–

TABLE 7. Effect of different fertilizer treatments on mineral and heavy metal contents of plantain flour samples derived from two cultivars and two hybrid genotypes.

Fertilizer treatment	Plantain genotype	Minerals							Heavy metals	
		Ca	Mg	K	P	Mn	Fe	Zn	Pb	Cd
		(mg kg^{-1} flour sample)								
Inorganic plot	Agbagba	41,552	8,889	71,285	3,047	57.0	524	95.6	< 0.05	< 0.002
	Mbi-Egome	38,041	8,602	62,735	2,836	50.8	522	73.0	< 0.05	< 0.002
	PITA 14	37,677	9,003	69,430	3,265	55.5	509	80.3	< 0.05	< 0.002
	PITA 24	43,963	8,052	54,957	4,928	47.2	327	48.3	< 0.05	< 0.002
Organic plot	Agbagba	38,985	12,792	64,797	1,871	41.4	418	76.5	< 0.05	< 0.002
	Mbi-Egome	38,873	11,534	65,329	3,599	40.0	469	61.2	< 0.05	< 0.002
	PITA 14	42,259	11,744	65,065	4,240	42.1	492	86.3	< 0.05	< 0.002
	PITA 24	42,818	15,007	71,892	3,357	51.0	482	99.5	< 0.05	< 0.002
In(organic) combined plot	Agbagba	32,210	13,047	65,330	2,789	58.8	586	72.3	< 0.05	< 0.002
	Mbi-Egome	38,233	11,396	61,507	3,587	41.5	466	75.9	< 0.05	< 0.002
	PITA 14	42,948	11,271	68,334	2,897	45.0	391	74.8	< 0.05	< 0.002
	PITA 24	45,026	13,161	74,350	3,044	58.4	713	62.6	< 0.05	< 0.002
$F\text{-}LSD_{(0.05)}$ for interaction effect		4,907	n.s.	9,855	n.s.	7.9	211	22.8	–	–

Table 8. Effect of different fertilizer treatments on vitamin composition of plantain flour samples.

Fertilizer treatment	β-Carotene (Vit. A)	Thiamine (Vit. B1)	Riboflavin (Vit. B2)	Niacin (Vit. B3)	Pyridoxine (Vit. B6)	Ascorbic acid (Vit. C)
	(µg 100 g^{-1})	(mg 100 g^{-1} flour sample)				
Inorganic plot	75.99	0.50	0.30	1.53	2.06	2.45
Organic plot	75.38	0.51	0.30	1.48	2.03	2.47
(In)organic combination	76.42	0.57	0.33	1.55	2.13	2.37
F-LSD$_{(0.05)}$	n.s.	0.04	n.s.	n.s.	n.s.	0.07

Table 9. Vitamin composition of plantain flour samples derived from two cultivars and two hybrid genotypes.

Plantain genotype	β-Carotene (Vit. A)	Thiamine (Vit. B1)	Riboflavin (Vit. B2)	Niacin (Vit. B3)	Pyridoxine (Vit. B6)	Ascorbic acid (Vit. C)
	(µg 100 g^{-1})	(mg 100 g^{-1} flour sample)				
Agbagba	74.36	0.54	0.31	1.51	2.11	2.36
Mbi-Egome	75.44	0.51	0.32	1.53	2.01	2.47
PITA 14	75.87	0.54	0.32	1.51	2.16	2.45
PITA 24	78.05	0.52	0.29	1.52	2.00	2.44
F-LSD$_{(0.05)}$	2.55	n.s.	n.s.	n.s.	0.13	n.s.

ingly higher in fruits harvested from the organic plot. Traces of heavy metals (Pb and Cd) were observed at very negligible amounts across the treatments. Except for Ca and Mn content, the four plantain genotypes did not differ significantly from each other in the other minerals (Table 6). Calcium was highest in 'PITA 24', followed by 'PITA 14', and least in 'Agbagba'; while Mn content was highest in 'Agbagba' and 'PITA 24'. 'Mbi-Egome' had the least content of minerals across the genotypes.

Fertilizer-by-genotype interaction significantly ($P<0.05$) influenced most of the mineral contents of the plantain flour samples (Table 7). The hybrids 'PITA 14' and 'PITA 24' had primarily the highest mineral content particularly in the organic plot. Among the vitamins studied in the plantain flour samples (Table 8), only vitamins B1 and C were significantly influenced by the fertilizer treatments. Vitamin C was the most abundant vitamin in the plantain flour samples, followed by vitamin B6, B3, B1, B2, and lastly, vitamin A. Except for vitamin C, all the vitamins were highest in the fruit samples harvested from the combined (inorganic + organic) plot. Vitamin C was higher in fruits from the organic and the inorganic plots. Except for vitamins A and B6, the four plantain genotypes did not differ significantly from each other in vitamin content (Table 9). 'PITA 24' plantain had the highest vitamin A content, whereas the 'PITA 14' had the highest vitamin B6. Significant ($P\leq0.05$) fertilizer-by-genotype interaction effects were recorded in most of the vitamins studied (data not shown). 'PITA 24' plantain had the highest contents for most of the vitamins particularly in the organic and inorganic plots, whereas 'PITA 14' had similarly high contents in the combined (inorganic + organic) plot.

Discussion

The quality of any agricultural produce is predetermined by the prevailing growth environment of which soil fertility management is a major determinant (Wills *et al.*, 1998; Lundegardh and Martensson, 2003). The variability observed in the nutritional qualities of the plantain fruit samples could be partly attributed to the varying fertilizer materials applied in the field which may have influenced the availability of plant nutrients and general nutrition of the plantain plants.

Mohammed (2002) reported that adequate nutrient supply results in the production of high quality and better nutritious plants. Woese *et al.* (1997) noted that organic foods generally possess a higher content of vitamin C, dry matter and minerals than those derived from conventional production system. This could be related to an increased content of health-related compounds, especially trace elements, vitamins and some secondary metabolites found in organically grown foods as reported in Lundegardh and Martensson (2003). Most of the vitamins assayed in the current study were highest in the fruit samples harvested from the combined and the organic plots. There is no doubt that the combined doses of organic and inorganic fertilizers applied in the present study provided a balanced nutrition for the plantain crops that translated to superior fruit nutritional quality compared to the inorganic plot.

Manure is a reservoir of macro- and micronutrients, and other organic molecules which are absent in most chemical fertilizers (Bot and Benites, 2005; Amanullah, 2007). Hence, the complementary application of poultry manure and mineral fertilizers must have provided the plants with a balanced nutrition and favorable growth conditions (good soil structure) for optimum nutrient uptake. The reduced dietary qualities of plantain fruits produced from the inorganic plot may be caused by imbalances arising from the supply of essential nutrient elements. The combined plot provided the highest ash content, whereas the organic plot supported the production of fruits with the highest fibre content. This is suggestive of adequate supply of mineral nutrients by the fertilizer treatments, particularly in the combined plot which sustained a superlative accumulation of minerals in the plantain fruit samples. The ash fraction represents the total mineral content in food, while fibre is the indigestible portion of plant food which provides bulking in the gastrointestinal tract to improve water and nutrient absorption, ease digestion and defecation (Eastwood and Kritchevsky, 2005).

Apart from environmental factors, the genetic differences between species and cultivars influence the nutritional value and chemical composition of food products (Mozafar, 1994; Mattheis and Fellman, 1999; Tenkouano *et al.*, 2002; Lundegardh and Martensson, 2003; Baiyeri and Tenkouano, 2006).

Although the present study did not show significant genotypic differences in the proximate qualities of the plantain fruit samples, the Ca, Mn, vitamin B6 and vitamin A contents differed significantly in the four plantain genotypes. The hybrids 'PITA 14' and 'PITA 24' had the highest quantity of minerals. Vitamin A content was highest in 'PITA 24', whereas 'PITA 14' had the highest content of vitamin B6. 'Mbi-Egome' recorded the least mineral content across the genotypes. The discernable variability implies genotypic differences in nutritional quality of the plantain fruits, suggesting differences in nutrient absorption and utilization efficiency among the genotypes. 'Mbi-Egome' seemed to be the most reticent genotype in terms of mineral nutrients absorption and accumulation in the harvested fruits.

'PITA 14' and 'PITA 24' plantains were derived from 'Mbi-Egome'. Both hybrids are rated for improved concentration of minerals (particularly micronutrients) and beta-carotene compared with most cultivars in Nigeria (Tenkouano *et al.*, 2002; Adeniji *et al.*, 2007a, b; Baiyeri *et al.*, 2009). The transfer of disease-resistant genes to the hybrid genotypes altered their fruit characteristics (Vuylsteke *et al.*, 1994), and probably the nutritional composition. The lead (Pd) and cadmium (Cd) contents of the plantain fruit samples presented in the current study (less than 0.05 mg kg^{-1} and 0.02 mg kg^{-1}, respectively) are in accordance with the values ranging from 0.03 to 0.14 mg kg^{-1} for Pd, and 0.02 to 0.04 mg kg^{-1} for Cd reported in plantain and banana composite (peel + pulp) flour by Adeniji *et al.* (2007a). These values are lower than the maximum tolerable levels for Pd (0.1 mg kg^{-1}) and Cd (0.05 mg kg^{-1}) in fruits and vegetables documented in FAO/WHO (2011). The negligible amounts of Pd and Cd present in the plantain fruit samples suggest that the soil amendments used in the current study were seemingly free of heavy metals, and the fruits harvested thereof would not pose any health challenge on consumers.

The non-significant genotypic differences recorded in proximate quality traits, content of heavy metals (Pb and Cd), and some basic minerals suggest a close similarity in dietary qualities between the cultivars and hybrids. Therefore, the study suggests that fruit nutritional quality traits were similar for the cultivars and hybrids, but the former had lower quantities of bioavailable minerals and some vitamins. The disease resistant hybrid genotypes are therefore recommended for adoption for improved yield and healthier nutrition. For optimum nutrient contents in plantain fruits, the use of organic soil amendments or the combined application of organic and mineral fertilizers is recommended.

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