

Original Article

Phytonutrients Composition of Nigerian Banana Fruits (*Musa species*) And Their Peel Extracts

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Abstract

Objective: The aim of this study is to determine the phytonutrients components of banana fruits and that of their peel extracts. **Methods:** Two (2) banana fruit types; Yoruba (local) and Igbo banana and their peel extracts were evaluated in this research. **Results:** The two banana types revealed the presence of some bioactive compounds such as like phenols, alkaloids, flavonoids, glycoside, terpenoid, tannin, saponin, carotenoids, potassium, sodium and fibre at varying concentrations. The phytonutrients analysis of the banana fruits samples showed that Alkaloids had a mean range between 0.17 ± 0.002 and 0.18 ± 0.001 mm. Phenolic contents with the mean values ranging from 1.57 ± 0.01 to 1.70 ± 0.01 mm. Carotenoid had a mean range between 3.79 ± 0.003 and 5.01 ± 0.01 mm. There was no significance difference in the Flavonoids contents with the mean values 0.09 ± 0.00 to 0.09 ± 0.001 mm. Potassium contents mean values of the two banana fruits samples ranged from 165.5 ± 0.71 to 175.00 ± 2.83 mm, Sodium contents of the banana fruits samples ranged from 122.00 ± 0.00 to 117.00 ± 1.41 mm and Fibre contents ranged from 0.01 ± 0.001 to 0.02 ± 0.002 mm. The phytonutrients analysis of the banana peel extract showed the presence of glycoside, terpenoid, alkaloids, flavonoids, tannin and saponins. The presence of these phytonutrients confirms the two *Musa* species tested to be of medicinal value. The extract of the two selected banana peels showed various inhibitory effect against selected microbial isolates. The results of this study revealed that Yoruba (local) banana peel extracts has the highest zone of inhibition (26.50 ± 3.61 mm) on *Staphylococcus aureus* compared to Igbo banana peel extracts (20.33 ± 2.47 mm). However, Igbo banana peel extract (18.33 ± 1.61 mm) showed a little higher growth inhibition on *Escherichia coli* compared to Yoruba (local) banana peel extract (17.43 ± 1.68 mm). **Conclusion:** The presence of these bioactive compounds in banana fruits and their peel showed a positive role in maintaining immune function in the body system.

Keywords: Igbo banana fruits, Yoruba banana fruits, Banana peel extracts, Phytonutrients

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Introduction

Since the dawn of human civilization plants have made large contributions to facilitate human health and wellbeing¹. The effect of rapidly growing urbanization is incessant generation of pollutants to the environment. This has caused increase in the interaction of human with free radicals reported to be associated with incidence of chronic diseases². The consumption of plant food as major sources of natural antioxidants has been effective mopping agent for free radicals³. The food consumed by human has a direct effect on their wellbeing. Public agencies and agricultural industries use nutritional information to promote fresh produce, while consumers on the other end are looking for variety

of diets and are aware of the benefits of consuming fresh foods. This is due to the awareness created on the importance of people to consume diet rich in antioxidants and other minerals vital for human health. Plant foods form a major part of Nigerian diet, one of such is banana, the most important tropical fruit in the world⁴. Banana is a comestible fruit botanically referred as berry. They are obtained from herbaceous flowering plants of genus *Musa*. Bananas are the fourth most important food crop in the world after rice, wheat, and maize⁴. They also constitute a major staple food crop for millions of people in developing countries. Banana is a perennial crop with a short gestation period, making it very easy to cultivate.

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Bananas are consumed as fruits, it may also be processed to other forms like smoothies, banana pan cake, plantain porridge, ice cream, yoghurt, cake, bread, nectar and baby food. At times, it is canned with syrup and used in bakery products, fruits salads and toppings⁵.

Bananas are considered as an abundant source of vitamin B6. Vitamin C, manganese and digestible food fibers are present in the fruits in sizeable levels⁶⁻⁷. About⁸ 358 mg of the potassium is present in every 100 g of the fruit, thus making it an easily accessible source of the nutrient to the common man. The work of Pareek⁴ showed that banana contains low amount of protein and substantial amounts of carbohydrates (hemicellulose, starch and pectin), vitamins A and C, potassium, calcium, sodium and magnesium. Phytonutrient are naturally occurring, biologically active chemical compounds in plants. In plants, phytonutrient act as a natural defense system for host plants and provide colour, aroma and flavour. These phytonutrients are localized to fruit, seed, stem epidermis, flower and other peripheral surfaces of plants⁹. They can also be called secondary metabolites, and they include flavonoids, alkaloids, saponins, terpenoids, anthraquinone and carotenoids. Phytonutrients are non-nutritive plant chemicals possessing varying degrees of disease-preventive properties. They are invaluable sources of raw materials for both traditional and orthodox medicine. Phytonutrients may display their health protective effects in diverse ways. They can act as antioxidants and protect cells against free radical damage, e.g. polyphenols, carotenoids etc¹⁰. They may also help in reducing risk for cancer by inhibiting tumor production¹¹. Other modes of action are via antibacterial activity and hormonal stimulation¹²

Methods

Source of Banana samples: The Banana fruit and peels samples used are *Musa acuminata* (Yoruba banana) and *Musa sapientum* (Igbo banana), bought at Shasha Market, Akure, Ondo State, Nigeria. (Figure 1a and 1b).

Sterilization/Preparation of Banana Peel: The fruits were washed in clean water and dried with sterile towel and after drying, the peels were carefully stripped off from the fruit. The stripped peels were then sun dried for about two weeks to reduce the moisture. After drying, the peels were blended into powdery form. It was packed



Figure 1a: *Musa acuminata* (Yoruba Banana)



Figure 1b: *Musa sapientum* (Igbo Banana)

in a container and carefully labelled to avoid misrepresentation¹³.

Preparation of Banana peel Extracts (*Musa acuminata* and *Musa sapientum*): The dried powder of each sample was weighed into 250g using a weighing balance (Triple beam) and was soaked separately in 500ml of methanol (99%) according to the method of¹⁴ with slight modification. It was then placed in a shaker for 48h to allow vigorous and intermittent shaking. Each preparation was filtered using a muslin cloth and a Whatman filter paper lined funnel into a conical flask. The extracts were evaporated in an hot- air oven for four days. All extracts obtained were stored in a refrigerator until required for use.

Determination of Phytonutrients Properties of Banana Fruits: Selected two species of banana fruits (*Musa acuminata* cv cavendish banana and

Musa sapientum) was screened and tested for the compounds; potassium, sodium, fiber, alkanoids, flavonoids, phenolics and ácarotenoids using standard procedures.

1. Determination of Potassium and Sodium:

Analysis for Sodium and Potassium was carried out using the method of¹⁵ where the calibration and measurement of absorbance of each element against a blank at its unique wavelength was done using Atomic Absorption Spectrophotometer (A. Analyst 300, Perkin Elmer, Morwalk, Conn, U.S.A).

2. Determination of Fiber: Dietary fiber content was determined with the modified acid-base digestion approach¹⁶. Digestion by boiling was carried out on 5 g of sample using 100 mL of 0.25 M sulfuric acid (H₂SO₄) and 100 mL of 0.31 M sodium hydroxide (NaOH) solution,

3. Determination of Alkaloid: The alkaloid content was determined according to UV Spectrophotometer method¹⁷. This method is based on the reaction between alkaloid and bromocresol green.

4. Determination of Flavonoids: Flavonoid contents was determined using aluminum chloride according to¹⁸. The flavonoid content was expressed as mg quercetin / 100 mg extract and the absorbance of samples and standards was measured using UV-Vis Spectrophotometer at 420 nm. The flavonoids content was expressed as milligram of quercetin equivalents per gram of dry weight (mg QEG-1 DW).

5. Determination of Phenolics: The phenol content was determined using Folin-ciocalteau method¹⁹. Folin-ciocalteau method allows the estimation of all flavonoids, anthocyanins, and non-flavonoid phenolic compounds, including phenols and tannins, (that is, all phenolics present in the sample)¹⁹. The phenol content of the sample was determined by mixing 0.5ml aliquot of freshly prepared sample with equal volume of water, 0.5 ml Folin-Ciocalteu's reagent, and 2.5 ml of saturated solution of sodium carbonate (Na₂CO₃). The absorbance was measured after 40 min at 725 nm.

6. Determination of Carotenoids: Carotenoid content was determined using the method¹⁵. One gram of the sample was mixed with 10 ml of

acetone in a 50 ml conical flask and allowed to rest for 20 min. with intermittent gentle shaking every 4 min. After sedimentation, the upper clear layer was decanted into a clean test tube and 5 ml of benzene added. This was shaken vigorously and the upper layer separated using a separating funnel. The absorbance read at 453 nm and used to extrapolate carotenoid content from a standard curve.

Determination of Phytonutrients of Banana Peel Extract:

The obtained extract of selected two species of banana peels (*Musa acuminata* cv cavendish banana and *Musa sapientum*) were used for phytonutrients. The samples were screened for the compounds; alkaloids, glycosides, tannins, flavonoids terpenoids and saponin.

1. Determination of Alkaloids: Alkaloid was determined using the method of²⁰. Five (5) g of the sample was weighed into a 250 ml beaker and 200 ml of 10% acetic acid in ethanol was added and covered and allowed to stand for 4 h. This was filtered and the extract was concentrated on a water bath to one-quarter of the original volume. Concentrated ammonium hydroxide was added drop wise to the extract until the precipitation was complete. The whole solution was allowed to settle and the precipitated was collected and washed with dilute ammonium hydroxide and then filtered. The residue is the alkaloid, which was dried and weighed.

2. Determination of Glycosides: Glycoside content was determined by²⁰ method. It was weighed into a 250 cm³ round bottom flask and about 200 cm³ of distilled water was added to one gram of each banana peel extract sample and allowed to stand for 2 hours for autolysis to occur. Full distillation was carried out in a 250 cm³ conical flask containing 20 cm³ of 2.5% NaOH (sodium hydroxide) in the sample after adding an antifoaming agent (tannic acid). Glycoside (100 cm³), 8 cm³ of 6 M NH₄OH (ammonium hydroxide), and 2 cm³ of 5% KI (potassium iodide) were added to the distillates, mixed and titrated with 0.02M AgNO₃ (silver nitrate) using a microburette against a black background. Turbidity which was continuous indicates the end point.

3. Determination of Tannins: Each banana peel extract (0.5 g) was extracted with 300 ml of

diethyl ether for 20 hours at room temperature. The residue was boiled for 2 h with 100 ml of distilled water, left to cool and was then filtered. The extract was adjusted to a volume of 100 ml in a volumetric flask. The content of tannins in the extract was determined colorimetrically by using Folin Denis reagent and measuring the absorbance of the blue complex at 760nm, using a tannic acid solution as a standard solution²¹.

4. Determination of Flavonoids: Flavonoid determination was by the method reported by²⁰. Exactly 50 cm³ of 80% aqueous methanol added was added to 2.50 g of sample in a 250 cm³ beaker, covered, and allowed to stand for 24 hours at room temperature. After discarding the supernatant, the residue was reextracted (three times) with the same volume of ethanol. Whatman filter paper number 42 (125 mm) was used to filter whole solution of each banana peel extract sample. Each banana peel extract sample filtrate was later transferred into a crucible and evaporated to dryness over a water bath. The content in the crucible was cooled in a desiccator and weighed until constant weight was obtained.

5. Determination of Terpenoids: Methodology is as reported by²⁰. Each banana peel extract sample (0.30g) was weighed into a beaker and extracted with 30 cm³ and component extracted for 2 hours. A mixture of chloroform (2 cm³) and concentrated tetraoxosulphate (VI) acid (3 cm³) was added to 5 cm³ of each extract to form a layer. The presence of a reddish brown colouration at the interface shows positive results for the presence of terpenoids.

6. Determination of Saponin: The specific method of was used²². 20 g from each banana peel extract was put into a conical flask and 100 ml of 20% aqueous ethanol was added. The samples were heated on a water bath for 1 h with continuous stirring at 55°C. The mixture was filtered and the residue re-extracted with another 200 ml 20% ethanol. The combined extracts were reduced to 40 ml over a water bath at about 90°C. The concentrate was transferred into a conical flask of 250 ml and 20 diethyl ether was added and shaken vigorously. The aqueous layer was recovered while the ether layer was discarded. This process was repeated and 60 ml of n-butanol

was added. The combined n-butanol extracts were washed twice with 10 ml of 5% aqueous chloride. The remaining solution was heated in a water bath. After evaporation, the samples were dried in the oven to a constant weight and the saponin content was calculated in percentage.

Statistical Analysis: All experiments were done in triplicates. Mean, Standard deviation were calculated for all data using Descriptive Statistics, all data obtained were subjected to one way analysis of variance (ANOVA) using Minitab software and Difference between means was determined by Least Significance Difference (LSD) Test at $p \leq 0.05$.

Results

Phytonutrients composition of banana fruit: The results of the phytonutrients analysis of Yoruba and Igbo banana fruits indicate the presence of Alkaloid, Flavonoid, Phenolics, Carotenoids, Potassium, Sodium and Fiber in the banana fruit samples. The Alkaloid contents in both samples (Yoruba and Igbo banana) ranged from $(0.17 \pm 0.002 - 0.18 \pm 0.001 \text{ mg/g})$. This shows that the Alkaloid content in Yoruba banana fruit is higher compared to that of Igbo. The Flavonoid contents of Yoruba and Igbo banana fruit which ranged from $(0.09 \pm 0.001 - 0.09 \pm 0.00 \text{ mg/g})$, reveals that there are no significance difference in the two samples (Table 1). The Phenolic, Carotenoid and Potassium content in Igbo banana fruit was higher with the values $(1.70 \pm 0.01 \text{ mg/g}, 5.01 \pm 0.001 \text{ mg/g}$ and $175.00 \pm 2.83 \text{ mg/g})$ respectively than the Yoruba banana fruit $(1.57 \pm 0.001 \text{ mg/g}, 3.79 \pm 0.003 \text{ mg/g}$ and $165.5 \pm 0.71 \text{ mg/g})$ respectively (Table 1). Also, Yoruba banana fruits has a higher Sodium content with the value $(122.00 \pm 0.00 \text{ mg/g})$ than Igbo banana fruits $(117.00 \pm 1.41 \text{ mg/g})$. The fibre content revealed that Yoruba and Igbo banana were significantly low which ranged from $(0.02 \pm 0.002 - 0.01 \pm 0.001 \text{ mg/g})$ respectively. In conclusion, among the two banana fruit samples analysed, Igbo banana had the highest value of Phenolic, Carotenoid and Potassium content $(1.70 \pm 0.01 \text{ mg/g}, 5.01 \pm 0.001 \text{ mg/g}$ and $175.00 \pm 2.83 \text{ mg/g})$ respectively (Table 1).

Phytonutrients composition of banana peel extract

The phytonutrients screening of Yoruba and

Igbo banana peel extract showed the presence of Glycoside, Terpenoid, Alkaloid, Flavonoid, Tannin and Saponin. It was shown that the highest value of glycoside content was present in Igbo banana ($0.72 \pm 0.002a$ mg/g) compared to Yoruba (local) banana ($0.67 \pm 0.02b$ mg/g).

Table 1: Phytonutrients composition of Yoruba and Igbo Banana Fruits

Composition	Yoruba	Igbo
Alkaloids	$0.18 \pm 0.001a$	$0.17 \pm 0.002b$
Flavonoids	$0.09 \pm 0.001a$	$0.09 \pm 0.00a$
Phenolic	$1.57 \pm 0.001b$	$1.70 \pm 0.01a$
Carotenoid	$3.79 \pm 0.003b$	$5.01 \pm 0.001a$
KI (ppm)	$165.5 \pm 0.71b$	$175.00 \pm 2.83a$
Na (ppm)	$122.00 \pm 0a$	$117.00 \pm 1.41b$
Fibre (%)	$0.02 \pm 0.002a$	$0.01 \pm 0.001b$

Values with similar alphabets along the same column are not significantly different ($p < 0.05$).

However, in Yoruba banana peel extract there was increase in the Terpenoid content ($1.41 \pm 0.004a$ mg/g) as compared to Igbo banana peel extract ($1.36 \pm 0.004b$ mg/g) (Table 2). Also, the results of the Alkaloid, Flavonoid and Tannin content of Igbo banana peel extract had the highest values (8.04 ± 0.006 mg/g, 14.7 ± 0.006 mg/g and 3.00 ± 0.17 mg/g) respectively as compared to Yoruba banana peel extract (6.76 ± 0.021 mg/g, 10.29 ± 0.01 mg/g and 0.89 ± 0.004 mg/g) respectively. In conclusion, Yoruba banana peel extract (1.55 ± 0.014 mg/g) demonstrate a higher value in the Saponin content compared to Igbo Banana peel extract (1.10 ± 0.014 mg/g) (Table 2).

Discussion

The results of this research work demonstrated the phytonutrients analysis of Yoruba and Igbo banana fruits. The phytonutrients analysis revealed the presence of some phytonutrients like phenols, alkaloids, flavonoids and carotenoids at varying concentrations. The presence of these phytochemicals confirms the two *Musa* species tested to be of medicinal value. This agrees with so many reports on their medicinal uses²³⁻²⁵. The results of the Potassium content of Igbo banana and Yoruba banana shows an increase in the potassium content than the Sodium content. This is comparable to the discovery of⁸ that higher

Table 2: Phytonutrients composition of Yoruba and Igbo Banana Peel Extract

Composition	Yoruba	Igbo
glycoside mg/100g	$0.67 \pm 0.02b$	$0.72 \pm 0.002a$
terpenoid g/100g	$1.41 \pm 0.004a$	$1.36 \pm 0.004b$
alkaloid %	$6.76 \pm 0.021b$	$8.04 \pm 0.006a$
flavonoid %	$10.29 \pm 0.01b$	$14.7 \pm 0.006a$
tannin %	$0.89 \pm 0.004b$	$3.00 \pm 0.17a$
saponin %	$1.55 \pm 0.014a$	$1.10 \pm 0.014b$

Values with similar alphabets along the same column are not significantly different ($p < 0.05$).

potassium to sodium content present in bananas are helpful in preventing high blood pressure and its other related complications. Also the results of Igbo banana fruit revealed a high phenolic content. This is similar to a work carried out by²⁶ which showed that the pulp of *Musa* species at the ripe stage contained phenols and saponin in abundance. The results of Igbo banana fruits and Yoruba banana fruits also shows an increase in the Carotenoid contents. This is in agreement with other studies²⁷⁻³⁰ that have also reported wide variability in carotene content in bananas. The results of the banana peel extract revealed the presence of some phytonutrients compounds like Glycoside, Terpenoid, Alkaloid, Flavonoid, Tannin and Saponin. This is line with the work of³¹ that Secondary metabolites such as flavonoids, tannins, phlobatannins, alkaloids, glycosides, and terpenoids were found in banana peel extract. The presences of these phytochemicals/ secondary metabolites might be responsible for the antibacterial activity of banana peel. Moreover, it is also reported that flavonoids, which is present in banana peel extract, are responsible for the antimicrobial activity associated with some ethnomedicinal plants³¹. This agrees with the present study which reports a high Flavonoid content in Yoruba and Igbo banana peel extract. Igbo banana peel extract which is also known scientifically as *Musa sapientum* was also revealed in this study to contain high content of Glycoside and Alkaloid. This correlates the discovery of³² that the presence of glycosides and alkaloids in *Musa sapientum* peels may be attributed to their use by traditional medicine practitioners

in healthcare systems in the treatment of some bacterial infections such as cough, fever, cold and venereal diseases. Banana peel extracts from three varieties of banana showed the presence of some phytochemicals, such as phenols, terpenoids, and saponins, and they exhibited antimicrobial activities³³.

Conclusion

This study shows that banana fruits and peels are reliable source of phytonutrients in *Musa sapientum* (Igbo banana peels) and *Musa acuminata* (Yoruba banana peels) and therefore suggests that the peels possessed valuable medicinal potentials. It

also details the information about phytonutrients present in banana peels. Therefore banana fruits and its peel extracts can be considered as powerful antioxidants.

Conflict of Interest: Nothing to declare.

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Ethical approval: Not applicable.

Authors' Contribution: The author was solely involved in study design, literature review, data collection and analysis, manuscript preparation, revision and finalization.

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