Comparative proximate, mineral elements and anti-nutrients composition between *Musa sapientum* (Banana) and *Musa paradisiaca* (Plantain) pulp flour

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Plants have played significant roles in maintaining the health and promoting the quality of human life for thousands of years. *Musa sapientum* (banana) and *Musa paradisiaca* (plantain), both of which are major starchy staples in the local food economies of sub-Saharan Africa, provides more than 25% of carbohydrates and 10% of the daily calorie intake for more than 70 million people in the continent. Plantain and banana flour are most important some of the raw material in the baking and confectionery industry, and complementary food formulation. The aim of this research was to carry out comparative assessment of the proximate composition, mineral elements and antinutrients contents between Plantain and banana. Biochemical studies with a view to compare the nutritional potentials between banana and plantain were carried out by evaluating the proximate composition, mineral elements and antinutritional content of the two varieties. The result showed that there is no significant difference (P > 0.05) in the carbohydrate, protein, ash, moisture, crude fibre and fat content of banana and plantain. The mineral elements analysis showed a significantly higher (P < 0.05) mean magnesium, iron, calcium, potassium and phosphorus in banana, with a significantly higher (P<0.05) mean zinc and sodium in plantain. The anti-nutrient analysis showed a significantly higher (P < 0.05) phytate content in plantain with significantly higher (P < 0.05) mean cyanide in banana. No significant difference (P>0.05) was observed when the saponin, tannin and oxalate content of both species were compared. This result showed that banana may be more nutritive than plantain.

**Key words:** Minerals, nutrients, antinutrients, biochemical, food, composition, industry.

**INTRODUCTION**

Plants have played significant roles in maintaining the health and promoting the quality of human life for thousands of years. The majority of the earth’s inhabitants in the developing world rely on traditional medicine for their primary health care needs and a major part of this therapy involves the use of plants, plant extracts or their active principles (Craig, 2001). In northern Nigeria, many indigenous plants are widely consumed as food or home remedies (Aliyu, 2009).

*Musa sapientum* (banana) and *Musa paradisiaca* (plantain), both of which are major starchy staples in the local food economies of sub-Saharan Africa, provides more than 25% of the carbohydrates and 10% of the daily calorie intake for more than 70 million people in the continent. Plantain and banana processing is a means of adding value, increasing product diversification, utilization and enhancing the market price of the new hybrids (Adeniji and Empere, 2001).

Plantain is a monoherbacious plant belonging to the family *Musaceae* referred to in India as coarse banana. The plants have two genera and 42 different species (Evans and Trease, 2002). It is up to 9m long with robust tree-like pseudostem, a crown of large elongated oval deep-green leaves (up to 365cm in length and 65cm in width) with a prominent midrib (Pradeep et al., 1986).
The whole plant as well as the specific parts (flowers, banana bracts, ripe fruit, unripe fruits, leaves and stems) of plant extract and its active constituents have been used for the treatment of a large number of human ailments (Kumar et al., 2012). The nutrients in banana and plantain include fats, carbohydrates, proteins, vitamins and moisture. Minerals include: calcium, phosphorus, magnesium, sodium and iron. Anti-nutrients include: saponin, tannin, oxalate, phytate as well as cyanide (Kumar, 1991).

The various effects of *M. paradisiaca* are documented in traditional and scientific literatures. The main pharmacological effects of this plant are: hepatoprotective, diuretic, analgesic, anti-ulcer, wound healing, antioxidant, hypoglycemic, hair-growth promoter, mutagenic effect and haemostatic activity (Kumar et al., 2012). *M. sapientum* fruits have been reported to prevent anaemia by stimulating the production of haemoglobin in the blood. Its role to regulate blood pressure has been associated with the high content of potassium. Banana helps in solving the problem of constipation without necessarily resorting to laxatives. Banana can also cure heart burns, strokes, ulcers and many other ailments. The peels have been reported to be useful in making banana charcoal, an alternative source of cooking fuel in Kampala (Surbhi, 2011).

Along with other fruits and vegetables, consumption of banana is associated with a reduced risk of colorectal cancer (Deneo-pellegrini et al., 1996), renal cell carcinoma (Rashidkhan et al., 2005) and breast cancer in women (Zhang et al., 2009). Banana stem extract from the *Musa sapientum* family has been suggested to be a useful agent in the treatment of hyperoxaluric urolithiasis (Poonguzhali and Chegu, 1994), kidney stones and high blood pressure. Oral administration of chloroform extract of the *Musa sapientum* flowers has been found to cause a significant reduction in blood glucose and glycosylated hemoglobin and prevents decrease in body weight (Pari and Uma-maheswari, 1999). In addition, the fruit is used as antiscorbutic, aphrodisiac and diuretic (Smith et al., 1996). The aim of this research was to carry out comparative assessment of the proximate compositions, mineral elements and antinutrients contents between *M. sapientum* (banana) and *M. paradisiaca* (plantain).

**MATERIALS AND METHODS**

**Collection and preparation of plant material**

The Banana (*M. sapientum*) and plantain (*M. paradisiaca*) cultivars were collected from Yan-lemo market of Kumbotso Local Government Area, Kano State. They were cut into pieces and air-dried. The dried samples were pounded into powder using mortar and pestle. The powder obtained was kept in the laboratory and used for proximate, mineral elements and antinutrients analysis during the period of the research.

**PROXIMATE ANALYSIS**

**Determination of moisture content**

A clean dried petri-dish was weighed as (W1), sample (5 g) was placed in it. The Petri-dish together with the sample was weighed as (W2). It was then taken into the oven at 120°C for 3 h. The dish was removed and cooled in a desiccator for 30 min. and finally weighed (A.O.A.C, 1984).

**Determination of ash content**

A clean dried crucible was weighed. 5g of dried (moisture free) sample was placed into the crucible and weighed. The sample was placed in the muffle furnace at 550°C. The ash was covered with Petri- dish and placed in a desiccator prior to weighing. This was then measured (A.O.A.C, 1984).

**Determination of crude protein**

Sample (0.15 g) was weighed and transferred into Kjeldhal digestion flask. Catalyst (0.8 g) and concentrated sulphuric acid (2 cm³) were also added into the Kjeldhal digestion flask. The mixture in the digestion flask was heated on the heating mantle for 1 hour until the liquid became clear. The digest was cooled and made alkaline 40% NaOH (15cm³). The digest was then transferred to steam out apparatus using minimum volume of water. The ammonia steamed distilled into 2% boric acid (10cm³) with 5 drops of methyl red indicator for 15 minutes. The distilled ammonia was then titrated with hydrochloric acid (0.02M) (Barenholz, 2002).

**Determination of crude fat**

Sample (3g) was carefully weighed (W1) into a folded fat free filter paper and a small cotton wool placed on top. This was properly tied with a thread at both ends and weighed (W2). It was then carefully placed in the extraction thimble and a small amount of cotton wool placed on top. The whole apparatus was then connected after the addition of about 300cm³ of 60 - 80°C petroleum ether. The extraction was then carried out for 3 h using the heating mantle and making sure there was continuous flow of water in the condenser. The sample was then removed, air-dried and placed in an oven at 80°C until a constant weight was obtained (W3) (A.O.A.C, 1990).

**Determination of crude fibre**

Sample (3 g) was weighed (W1) into the extraction
apparatus and extracted three times with light petroleum ether by stirring, settling and decanting. The air-dried extracted sample was transferred to a dry 100 cm$^3$ conical flask. 0.1275M sulphuric acid (80 cm$^3$) was measured at ordinary temperature and brought to its boiling point. This was boiled for 30 min. While a constant volume was maintained, the flask was rotated every few minutes in order to mix the contents and remove particles from the side. Buchner funnel was fixed to a perforated plate and to the funnel; a filter paper was also fixed to cover the holes in the plate. The mixture was poured immediately into the prepared funnel. The funnel was adjusted so that filtration was completed within 10 min. The insoluble matter was washed with boiling water for several times until the washing were free of acid. It was then transferred back to the conical flask and 0.313 M sodium hydroxide (80 cm$^3$) measured at ordinary temperature and brought to boiling point. The mixture was boiled for 30 min; it was then allowed to stand for 1 min. and then filtered immediately. The insoluble material was transferred to the filter paper by means of boiling water, and then, it was washed with 1% hydrochloric acid and washed again with boiling water until it was free from acid. Then washed twice with ethanol and three times with ether, the insoluble matter was then transferred to a dried weighed crucible and dried at 100°C to a constant weight (W2) the crucible and its contents were placed on a heating mantle in a fume cupboard to burn off the organic matter. It was then transferred to a muffle furnace at 550°C for 3 h, the ash content after cooling was then determined by weighing (W3) (A.O.A.C, 1990).

**Determination of total carbohydrate**

To determine the crude carbohydrate content of a sample, the percentages of the remaining constituents are summed up and subtracted from 100%. The value obtained from this, gives the crude carbohydrate content of the sample (A.O.A.C, 1984).

**MINERAL ELEMENT ANALYSIS**

**Determination of mineral elements**

Finely ground (5 g) of sample was oven dried at 60°C and was weighed into crucible. The sample was ignited into a muffle furnace for 6-8 hours at a temperature between 450°C and not exceeding 500°C, a grayish white ash was obtained. The sample was cooled on asbestos sheet and 5 cm$^3$ 1N HNO$_3$ solutions was added to it. It was evaporated to dryness on a steam bath or a hot plate at a low heat of 400°C for 15 min. until a perfectly white or grayish white ash is obtained. The sample was later cooled on asbestos sheet and 10 cm$^3$ 1N HCl was added and the solution filtered into 50 cm$^3$ volumetric flask. The crucible and filter paper were washed with additional 10 cm$^3$ portion of 0.1N HCl three times to make up to the volume with 0.1N HCl solution. The filtrate was stored for Na, P, K, Ca, Mg, Fe, Cu and Zn determination using Atomic Absorption Spectrophotometer (A.O.A.C, 1990).

**ANTINUTRIENTS ANALYSIS**

**Determination of tannin**

Plant extract (15 cm$^3$) was transferred to a stoppered conical flask, 0.1N iodine (10 cm$^3$) and 4% NaOH (10 cm$^3$) were added. This was mixed and kept in the dark for 15 minutes. The mixture was diluted with water and acidified with 4% H$_2$SO$_4$ (10 cm$^3$). The mixture was titrated with 0.1N sodium thiosulphate solution using starch solution as indicator. The number of cm$^3$ of 0.1N sodium thiosulphate used corresponds to the fume of tannins and pseudo tannins.

Another plant extract (25 cm$^3$) was mixed with gelatin solution (15 cm$^3$) in a 100 ml measuring flask and complete to volume with water; filter. To the 20 cm$^3$ filtrate, 0.1N iodine (25 cm$^3$) and 4% NaOH (10 cm$^3$) were added. This was mixed and kept in the dark for 15 minutes. The mixture was diluted with water (10 cm$^3$) and acidified with 4% H$_2$SO$_4$ and then titrated with 0.1N sodium thiosulphate using starch as indicator. The number of cm$^3$ of 0.1N sodium thiosulphate used corresponds only to pseudo tannin content. A blank was prepared using distilled water (Joslyn, 1970).

**Determination of saponin**

Plant extract (50 cm$^3$) were placed in a 500 cm$^3$ flask. 50% alcohol (300 cm$^3$) were added and boiled under reflux for 30 min and filtered while hot through a gauze filter paper. Charcoal (2 g) was added to the filtrate, boiled and again filtered while hot. The filtrate was cooled and an equal volume of acetone was added to completely precipitate the saponin. The precipitated saponin was collected by decantation and dissolved in a small amount of boiling 95% alcohol and filtered while hot. The filtrate was cooled to room temperature to separate the saponin in a relatively pure form. The clear supernatant fluid was decanted and the saponins suspended in alcohol (20 cm$^3$) and filtered. The filter paper was transferred to a desiccator containing anhydrous calcium chloride and left to dry and weighed (Odebiyi and Sofowora, 1978).

**Determination of phytate**

Sample powder (4 g) was soaked in 2% HCl (100 cm$^3$) for 3 hours and then filtered through Whatman No 1 filter paper. Filtrate (25 cm$^3$) was placed in a 100 cm$^3$ conical flask and 0.3% ammonium thiocyanate (5 cm$^3$) solution
Table 1. Proximate composition of banana and plantain.

<table>
<thead>
<tr>
<th>Samples</th>
<th>Ash (%)</th>
<th>Moisture (%)</th>
<th>Crude Fibre (%)</th>
<th>Crude Fat (%)</th>
<th>Crude Protein (%)</th>
<th>Total CHO (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana</td>
<td>4.93±0.81</td>
<td>73.63±2.01</td>
<td>3.09±0.57</td>
<td>1.05±0.05</td>
<td>7.30±0.70</td>
<td>22.01±1.18</td>
</tr>
<tr>
<td>Plantain</td>
<td>4.71±1.01</td>
<td>64.13±1.06</td>
<td>2.21±0.31</td>
<td>0.53±0.06</td>
<td>8.83±0.85</td>
<td>30.98±1.44</td>
</tr>
</tbody>
</table>

Results are expressed as Mean ± S.D, n = 3.

Table 2. Mineral element composition of banana and plantain.

<table>
<thead>
<tr>
<th>Samples</th>
<th>Ca (mg/L)</th>
<th>K (mg/L)</th>
<th>P (mg/L)</th>
<th>Mg (mg/L)</th>
<th>Fe (mg/L)</th>
<th>Zn (mg/L)</th>
<th>Na</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana</td>
<td>400.01±0.20</td>
<td>48.74±0.04</td>
<td>113.09±0.01</td>
<td>37.49±0.01</td>
<td>25.05±0.05</td>
<td>5.58±0.00</td>
<td>14.51±0.02</td>
</tr>
<tr>
<td>Plantain</td>
<td>3.00±0.05</td>
<td>27.50±0.01</td>
<td>106.81±0.02</td>
<td>25.05±0.05</td>
<td>20.83±0.01</td>
<td>8.31±0.01</td>
<td>16.12±0.02</td>
</tr>
</tbody>
</table>

Results are expressed as Mean ± S.D, n=3.

Values in the same column having the same superscript are significantly different at P < 0.05.

was added as indicator. Then, distilled water (53.5 cm³) was added to the mixture to give it proper acidity; this was titrated with a standard iron III chloride solution, which contains about 0.00195 g of iron per cm³, until a brownish – yellow color appeared which persists for 5 min. (Wheeler and Ferrel, 1971).

Determination of oxalate

Sample powder (2 g) was suspended in distilled water (190 cm³) contained in a 250 cm³ volumetric flask and boiled for 1 h. 6M HCl (10 cm³) was added before digestion at 100°C. The suspension was cooled and made-up to the 250 cm³ mark of the flask and then filtered (Trease and Evans, 1989).

Oxalate precipitation

Duplicate portion (125 cm³) of the filtered sample powder digest was placed in two different 250 cm³ beakers, followed by the addition of conc. NH₄OH solution (drop-wise) until the test solution changed from its salmon pink colour to a faint yellow colour. Each portion was heated to 90°C, cooled and filtered with Whatman No.1 filter paper to remove brownish precipitate containing ferrous ions. The golden yellow filtrate was heated to 90°C and 5% calcium chloride solution (10 cm³) was added while being stirred constantly. The solution was cooled and left overnight at 5°C, thereafter, the solution was centrifuged at 2500 rpm for 5mins. The supernatant was decanted and the precipitate completely dissolved in 20% v/v H₂SO₄ solution (20 cm³).

Permanganate titration

The total filtrate resulting from the digestion and oxalate precipitation, which dissolved in 20% v/v H₂SO₄ solution (20 cm³), was titrated against 0.05M KMnO₄ solution to a faint pink colour which persisted for 30 s.

Determination of cyanide

Sample (10 g) was soaked in a mixture of water (200 cm³) and orthophosphoric acid (10 cm³). The mixture was left for 12 hours to release all bounded hydrocyanic acid. A drop of anti-foaming (paraffin) and anti-bumping agents were added and the solution distilled until the distillate (150 cm³) was collected. The distillate (20 cm³) was transferred into a conical flask and diluted with 5% (w/v) potassium iodide (KI) solution (2.0 cm³). The mixture was titrated with 0.02M silver nitrate (AgNO₃) using a micro burette until a faint but permanent turbidity was obtained (1 cm³ 0.02M AgNO₃ 1.08 mg HCN) (Joslyn, 1970).

RESULTS

The result of the proximate composition of banana and plantain were determined and compared (Table 1). However, no significant difference was observed when the moisture, ash, crude fibre, crude fat, crude protein and total carbohydrate contents of the two Musa species were compared to each other at P < 0.05.

The results of mineral elements composition of banana and plantain were determined and compared (Table 2). A significantly higher (P < 0.05) mean Magnesium, Iron, Calcium, Potassium and Phosphorus contents were observed in banana compared to that of plantain. On the other hand, a significantly higher (P < 0.05) mean Zinc and Sodium contents were observed in plantain compared to that of banana.

The results of antinutrients composition of banana and plantain were determined and compared (Table 3). A significantly higher (P < 0.05) mean phytate content was observed in plantain compared to that of banana. However, no significant difference (P > 0.05) was observed in the mean saponin, tannin and
oxalate content of the two Musa species.

Discussion

According to this research, both species were observed to contain all the nutrients being analyzed. The carbohydrate, fat, protein and energy contents of banana and plantain are higher compared to that of apple. This signifies that both banana and plantain may be richer sources of these nutrients than apple. The moisture content in apple is higher than that of banana and plantain. This shows that apple may ease digestion faster than banana and plantain.

With respect to the result obtained in this research, in comparison with the mineral elements composition of apple, banana and plantain contain higher amounts of iron, potassium and sodium than apple. This shows that banana and plantain may have the tendency to lower blood pressure, aid in RBCs formation and also aid in the transmission of nerve impulse due to their high potassium, iron and sodium contents respectively. Apple tends to contain a higher amount of calcium compared to banana and plantain. This shows that apple may aid in blood clotting than banana and plantain.

The recommendations are made on the basis of data presented in the current research. Based on the research conducted, further research can be carried out on different species of the Musaceae family to determine their differences in nutritional and antinutritional values. The two Musa species (Banana and Plantain) used in this research may be recommended for people with high blood pressure due to their high potassium content. Banana and plantain may be recommended to people with hypercholesterolemia and diabetes mellitus since they contain high amount of crude fibre which decreases cholesterol and help lower blood glucose level.

Conclusion

The results obtained showed that both banana and plantain contain detectable amounts of carbohydrate, protein, moisture, ash, fat and fibre. Banana was found to contain significantly higher (P<0.05) amounts of magnesium, iron, calcium, potassium and phosphorous while plantain contains higher amounts of zinc and sodium. Plantain was also found to contain higher amount of Phytate while banana contain higher amount of hydrogen cyanide. Thus, the two species can serve as good sources of nutrient and mineral element with trace amount of antinutrients.

RECOMMENDATIONS

The recommendations are on the basis of data presented in the current research. Based on the research conducted, further research can be carried out on different species of the Musaceae family to determine their differences in nutritional and antinutritional values. The two Musa species (Banana and Plantain) used in this research may be recommended for people with high blood pressure due to their high potassium content. Banana and plantain may be recommended to people with hypercholesterolemia and diabetes mellitus since they contain high amount of crude fibre which decreases cholesterol and help lower blood glucose level.

REFERENCES


Table 3. Antinutrients composition of banana and plantain.

<table>
<thead>
<tr>
<th>Samples n = 3</th>
<th>Saponin (g)</th>
<th>Tannin (%)</th>
<th>Oxalate (mg/g)</th>
<th>Phytate (%) x 10⁻³</th>
<th>Cyanide (mg) x 10⁻³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana</td>
<td>1.06 ± 0.06</td>
<td>0.34 ± 0.08</td>
<td>0.59 ± 0.13</td>
<td>2.48 ± 0.15</td>
<td>5.97 ± 0.70</td>
</tr>
<tr>
<td>Plantain</td>
<td>1.57 ± 0.20</td>
<td>0.28 ± 0.03</td>
<td>0.52 ± 0.03</td>
<td>5.08 ± 0.12</td>
<td>3.30 ± 0.66</td>
</tr>
</tbody>
</table>

Results are expressed as Mean ± S.D. Values in the same column having the same superscript have significant difference at P < 0.05.