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Full Length Research Paper

Analytical screening of nutritional and non-essential components in unripe and ripe fruits of banana (*Musa sapientum)*

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Proximate qualities, vitamins B_2, B_9 and C as nutritional components; also phytates oxalates and tannins as non-essential components were determined in the edible pulp (mesocarp) and peel (pericarp) of banana fruits. The determinations were done to find out if these parameters varied according to fruit part (mesocarp and pericarp) and state of maturity (unripe and ripe) of the fruit. Moisture, ash, crude fibre and crude protein were higher in the unripe mesocarp while carbohydrate was higher in the ripe mesocarp. The pericarps presented a different distribution. Ash and crude fibre were higher in the unripe pericarp while moisture and carbohydrate were higher in the ripe pericarp. Lipid extract in both mesocarp (0.20% unripe and 0.21% ripe) and pericarp (0.12% unripe and 0.10% ripe) were negligible. The vitamins analysed were higher in the ripe mesocarp than in the unripe. Riboflavin was 2.10 mg/100 g in ripe and 1.40 mg/100 g in unripe; folic acid was 55.50 µg/100 g in ripe and 41.40 µg in unripe while ascorbic acid was 36.10 mg/100 g in ripe and 23.10 mg/100 g in unripe. These vitamin concentrations were found to be nutritionally significant. Tannins, oxalates and phytates were generally higher in the pericarps than the mesocarps but these concentrations were all found to be below stated lethal levels. Therefore, concentrations of nutritional and non-essential components analyzed varied according to fruit part (mesocarp and pericarp) and state of maturity (unripe and ripe).

Key words: Qualities, vitamins, phytates, nutrition, banana, fruits.

INTRODUCTION

The word “banana” is said to have its roots in the Arabic word “banan” which means “finger” (Wikipedia, 2006). Banana is a general term embracing a number of species or cultivars in the genus *Musa* of the family *musaceae*. Most edible fruited bananas are usually seedless and belong to the species *Musa acuminata*, *Musa sapientum*, *Musa cavendishi, Musa paradisiaca* etc. Other species include *Musa balbisiano colla* of southern Asia which bears a seeded fruit. *Musa basjoosieb* of Japan and *Musa ornate* from Pakistan are grown mainly as ornamental plants and for fibre. *Musa textiles Nee* of the Philippines is grown for its fibre and for making tissue thin tea bags. *Musa enseta Gmel* is cultivated in Ethiopia for fibre and for the foods derived from the young shoot, base of the stem and the corm, (Morton, 1987).

Banana plant is a herb but is often mistaken for a tree because of its size and structure (Wikipedia, 2006). Banana fruit is technically a false berry made up of a peel (pericarp) and inner edible portion (mesocarp). The pericarp is usually glossy deep green, firm and sticks to the mesocarp when the fruit is unripe. When the fruit is ripe, the pericarp turns yellow, light green or dull green with black speckles. The pericarp of the unripe fruit sticks firmly to the mesocarp but peels off easily when the fruit is ripe. The flavor may be mild and sweet or sub acid with a distinct apple tone. Wild banana fruits are nearly filled with black hard round or angled seeds

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and have scant fleshy portion. The commonly cultivated and consumed domesticated types are generally seedless with just minute vestiges of ovules visible as brown speckles in slightly hollow or faintly pithy centre which is especially evident when the fruit is over ripe (Morton, 1987 and Wikipedia, 2006).

Bananas are important food crops in the humid forest and mid altitude zones of sub-saharan Africa. It has been estimated that bananas provide nearly 60 million people in Africa with more than 200 calories (food energy) a day (Stover and Simmond, 1987). In tropical America and the Caribbean, bananas are of great nutritional and socio-economic significance generating considerable export earnings and employment. Bananas and plantains together constitute the fourth most important global food commodity after rice, wheat and maize in terms of gross production and consumption (INIBAP, 1992). Banana flour is an important raw material in the confectionery industry and complementary infant food formulation in Nigeria (Ogazi, 1996, Adeniji and Empere, 2001).

Ripe banana fruit is utilized in a multiple of ways in the diet, from simply being peeled and eaten out of hand to being sliced and served in fruit drinks, and salads, sandwiches, custards etc. Banana fruits are also smashed and incorporated into ice cream, bread and cream pies. The fruit is used in making jam, sauce or jelly. Banana Puree is an important component of most infant food. Matured unripe banana fruits are boiled or baked and eaten with soups or stews; or the fruit is thinly sliced and fried till crisp to make banana chips (Wikipedia, 2006).

Eating ripe banana fruit is reported to help relief problems of constipation. Banana fruit is also used as the dietary food against intestinal disorders because of its soft texture and smoothness. Ripe banana fruit when eaten neutralize acidity and reduce irritation by coating the stomach lining (Morton, 1987). Ripe banana fruits that have been rejected are usually supplemented with proteins, vitamins and mineral salts and used as feed to animals. Animals themselves seem to relish banana peels of the ripe fruits. Beef cattle can be fed with green matured banana fruits which have been mixed with urea and molasses to mask the astringent taste (Okaka et al., 2002). Banana leaves, being large, flexible and water proof are used in wrapping food for cooking or storage, and also for thatching. The fibre obtained from the pseudostem of banana is used for diverse purposes like fabrics, teabags, paper, shoe soles etc. (Morton, 1987). Hence, the importance of studying the nutritional and non-essential components in the unripe and ripe fruit cannot be over emphasized.

Although various studies have been carried out on banana fruit, most of these were on the mineral element concentration of the matured and ripe fruit. The purpose of this research therefore is to evaluate the nutritional (in terms of proximate composition and some vitamins); and non-essential components in banana fruit

MATERIALS AND METHODS

Banana fruits were sampled from orchards within Yola vicinity. Bunches of matured unripe fruits were harvested from their plants using a sterilized knife. About 2.0 kg of the fruits were selected randomly from the harvested lot. Half (1.0 kg) of the fruits were set aside to ripen (Morton, 1987) and then sampled as the ripe fruits. The other half (1.0 kg) was immediately taken in clean polythene bags to the laboratory as the unripe fruit samples.

Sample Preparation

In the laboratory, the unripe banana fruits were carefully separated into mesocarps (edible pulp) and pericarp (peel). A portion of each of the samples were thinly sliced and dried at 105^0c in an oven (pickstone). After cooling, the dried samples were ground to powder form and kept air tight in previously washed, dried and labelled sample containers. This sample powder was used for ash, crude protein, crude fibre and lipid extract determinations. The remaining fresh portion was used for vitamins, phytate, oxalate and tannin determinations.

Analytical studies of Samples Determination of moisture

The method described by AOAC (2000) was used. 2.0 g of pericarp and mesocarp (triplicate) were weighed into previously weighed crucibles and dried at 95 – 100^OC for two hours in an oven. The samples were removed, cooled in a desiccator, weighed and returned into the oven again for an hour. The samples were then brought out and cooled in a desiccator before weighing. This was repeatedly done until a constant weight was obtained with three consecutive weighings. The percentage of moisture was determined from the results of the weighing.

Determination of Ash

Ash content was determined in triplicates as described by Forster et al (2003). About 2.0 g of finely ground samples obtained after moisture determination were weighed into porcelain crucibles. The samples were charred on a heating mantle inside a fume cupboard to get rid of the smoke. The samples were then transferred into a muffle furnace and gradually heated to a temperature of 550 ^OC for 8 hours until a clear grey ash was obtained and then after which the samples were cooled in a desiccator and weighed. The percent

ash was determined from the results of the weighing.

Determination of crude fibre

Crude fibre was determined using the method of Nelson (1994). About 2.0 g of sample was weighed into a round bottomed flask and 100 cm^3 of 0.25 MH_2SO_4 was added and the mixture boiled for 30 minutes**.** The solution was quickly filtered under suction. The insoluble matter residue was washed several times with hot water until it was acid free. It was quantitatively transferred into the flask and 100 cm^3 of 0.3 M NaOH solution was added and the mixture boiled again under reflux for 30 minutes before it was quickly filtered. The residue was washed with boiling water until it was base free; It was dried to constant weight in the oven at 100^0C, cooled in a desiccator and weighed (C_1). The weighed residue (C_1) was then incinerated in a muffle furnace at 550^oC for two hours, cooled in the dissicator and weighed (C_2). The loss in weight on incineration divided by the original weight of sample multiplied by 100 gave the percent crude fibrele

Determination of Lipids

Lipid contents were determined using the method of AOAC (2000). A previously cleaned and dried 500 cm^3 round bottomed flask containing a few anti-bumping granules was weighed (W_1) and 300 cm^3 of petroleum ether was poured into the flask fitted with soxhlet extraction unit. The extraction thimble containing 20.0 g of the sample was fixed into the round bottomed flask and a condenser connected to the soxhlet extractor. Cold water circulation was put on, the heating mantle switched on and heating rate adjusted until the solvent was refluxing at a steady rate. Extraction was carried out for six hours, the solvent was recovered and the lipid extract obtained was dried in an oven at 70^oC for an hour. The round bottomed flask with lipid extract was cooled and then weighed. Lipid content was calculated and expressed in percentage.

Determination of Crude Protein

Crude protein was determined using Kjeldahl method as described by Mendham *et al.*, (2006). 5.0 g of the dried sample was weighed into a 500 cm^3 Kjeldahl flask. 10.0 g of K_2SO_4 and 0.7 g of Ca_2SO_4 (both as catalyst) was added followed by 40 cm^3 of 98% H_2SO_4. The mixture was gently boiled for over two hours to obtain a clear digest solution. 50 cm^3 of the digest was poured into a distillation flask. 20 cm^3 of water and a few anti-bumping granules were added. 100 cm^3 of 10% NaOH solution was poured into the funnel of the distillation flask. 100 cm^3 of 0.1 M HCl was poured into a receiving conical flask with the funnel tap was opened. The flask was heated to gentle boiling and distillation continued for about 40-45 minutes (or until about 150 cm^3 of liquid had distilled out). A few drops of mixed indicator (methyl red-bromocresol green) was added and titrated against 0.1 M NaOH solution. A blank titration was carried out with an equal measured volume of 0.1M HCl acid. Results were expressed as percent nitrogen.

Determination of Carbohydrate

The total carbohydrate contents in the samples were determined using the method of difference (Onwuka, 2005). Thus percentage available carbohydrate was obtained as:
% carbohydrate = 100 – (% moisture + % ash + % crude protein + % lipid extract + % crude fibre).

Determination of vitamins (B_2, B_9 and C)

Vitamins (B_2, B_9 and C) were analysed in the unripe and ripe mesocarps using VU-Visible spectrophotometry. The method of Jacobs, (1999) was used. About 5.0 g of the sample slurry was placed in a conical flask, to which was added 20 cm^3 of methanol was added and the mixture was shaken very well then left overnight. It was then shaken, filtered and washed several times with the solvent. The filtrate was made up to mark in a 50 cm^3 volumetric flask.

Folic acid (B_9): Absorbance for folic acid was read at 273.00 nm using UV-Visible spectrophotometer (Shimadzy UV-2550). Folic acid standards were prepared and calibration curve of absorbance against concentration plotted. Concentrations of the samples were read from the calibration curve.

Riboflavin (B_2): Absorbance for riboflavin was read at 261.00 nm. Riboflavin standard solutions were prepared and a calibration curve of absorbance against concentrations plotted. Concentrations of the samples were obtained from the calibration curve.

Ascorbic acid (C): Absorbance for ascorbic acid was read at 478.50 nm. Standard ascorbic solutions were prepared and a calibration curve of absorbance against concentration plotted. Concentrations of the samples were obtained from the calibration curve.

Determination of Tannins

Tannin was quantitatively determined as reported in the manual of food quality control (AOAC, 1984).
The samples were ground into slurry and 0.5 g of the slurry was weighed into a conical flask and mixed with 10 cm^3 of distilled water. This was shaken and allowed to stand for 1hour. About 1 cm^3 of the extract was pipetted into another test tube, This was followed by addition of 5 cm^3 distilled water. Two drops of $FeCl_2$ in

Table1: Nutritional components in mesocarps and pericarps of M sapientum fruits

	Moisture(%)	Ash(%)	Crude fibre(%)	Lipid extract(%)	Crude protein(%)	Carbohydrate (%)
Sample Description						
Mesocarp						
Unripe	75.85±0.02	0.97±0.01	0.90±0.01	0.20±0.01	1.76±0.01	20.12±0.02
Ripe	74.34±0.02	0.91±0.01	0.88±0.01	0.21±0.01	1.67±0.01	21.78±0.01
Pericarp						
Unripe	72.74±0.01	2.68±0.01	5.80±0.02	0.12±0.01	2.63±0.02	16.00±0.01
Ripe	72.87±0.02	2.37±0.01	5.60±0.01	0.10±0.01	2.66±0.02	16.26±0.01

0.1M HCl was added. It was shaken to mix properly and about four drops of Potassium ferrocyanide was also added. Absorbance of a portion of the mixture was read at 620 nm on a using UV-Visible spectrophotometer. The concentration of tannin was calculated and expressed as percent tannin in the sample.

Determination of Phytate

Phytate was determined using the modified method of Reddy and Love, (1999). 50 cm^3 of 0.5 M HCl was added to about 2.0 g of sample in a conical flask and kept over night then filtered. 12 cm^3 of the filtrate was pipetted into a conical flask. 2 cm^3 of 20% $BaCl_2$ was added and the solution heated in a water bath at 80 ^OC for 1 hour. This was centrifuged at 7000 rpm for 7 minutes. The supernatant was discarded and the precipitate washed out of test tube with 0.1M dil. HCl and heated for 15 minutes. The precipitate was washed again with hot water, centrifuged and transferred to a beaker. 1.2 cm^3 of 60% perchloric acid and 1.0 cm^3 conc H_2SO_4 were added and the solution heated strongly until all fumes were lost. 20cm^3 of distilled water was added and the solution neutralized with dillute NaOH, filtered and made up to 50 cm^3 in a volumetric flask.

The absorbance was read at 470 nm. Standard phytic acid solutions were prepared and a calibration curve constructed from which the concentrations of the sample solutions were obtained extrapolated.

Determination of Oxalate

Oxalate content was determined using the titrimetric method of Oke, (1969), (Onwuka, 2005). About 2.0 g of the powdered sample was weighed into a 250 cm^3 conical flask and 190 cm^3 of distilled water added. 10 cm^3 of conc. HCl was added and the suspension digested at 100 ^OC for 1hour, cooled and made up to mark with distilled water before filtering. Duplicate portions of 125 cm^3 of the filtrate was measured into 250 cm^3 conical flask and four drops of methyl red indicator added to each. Concentrated NH_4OH was added until the salmon pink colour of the test solutions changed to a permanent faint yellow. Each portion was heated to 90 ^OC, cooled and filtered to remove precipitates. The filtrate was heated to 90 ^OC and 10 cm^3 of 5% $CaCl_2$ added with constant stirring. The portions were cooled and left over night at 5 ^OC after which they were centrifuged at 2500 rpm for five minutes. The supernatants were decanted and the precipitate dissolved completely in 10 cm^3 of 20% (v/v) H_2SO_4 solution and then filtered. Now the total filtrate resulting from the duplicate portions of 125 cm^3 were transferred into the same flask (300 cm^3 capacity) and made up to mark with distilled water. 125 cm^3 aliquots of the filtrate were heated in a conical flask to near boiling point and then titrated against 0.05 M standardized $KMnO_4$ solution to a faint pink colour. The titre value was recorded and oxalate content was calculated.

RESULTS AND DISCUSSION

Nutritional and Non-essential Components in banana fruits

Proximate qualities as nutritional components in the mesocarps and pericarps are in Table 1. The non-essential components in the mesocarps and pericarps are also presented in Table 2 presents concentration of nutritional components in the mesocarps and pericarps of matured unripe and ripe fruits of the locally cultivated banana. Moisture content was high in all the samples which is in agreement with values obtained by Swaminathan, 2002) where the moisture level of most fresh fruits is in the range 75-90%. The mesocarps however, gave higher moisture (75.85% unripe and 74.34% ripe) than the pericarps (72.74% unripe and 72.87% ripe). Carbohydrate was found to be the next

Table 2: Non-essential components in mesocarps and pericarps of *Musa sapientum* fruits

	Oxalates (mg/g)	Tannins(mg/g)	Phytates(mg/g)
Sample Description			
Mesocarp			
Unripe	117.00	1.10	255.37
Ripe	49.49	4.29	185.60
Pericarp			
Unripe	157.00	5.86x	285.20
Ripe	132.02	5.55	269.34

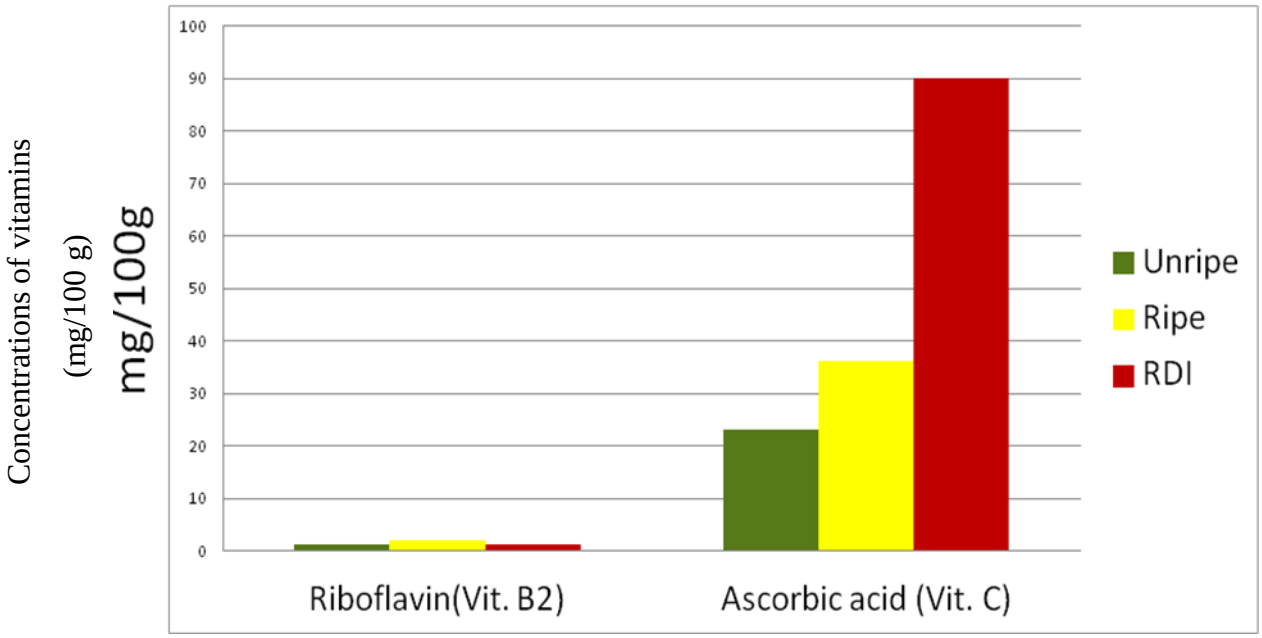

Figure 1. Vitamins B_2 and C in mesocarps of *Musa Sapientum* fruits.

abundant component with the mesocarp giving higher values (20.12% unripe and 21.75% ripe) compared to the pericarps (16.00% unripe and 16.26% ripe). This relatively high carbohydrate content of the mesocarps perhaps explains why *Musa sapientum* is taken as staple in some communities (Morton, 1987). Substantial values were obtained for crude protein. The unripe mesocarp gave higher value (1.7%) than the ripe (1.67%). These values are higher than those reported for edible portion of *Carica papaya* fruits (0.50% for the unripe and 0.40% for the ripe). Ladele et al (1984) reported higher values for crude protein in *Musa parasidiaca* fruits with the ripe mesocarp giving higher value (3.0%) compared to the unripe (2.9%). Thus, the crude protein in *Musa parasidiaca* is higher than that in *Musa sapeintum*. The pericarps of *Musa sapientum* gave higher values than the mesocarps. The unripe pericarp gave 2.63% while the ripe pericarp gave 2.66%. Ash values obtained for *Musa sapientum* was found to be higher in the pericarps (2.68% for unripe and 2.37% for ripe) compared to the mesocarps (0.97% for unripe and 0.91% for the ripe). Ladele et al (1984) gave higher ash values for *Musa paradisiaca* with the unripe mesocarp giving higher value (1.90%) than the ripe (0.96%). These values are low when compared to values obtained for the mesocarp of *Carica papaya* (7.4% unripe and 4.8% for the ripe). Crude fibre analysed in *Musa sapientum* was found to be higher in the pericarps (5.80% unripe and 5.60% ripe) compared to the mesocarps (0.90% unripe and 0.88% ripe). The relatively high ash, crude fibre and crude protein contents of the pericarps likely gives the pericarps a good taste and perhaps explains why animals seem to relish the pericarps, especially those of the ripe fruits. Lipid extract obtained in the mesocarps and pericarps of *Musa sapientum* were quite low. The mesocarps

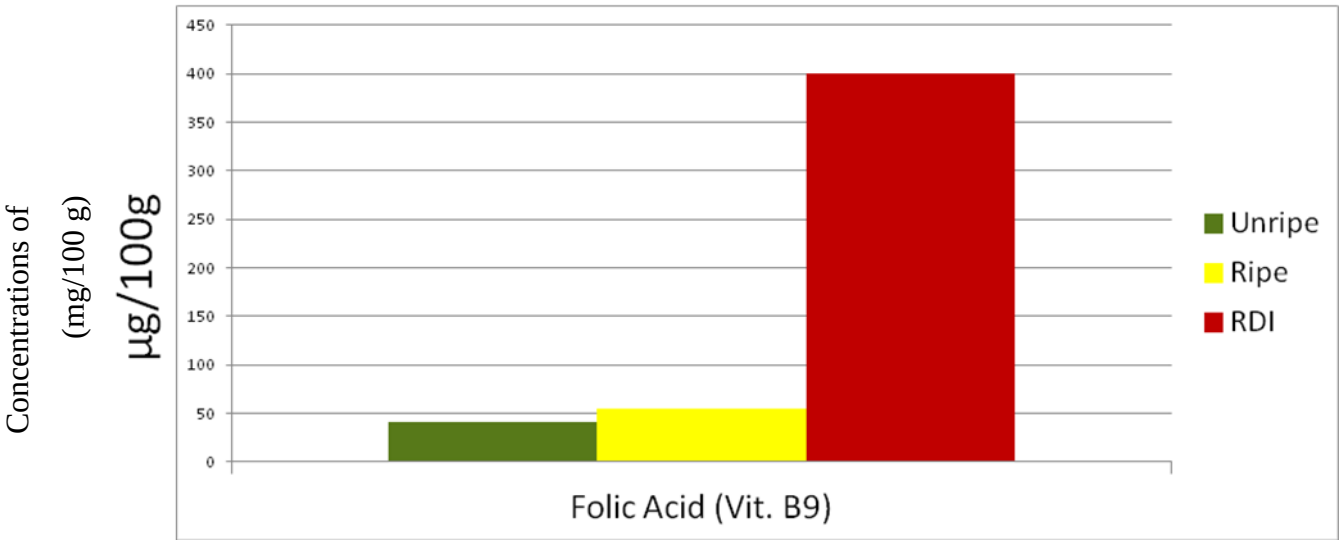

Figure 2: Folic acid (Vit. B_9) in mesocarps

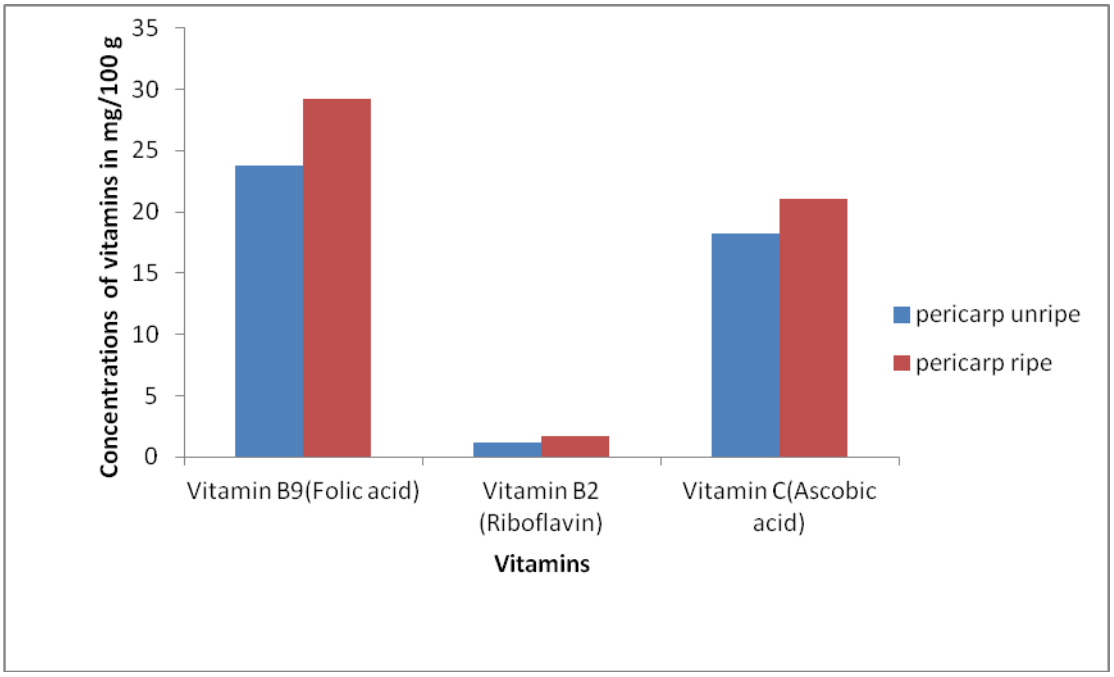

Figure 3.Vitamin B_2,B_9 and C in pericarp of Musa sapientum

gave 0.20% for unripe and 0.21% for ripe while the pericarps gave 0.12% unripe and 0.10% ripe. These values are lower than those obtained for *Musa paradisiacal* (0.58% for the unripe and 0.74% for the ripe). *Carica papaya* also gave higher lipid extract values (0.56% for unripe and 0.46% for the ripe).

Figure 1 shows the distribution of riboflavin(vitaminB_2) and ascorbic acid in mesocarps and pericarps of *Musa sapientum*. Riboflavin (vitamin B2) was found to be very low in both ripe and unripe mesocarp whereas ascorbic acid is significantly high in ripe and unripe mesocarp. The presence of riboflavin is of significance since the recommended daily intake for riboflavin is 1.3 mg per day (Lieberman and Bruning, 1990; Institute of medicine, 2007). Figure 2 shows the distribution of Folic acid (vitamin B9) in both unripe and ripe mesocarps.The presence of folic acid in both samples is of significance. The figure however shows a slightly higher concentration of folic acid in the ripe mesocarp. Figure 3 shows the concentrations of the vitamins in the

pericarp. The results indicated that the vitamins are all lower in the pericarp of Musa sapientum. These result indicate that banana fruit is likely to be a good source of folic acid given the average recommended daily intake for the acid to be 400 µg/day (Lieberman and Bruning 1990; Wikipedia, 2002). Wikipedia (2002) and Institute of medicine (2007) gave the recommended daily intake for ascorbic acid to be 90 mg per day for an adult.

CONCLUSION

The concentration of nutritional and non-essential components analysed in the unripe and ripe mesocarp showed variations. The moisture, ash, crude fibre and crude protein content were higher in the unripe mesocarp while carbohydrate was higher in the ripe mesocarp. The variation in lipid extract content in the unripe and ripe mesocarps was negligible. The pericarps showed a slightly different distribution. The ash and crude fibre content were higher in the unripe pericarp while the moisture and carbohydrate were higher in pericarp of the ripe fruit. Lipid extract and crude protein content showed no significant variations in both unripe and ripe pericarps. Vitamins B2 (riboflavin), B9 (folic acid) and C (ascorbic acid) analysed in the unripe and ripe mesocarps gave values that are of nutritional significance. The pericarps gave generally higher content of the non-essential components than the mesocarps. Tannins, oxalates and phytates were all higher in the unripe pericarps than in the ripe.

Recommendations

In view of the concentrations of nutritional components found in the mesocarps of *Musa sapientum*, the fruit is highly recommended to all. However, to get more information on the nutritional components in the fruit, other parameters like reducing and non-reducing sugars, amino acid profile and more vitamins should be analysed in the fruit. The action of banana lectin,) should also be studied.

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