

Proximate Composition and Antioxidant Activities of Different Species of *Mangifera indica* Seeds Kernel Cultivated in Esan West Local Government Area of Edo State

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DOI: [10.36348/sijcms.2020.v03i08.002](https://doi.org/10.36348/sijcms.2020.v03i08.002)

| Received: 05.10.2020 | Accepted: 20.10.2020 | Published: 30.10.2020

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Abstract

Antioxidant activities of some species of *Mangifera indica* seed kernel (sucking mango, bush mango and opiororo mango) extracts were studied. The antioxidants capacities of the mango seed extracts were compared to some known synthetic antioxidant. Results obtained showed that the three different species of *Mangifera indica* seed kernel which have $30.24 \pm 0.030\%$, $21.11 \pm 0.010\%$ and $15.14 \pm 0.020\%$ for sucking, bush and opiororo mangoes respectively had a lower scavenging capacity compared to the synthetic positive control standard (vitamin C) which recorded $32.57 \pm 0.001\%$ in DPPH radical scavenging assay. *Mangifera indica* specie B (bush mango) had the highest scavenging capacity ($66.76 \pm 0.014\%$) compared to the synthetic positive control BHT ($64.40 \pm 0.020\%$) in the reducing power determination assay. *Mangifera indica* specie B (bush mango) and specie C (opiororo mango) had higher scavenging capacities of $14.64 \pm 0.031\%$ and $14.29 \pm 0.019\%$ for hydrogen peroxide scavenging capacity compared to synthetic sodium pyruvate which has $13.01 \pm 0.009\%$. Proximate composition of three varieties of mango seeds was also determined. The percentage moisture, ash crude fat, crude fibre, protein and carbohydrate contents was determined using A.O.A.C. method. Opororo mango and Sucking mango had similar values for moisture content (8.00%) while Bush mango had comparable value of 8.05%. The ash content ranged between 0.40 - 1.80% and Bush mango had the highest value of $1.80 \pm 0.03\%$. The fat content was observed to be between $14.29 \pm 0.05\%$ and $27.14 \pm 0.01\%$ with sucking mango having the highest fat content ($27.14 \pm 0.01\%$). Bush mango and Opororo mango had similar values for crude fibre (49.50%) while sucking mango had comparable value of $49.00 \pm 0.03\%$. The crude protein ranged between 9.26 - 14.27%. This study suggests that the seeds may be nutritionally potent with appreciable high levels of nutrients and energy which can be incorporated into feed/food.

Keywords: Proximate composition, antioxidant, *Mangifera indica*, DPPH and BHT.

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INTRODUCTION

Research into nutraceutical and functional food has highlighted the health compound found in fruit and vegetables. Tropical fruits having remarkably great qualities can be eaten unprocessed and without added sugars. Being an important source of carbohydrate, vitamins, minerals and fibres, tropical fruits grow on all habitats. These fruits are primary sources of nutrition and a delicious component of healthy, balanced diet. Across the world, there are different types of tropical fruits grown and exported.

Mango came to Nigeria in the 20th Century through itinerant merchant missionaries and colonialists where it has become an integral part of indigenous cropping systems [1, 2]. The savanna zones of Nigeria

are credited with producing greater percentage of the fruit in [3], with Benue state topping the list. Unfortunately, the history of mango production in the state is not very clear. Reports however indicate that improved mango varieties were introduced to Yandev Farm Centre by the early Agricultural Officers in Zaria and Ibadan in the 1950s [2]. Fruits from different varieties can be highly variable in shape, colour, taste, and flesh texture. Fruit shapes vary from round to ovate to oblong and long with variable lateral compression. Fruits can weigh from less than 50 g (0.35 lb) to over 2 kg (4.4lb) [4].

The ripe fruits vary in size, shape, colour, sweetness and eating quality. Cultivars are variously yellow, orange, red or green and carry a single flat oblong pit that can be fibrous or hairy on the surface

and which does not separate easily from the pulp. The fruit maybe somewhat round, oval-shaped, ranging from 5-25cm in length and from 140g to 2kg in weight per individual fruit. The skin is leather-like, waxy, smooth and fragrant with colour ranging from green to yellow, yellow to orange, yellow-red or blushed with various shades of reds when fully ripe [5].

The chemical composition of mango pulp varies with the location of cultivation, variety, and stage of maturity [6]. There is an increase from 1 to 14% in the starch content during fruit development, and towards the end of maturity, both reducing and non-reducing sugars are found to be increasing. During processing, by-products such as peels and kernels are generated. Kernels take up to about 17-22% of the fruit. The major component of mango seed kernel consist of about 44-48% saturated fatty acid and 52% unsaturated, they contain low content of protein but most of the essential amino acid [5]. Mango seed kernels were shown to be a good source of polyphenol, phytosterol as ampostero, sistosterol and tocopherol [5]. In addition, mango seed kernel could be used as potential source of functional food ingredients, anti-microbial compounds and cosmetics due to its high quality fats and protein as well as high levels of natural antioxidants. Mango stone obtained after decortication of mango seeds can be utilized as absorbents [5].

Antioxidants are believed to play a very important role in the body defence system [7]. In another term, antioxidant is any substance that substrate significantly delays, prevents or remove oxidative damages to a target molecule. Antioxidants are inhibitors of the process of oxidation, even at relatively small concentration and this have dispersed physiological roles in the body. Antioxidants constituent of plant material acts as radical scavenger and helps in converting the radicals to less reactive

species. A variety of free radical scavenging antioxidants is found in dietary sources like fruits, vegetables and tea etc.

In addition, there are studies that research genetic chemical or biological modification in order to increase the antioxidant property of fruits [8]. Experimental evidences prove that mango fruit can protect human body from free radicals and reactive oxygen species [9], thus might retard and prevent various pathophysiological processes associated with oxidative stress such as cancer, neurodegenerative and cardiovascular disease [10].

Proximate composition originally gives the most extensive information about the composition of the foods which was based on a system of analysis described as the proximate analysis of foods. This analysis was devised over 100 years ago by two German Scientists, Hanneberg and Stohmann. This system of analysis divides the food into six fractions; moisture, fat, crude protein, ash, crude fibre and carbohydrate. The proximate analysis gives the overall nutritional composition of the food sample this is briefly complemented by antinutrient and mineral composition of the sample [11].

This research investigated the antioxidant activities and proximate compositions of different species of mango (*Mangnifera indica*) seeds kernel.

MATERIALS AND METHODS

Sample Collection

Different species of mango fruits were bought from Ekpoma market, Esan west Local Government area of Edo State. The local names of the mango fruits bought were represented as illustrated in the Table 1. All chemicals used were analyte grade chemicals.

Table-1: Local names of Mangnifera indica species analysed.

Local names of the mango species	Alphabetical representation
Sucking mango	Specie A
Bush mango	Specie B
Opororo mango	Specie C

Preparation of Extracts for Antioxidant Assay

The samples were treated separately as to how they are be utilized in the preparation. The barks and edible flesh of the different species of *Mangnifera indica* were separated from the seeds, while the kernels were removed from the seeds and thereafter the kernels were sun dried for 7 days before pulverizing them into powder.

Thereafter, ten grams of each powdered samples were extracted in 200 ml distilled water by shaking for 48 hours. Each extract was filtered with whatman No 1 filter paper. Filtrates obtained were then used for antioxidant assay.

Antioxidant Analysis

Reducing Power Determination

The iron (III) ion Fe^{3+} -reducing powers of the extracts were determined by the method described by Oyaizu [28] with a slight modification. Different concentrations (0.0 – 0.4 mg/ml) of the extract (0.5 ml) were mixed with 0.5 ml phosphate buffer (0.2 M, pH 6.6) and 0.5 ml potassium hexacyanoferrate (0.1%), followed by incubation at 50°C in a water bath for 20 min. After incubation, 0.5 ml of TCA (10%) Trichloroethanoic acid (CCl_3COOH) was added to terminate the reaction. The upper portion of the solution (1 ml) was mixed with 1 ml distilled water, and 0.1 ml $FeCl_3$ solution (0.01%) was added. The reaction mixture

was left for 10 min at room temperature and the absorbance was measured at 700 nm against an appropriate blank solution. All tests were performed three times. A higher absorbance of the reaction mixture indicated greater reducing power. Butylated hydroxytoluene (BHT) was used as a positive control.

$$\% \text{ Inhibition} = \frac{A_{\text{control}} - A_{\text{test}}}{A_{\text{control}}} \times \frac{100}{1}$$

Where;

A_{control} = is the absorbance of the control reaction

A_{test} = is the absorbance in the presence of the sample of the extracts.

Hydrogen Peroxide Scavenging Determination

This was assayed using the method of Elizabeth and Rao [12] with a slight modification. The assay was based on quantification of the degradation product of 2-deoxyribose by condensation with TBA. Hydroxyl radical was generated by the Fe^{3+} -ascorbate. EDTA- H_2O_2 system (the febtion reaction). The reaction mixture contained, in a final volume of 1 ml, 2-deoxy-2-ribose (2.8 mM); KH_2PO_4 -KOH buffer (20 mM, pH 7.4); FeCl_3 (100 μM); H_2O_2 (1.0 mM); ascorbic acid (100 μM); EDTA (100 μM) and various concentrations (0 – 200 $\mu\text{g}/\text{ml}$) of the test sample or reference compound. After incubation for 1 hour at 37 $^\circ\text{C}$, 0.5 ml of the reaction mixture was incubated at 90 $^\circ\text{C}$ for 15 minutes to develop the colour.

After cooling, the absorbance was measured at 532 nm against an appropriate blank solution. All tests were performed in triplicate. Mannitol, a classical OH

scavenger was used as a positive control. Percentage inhibition was evaluated by comparing the test and blank solutions.

$$\% \text{ Inhibition} = \frac{A_{\text{control}} - A_{\text{test}}}{A_{\text{control}}} \times \frac{100}{1}$$

Where; A_{control} = is the absorbance of the control reaction

A_{test} = is the absorbance in the presence of the sample of the extracts.

Determination of Hydroxyl Radical Scavenging

This activity was determined according to the method described by Long et al., [13] with little modifications. An aliquot of 50 mM hydrogen peroxide (H_2O_2) and various concentrations (0 – 2 mg/ml) of samples were mixed (1:1 v/v) and incubated for 30 minutes at room temperature. After incubation, 90 μl of the H_2O_2 -sample solution was mixed with 10 μl HPLC-grade methanol and 0.9 ml FOX reagent was added (prepared in advance by mixing 9 volumes of 4.4 mM butylated hydroxytoluene (BHT) in HPLC-grade methanol with 1 volume of 1 mM xylenol and 2.56 mM ammonium ferrous sulphate in 0.25M H_2SO_4). The reaction mixture was then vortexed and incubated at room temperature for 30 minutes. The absorbance of the ferric-xylenol orange complex was measured at 506 nm. All tests were carried out three times and sodium pyruvate was used as the reference compound [14].

$$\text{Hydroxyl radical scavenging activity (\%)} = \frac{\text{Abs reference} - \text{Abs sample}}{\text{Abs references}} \times 100$$

Where:

Abs references = absorbance of the reference (reacting mixture without the test sample)

Abs sample = Absorbance of reacting mixture with the test sample

Determination of Total Phenolic Content

Total phenolic content was determined using FolinCiocalteu (FC) reagent. Gallic acid standard curve was obtained using 6 different test tubes. All test tubes labeled 1 to 6. To test tube (1) 0.0ml gallic acid was added followed by 1ml distilled water, 0.5ml FC reagent was added followed by 1ml Na_2CO_3 and the test tube containing the solution was incubated for 20mins. The absorbance was measured at 765nm. The same procedure was carried out with test tubes 2,3,4,5 and 6 by adding 0.2,0.4,0.6,0.8 and 1.0ml of gallic acid respectively followed by 0.8,0.6,0.4,0.2 and 0.0ml distilled water to test tubes 2,3,4,5 and 6 respectively. 0.5ml FC reagent was added to each test tube followed by 1ml Na_2CO_3 . The same test was carried out with the test samples, about 0.5ml of the sample was pipette into

a test tube with 0.5ml FC reagent and 1.0ml Na_2CO_3 and the absorbance was measured after 20mins of incubation.

Determination of Total Flavonoid content

The total flavonoid content was determined with AlCl_3 (Aluminum chloride) according to a known method [15] using quercetin as standard. The quercetin standard curve was prepared by adding 0.2, 0.4, 0.6, 0.8 and 1.0ml of quercetin to test tubes 1, 2, 3, 4 and 5 respectively. 0.3ml distilled water was added to each test tube and shaken for 1min for proper reaction. 0.3ml NaNO_2 was added to each test tube, samples was incubated for 5mins at 20 $^\circ\text{C}$, 0.3ml AlCl_3 was added to each test tube and the solution was incubated for 5mins. 0.2ml NaOH was added to each test tube followed by 1ml distilled water. The absorbance was measured using a UV Visible spectrophotometer at 510nm.

Determination DPPH Radical Scavenging Activity

Scavenging activity on DPPH free radicals was assessed Gyamfi et al. [16] with slight modifications [17]. 2.0 ml solution of the extract at different concentrations diluted two-fold in methanol was mixed

with 1.0 ml of 0.3 mM DPPH in methanol. The mixture was shaken vigorously and allowed to stand at room temperature in the dark for 25 min. Blank solutions were prepared with each test sample solution (2.0 ml) and 1.0 ml of methanol while the negative control was 1.0 ml of 0.3 mM DPPH solution plus 2.0 ml of methanol. L-ascorbic acid was used as the positive control. Thereafter, the absorbance of the assay mixture was measured at 518 nm against each blank with a UV-visible spectrophotometer. DPPH radical inhibition was calculated using the equation:

$$\% \text{ inhibition} = \frac{A_{\text{control}} - A_{\text{test}}}{A_{\text{control}}} \times 100$$

Where A_{control} = Absorbance for blank reading, A_{test} = Absorbance for sample reading

Proximate Composition Analysis

The proximate analysis was determined according to AOAC [18] standard test methods.

Determination of Moisture Content

Moisture was determined by oven drying method. About 1.5 g of well-mixed sample was accurately weighed in clean, dried crucible (W_1). The crucible was allowed in an oven at 100-105 °C for 6-12 hours until a constant weight was obtained. Then the crucible was placed in the desiccator for 30 min to cool. After cooling it was weighed again (W_2). The percent moisture was calculated by following formula:

$$\% \text{ Moisture content} = \frac{W_1 - W_2}{\text{Wt of sample}} \times 100$$

Where;

W_1 = Initial weight of crucible + Sample

W_2 = Final weight of crucible + Sample

Note: Moisture free samples were used for further analysis.

Determination of Ash

For the determination of ash, clean empty crucible was placed in a muffle furnace set at 600 °C for an hour, cooled in desiccator and then the weight of empty crucible was obtained (W_1). About 1 g of each sample was taken in crucible (W_2). The sample was ignited in a furnace at 550 °C for 3 hours. The appearances of gray white ash indicated complete oxidation of all organic matter in the sample. After ashing furnace was switch off. The crucible was cooled in a dessicator and weighed (W_3). Percent ash was calculated by following formula:

$$\% \text{ Ash content} = \frac{\text{Difference in Weight of Ash}}{\text{Weight of sample}} \times 100$$

$$\text{Difference in wt. of Ash} = W_3 - W_1$$

Determination of Crude Protein

Protein in the sample was determined by Kjeldahl method. About 1.0 g of dried samples was taken in digestion flask. 15 ml of concentrated H_2SO_4 and 8 g of digestion mixture i.e. $\text{K}_2\text{SO}_4:\text{CuSO}_4$ (8:1) were added. The flask was swirled in order to mix the contents thoroughly then placed on heater to start digestion till the mixture become clear (blue green in colour) which was after two hours of digestion. The digest was cooled and transferred to 100 ml volumetric flask and volume was made up to mark by the addition of distilled water. Distillation of the digest was performed in Markham Still Distillation Apparatus. 10 mL of digest was introduced in the distillation tube then 10 ml of 0.5 N sodium hydroxide was gradually added through the same way. Distillation was continued for at least 10 min and ammonia produced was collected as ammonium hydroxide in a conical flask containing 20 ml of 4 % boric acid solution with few drops of methyl red indicator. During distillation yellowish colour appears due to ammonium hydroxide formed. The distillate was then titrated against standard 0.1 N hydrochloric acid solutions till the appearance of pink colour. A blank titration was also determined through all steps as above without sample. Percent crude protein content of the sample was calculated by using the following formula:

$$\% \text{ N} = \frac{(S-B) \times N \times 0.014 \times D}{\text{weight of sample} \times V} \times 100$$

$$\% \text{ Crude Protein} = 6.25 \times \% \text{ N}$$

Where;

S = Sample titration reading

B = Blank titration reading

N = Normality of HCl

D = Dilution of sample after digestion

V = Volume taken for distillation

0.014 = Milli equivalent weight of Nitrogen

Determination of Crude Fat Content

About 150 mL of an anhydrous diethyl ether (petroleum ether) of boiling point of 40-60 °C was placed in the flask. About 5.0 g of the sample was weighed into a thimble and the thimble was plugged with cotton wool. The thimble with content was placed into the soxhlet extractor; the ether in the flask was then heated. As the ether vapour reaches the condenser through the side arm of the extractor, it condenses to liquid form and drop back into the sample in the thimble, the ether soluble substances were dissolved and are carried into solution through the siphon tube back into the flask. The extraction continued for at least 4 hours. The thimble was removed and most of the solvent was distilled from the flask into the extractor. The flask was then disconnected and placed in an oven at 65 °C for 4 hours, cooled in desiccators and weighed.

CALCULATION

$$\% \text{ Crude fat content} = \frac{\text{Weight of flask+extract}-\text{tare weight of flask}}{\text{Weight of sample}} \times 100$$

Determination of Crude Fibre

About 5.0 g of sample and 200 mL of 0.25M sulphuric acid were heated for 30 min and filtered with a Buchner funnel. The residue was washed with distilled water until it was acid-free. 200 ml of 0.03M sodium hydroxide was used to boil the residue for 30 minutes it was filtered and washed several times with distilled water until it was alkaline-free. It was then rinsed once with 10% hydrochloric acid and twice with ethanol. Finally it was rinsed with petroleum ether three times. The residue was put in a crucible and dried at 105 °C in an oven overnight. After cooling in a desiccator, it was ignited in a muffle furnace at 550 °C for 90 minutes to obtain ash which was then weighed. The percentage crude fiber was calculated using the formular below;

Calculation

$$\% \text{ Crude Fibre} = \frac{\text{Loss in weight on ignition}}{\text{Weight of sample}} \times 100$$

Determination of Carbohydrate

Percentage carbohydrate was calculated by difference using the expression below; % Carbohydrate = (100 - % moisture + % crude protein + % crude fat + % crude fiber + % ash)

RESULTS AND DISCUSSION

Results

The antioxidant and proximate composition analysis results are presented in Tables 2 and 3 respectively for different species of *Mangnifera indica* seeds.

Table-2: Antioxidants capacities of various species of *Mangnifera indica* seeds kernel

Sample	DPPH (%)	Reducing power (%)	Hydroxyl radical (mg/100ml)	Total Phenolic (µ/mL)	Total flavonoids (µ/mL)	H ₂ O ₂ Scavenging (%)
Specie A (sucking mango)	30.24±0.030	62.24±0.013	10.26±0.011	0.69±0.021	0.91±0.010	43.83±0.062
Specie B (bush mango)	21.11±0.010	66.76±0.014	14.64±0.030	0.73±0.001	1.15±0.005	41.90±0.006
Specie C (opiororo mango)	15.14±0.020	65.29±0.019	14.29±0.019	0.30±0.030	1.03±0.025	42.20±0.022
Standard BHT	-	64.40±0.021	-	-	-	-
Standard (vitamin C)	32.57±0.001	-	-	-	-	-
Sodium pyruvate	-	-	13.01±0.009	-	-	-
Mannitol	-	-	-	-	-	43.50±0.120

Table 3: Proximate composition of various species of *Mangnifera indica* seeds kernel

Parameters (%)	Specie A (sucking mango)	Specie B (bush mango)	Specie C (opiororo mango)
Moisture	8.00±0.17	8.05±0.01	8.00±0.06
Ash	1.30±0.10	1.80±0.03	0.40±0.08
Crude fat	27.14±0.01	14.29±0.05	25.29±0.03
Crue fibre	49.50±0.08	49.00±0.03	49.50±0.03
Crude protein	1.14±0.07	15.75±0.01	6.65±0.06
Carbohydrate	14.27±0.07	10.66±0.11	9.26±0.28

Results = mean ± standard deviation

DISCUSSION

Antioxidant activity

The reducing capability of the various extracts was monitored by transformation of blue colour at 700nm. The highest reducing power activity was in *Mangnifera indica* specie B (bush mango) with 66.76±0.014 compared to BHT as the positive control which has a reducing power of 64±0.02 while other species analysed had different values. It was also observed that *Mangnifera indica* specie A (sucking mango) had the lowest reducing power of 62.24±0.013.

The reducing capacity of a compound may serve as a significant indicator of its potential antioxidant activity. However, the activities of antioxidants have been attributed to various mechanisms such as prevention of chain initiation, decomposition of peroxides, reducing capacity and radical scavenging [19].

The hydroxyl scavenging activity of *Mangnifera indica* specie B (bush mango) had the highest hydroxyl scavenging of 14.64±0.030 while sodium pyruvate which was the reference compound had 13.01±0.009% from the results.

Hydrogen peroxide scavenging was generated by reaction of ferric-EDTA and TCA and ascorbic acid when the different extracts were incubated with the above reaction mixture and it could free radicals. *Mangnifera indica* specie a (sucking mango) had the highest hydrogen peroxide scavenging (43.83 ± 0.062) while *Mangnifera indica* specie B (bush mango) had the lowest hydrogen peroxide scavenging (41.90 ± 0.006) value. Hydrogen peroxide is a weak oxidizing agent that inactivates a few enzymes directly, usually by oxidation of essential thiol (-SH) groups.

DPPH is a stable free radical at room temperature and accepts an electron/ hydrogen radical to become a stable diamagnetic molecule. The reduction capability is determined by the decrease in its absorbance at 518nm induced by antioxidants. The synthetic positive control BHT (32.57 ± 0.001) had the highest DPPH value compared to the species of *Mangnifera indica* specie C which had the lowest value of (15.14 ± 0.02).

The Phenolic content recorded 0.73 ± 0.001 (μmL) for specie B (bush mango) as the highest value while specie a (sucking mango) had the least value of 0.69 ± 0.021 (μmL). Flavonoids had same trend as specie a (sucking mango) recorded 1.15 ± 0.005 (μmL) as the highest value. Phenolic compounds act as antioxidants through mechanisms which include donation of protons, quenching of singlet oxygen and chelating of metals [20]. Polyphenolic compounds are known to have antioxidant activity and it is likely that the activity of the samples is due to these compounds [21]. This activity is believed to be mainly due to their redox properties, which play an important role in adsorbing and neutralizing free radicals, quenching singlet and triplet oxygen, or decomposing peroxides [22] thereby preventing DNA oxidative damage and scavenging of reactive oxygen species (ROS), such as superoxide, hydrogen peroxide and hydroxyl radical.

Proximate Composition

Moisture content determination is one of the most important analyses performed on food products because it determines the quality of the product. The higher the moisture content of a product, the more it is susceptible to spoilage by microbial actions [29]. From this study, Opororo mango and sucking mango had similar moisture content (8.00 ± 0.06 and $8.00 \pm 0.17\%$) respectively and bush mango had slightly higher value of $8.05 \pm 0.01\%$. However, the values were quite higher than $2.40 \pm 0.19\%$ reported by Arukwe et al., [23] for Avocado seed.

The results of this study shows that the ash content of sucking, bush and opiororo mango was observed to be $1.30 \pm 1.10\%$, $1.80 \pm 0.03\%$ and $0.40 \pm 0.08\%$ respectively. This clearly shows that bush mango variety tend to contain more mineral content followed by sucking mango and then opiororo mango

which contains the least mineral content. These results are comparable to (1.31%) reported by Gumte et al., [24] for mango kernel flour.

Mango seeds from sucking mango had high fat content ($27.14 \pm 0.01\%$) than Opororo mango ($25.29 \pm 0.03\%$), while bush mango was observed to have the least value ($14.29 \pm 0.05\%$). These results are lower than $30.83 \pm 0.01\%$ reported by Justina et al., [25].

The crude fibre content had comparable values for the three varieties of mango species ($49.50 \pm 0.08\%$, $49.50 \pm 0.03\%$ and $49.00 \pm 0.03\%$) which is quite higher than that reported by Kittiphoom, [5] (3.96%) for mango seed and Justina et al., [25] ($13.76 \pm 0.02\%$) for Avocado seed. The difference in values may be due to difference in specie and geographical location of cultivation.

The protein content of the three varieties of mango seeds studied shows that bush mango had the highest value ($15.75 \pm 0.01\%$) compared to Opororo and sucking mango seed ($6.65 \pm 0.06\%$) and ($1.14 \pm 0.07\%$) respectively. These results are similar to $15.23 \pm 0.18\%$ and $15.55 \pm 0.36\%$ reported by Justina et al., [25].

Carbohydrate content shows that sucking mango contains the highest amount of carbohydrate (14.27 ± 0.07) followed by bush mango ($10.66 \pm 0.11\%$) and the least from Opororo mango ($9.26 \pm 0.28\%$). These are quite lower than $48.11 \pm 4.13\%$ reported by Arukwe et al., [23] for Avocado seed and was also observed to be lower than 17.32 ± 0.09 and $19.02 \pm 0.30\%$ as reported by Ayoola et al., [26] and Okolo et al., [27] respectively for Groundnut and Soybeans. Carbohydrate generates energy [23], therefore the carbohydrate content in these samples may be an indication that the sample could produce energy to power the cells and tissues of the body on consumption.

CONCLUSION

Although, the antioxidant properties of natural products have been widely recognised, natural antioxidants are still not widely used due to issues of high cost, colour and flavour. However, high amounts of antioxidants in mango seed kernel as shown in this study, has shown that it may be commercially feasible and justified in the near future to perform large scale extractions of antioxidants. The nutritional composition of the various seeds of mango species contains substantial percentage nutrients required for the body proper functioning, consequently, it is recommended for consumption as it can be included in animal feeds formulation.

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