PROXIMATE, MINERAL AND ANTINUTRIENT COMPOSITION OF AVOCADO (*Persea americana*) SEEDS AND PEELS

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Abstract

The proximate, mineral and anti-nutrient analysis of Avocado (*Persea americana*) peels and seeds were determined. The proximate composition, mineral and the anti-nutrients were determined by the AOAC (2005). The results showed that the Avocado peel is high in carbohydrates (76.21±0.03), Crude fibre (9.19±0.01), Crude protein (6.46±0.03), Ash content (5.10±0.00), Lipids (3.04±0.01), Moisture content (1.96±0.00). The Mineral content read: Potassium (1.25±0.01), Sodium (0.45±0.00), Iron (0.13±0.00), Magnesium (0.11±0.01), and Calcium (0.06±0.00). The Anti-nutrient was as follows: Phytate (50.63±0.01), Oxalate (1.45±0.001), Tannin (0.48±0.01) and Saponin (0.26±0.01). The seeds were found to contain 77.41±0.05% of carbohydrate, crude lipid (9.15±0.00%), moisture (11.39± 0.30%), Ash content was found to be 5.77±0.57%, crude fiber (1.81±0.00) and protein (3.86±0.02). The seeds also contains minerals in appreciable concentrations: Calcium (0.05±0.00), iron (0.22±0.00), magnesium (0.10±0.00), potassium (0.69±0.01), and sodium (0.29±0.00). Anti-nutrients were also present in low amounts. The seed presented total oxalate (3.65±0.01), Saponin (0.54±0.01), Tannin (6.53±0.01) and Phytate (8.76±0.01). From these results the Avocado seeds and peels are thus be considered as a good source of carbohydrate and minerals with high nutritional value.

Key words: Avocado seeds, Avocado peels, proximate composition, mineral and anti-nutritional analysis.

Introduction

Avocado plant (*Persea americana*), a plant belonging to the family of Lauraceae and genus, persea produces avocado pear fruit or alligator pear that contains the avocado pear seed. Some reported uses of avocado pear seed include use in the management of diabetes, cancer, hypertension, and inflammation (Ojewole and Amabeoku, 2006). Different parts of avocado pear have been used in traditional medical practice for various purposes including as an antimicrobial. The oil of an avocado has medicinal properties (Lu *et al*., 2005) and its peel contains significant amounts of minerals (Gondin *et al.*, 2005) in addition to compounds that prevent lipid oxidation (Rodriguez *et al.*, 2012). The leaves and peels could also be consumed as medicinal food (Marques, 2001). That notwithstanding, the avocado pear seeds are majorly discarded as agro-food wastes hence are underutilized. Considering the possible dietary and therapeutic potentials of especially underutilized agro-food wastes will in addition reduce the possible environmental waste burden (Egbuonu, 2017).

This work is aimed at assessing the proximate, mineral and anti-nutritional composition of the avocado (*Persea americana*) seed and peel sourced from Zaria in Kaduna State Nigeria, West Africa using standard methods.

Materials and Methods

Sample collection

The seeds and fruits of the *Persea americana* were bought from a fruit vendor, opposite the Ahmadu Bello University (A.B.U) Samaru campus main gate, Zaria, Kaduna State, Nigeria. The seeds and fruit were identified and authenticated by an agronomist at the Department of Biological Sciences, A.B.U, Zaria where a specimen herbarium exist.

Sample preparation

The fleshy part of the seed and fruit were removed separately to obtain the seed and peel, and were properly washed with clean water. The seed and peel were chopped into smaller sizes using a manual grater and were allowed to dry (controlled air drying) properly for two weeks. The pieces were thereafter ground to powder with a mill and sieved using a 150.0 µm sieve, coded separately and stored in an airtight container for further use.

Proximate Analysis

Moisture content

Moisture content was determined by the method of the Association of Official Analytical Chemists (AOAC, 2005) by drying the sample in an oven until a constant weight was obtained. 0.5 grams of the sample was accurately weighed into a previously cleaned, dried and weighed glass crucible. The crucible with its content was put into a drying oven and was heated at 105.0 °C for 6hrs. The sample was then cooled in a desiccator and weighed. The process was repeated until a constant weight was obtained. The percent moisture content was calculated using the formula below.

$$\% \text{ Moisture content} = \frac{W_2 - W_3}{W_2 - W_1} \times 100$$

W_1 = weight of empty crucible

W_2 = weight of empty crucible + sample before oven drying

W_3 = weight of empty crucible + sample after oven drying

Ash content:

Ash *content* was determined by the method of the Association of Official Analytical Chemists' (AOAC, 2005). A 1.0 g sample was weighed into a previously dried and weighed porcelain crucible. The crucible with its content was placed in a Muffle furnace for ashing at 580°C – 600 °C for 8.0 hours. After this period the crucible with its content was removed and cooled in a desiccator. The crucible with its content was then weighed. The percent ash present was calculated using the formula below.

$$\% \text{ Ash content} = \frac{W_3 - W_1}{W_2 - W_1} \times 100$$

Crude protein;

Digestion

About 0.2g of the samples was weighed and placed in a 500.0 cm^3 long - necked kjeldahl flask. One spatula full of kjeldahl catalyst [mixture Selenium + $CuSO_4$ + Na_2SO_4] was added. A 10.0 cm^3 concentrated H_2SO_4 was added to digest the sample until the mixture was clear and colourless. The flask was left to cool and the mixture decanted into a 100.0 cm^3 volumetric flask and distilled water added to make up to the 100.0 cm^3 mark.

Distillation

An aliquot of 10. 0 cm^3 of digested mixture was transferred by means of pipette into a kjeldahl distillation apparatus. An amount of 90.0 cm^3 of distilled water was added to make it up to 100.0 cm^3 in the distillation flask. A 10.0 cm^3 of 40.0% NaOH was added and placed in a distillation unit. The distillate was collected (100.0 cm^3) over 10.0 cm^3 of 2.0% boric acid containing three (3) drops of mixed indicator in a 200.0 cm^3 conical flask.

Titration

A 100 cm^3 of the distillate collected was titrated with 0.IN HCl till green colour changed to pink.

Calculation

The weight of sample used, the dilution and the aliquot taken for distillation were considered in the crude protein calculation. The weight of the sample used was determined as:

Weight of sample used, $W_T = 0.2g$

Volume of digest, $V_D = 100.0\ cm^3$

Normality of the acid (HCI), Na = 0.01N

T= Titre value

Blank = 0.28

Volume of aliquot = 10 cm^3

Thus, the percentage of Nitrogen in the fruit and leaf samples was express as;

$$\% \text{ N} = \frac{0.014 \times 0.01 \times 100 \times 100(T-B)}{W_T \times \text{Aliquot taken}}$$

% Crude Protein (CP) = %N × 6.25 (Protein factor) (AOAC, 2005).

Crude Fibre

The crude fibre of Avocado was determined by the AOAC 2005 method. An amount of 2.0 g of dried sample was transferred into a digestion flask. 250.0 cm^3 of hot sulphuric acid was added and the digestion flask was placed under a condenser and brought to boiling within 1.0 minute. It was boiled gently for exactly 30min. It was filtered immediately and washed with boiling water. The residue was transferred back into the digestion flask and 250 cm^3 of hot sodium hydroxide solution added. It was replaced under the condenser and again brought to boil within 1min. After boiling for exactly 30.0 minutes, it was filtered through porous crucible and washed with boiling water and about 15mL of 95.0% alcohol. Then it was dried at 105.0°C until constant weight obtained, cooled, and weighed. The residue was ashed at 550.0°C for 30.0 minutes, cooled and weighed. The weight of fibre was by difference as:

$$\%Crude\ fiber = \{(weight\ of\ crucible + dried\ residue) - (weight\ of\ crucible + ashed\ residue)x\ 100\}/\text{Weight of sample}$$

Determination of Lipids (Fat) by Soxhlet method

A clean 250.0 cm^3 round bottom flask was dried in an oven at 100°C. It was then transferred into a desiccator; allowed to cool and weighed (W_1). About 2.0g each of the samples were weighed into labeled extractor thimbles and fixed into the Soxhlet unit. The round bottom flask containing 100 cm^3 petroleum ether (40°C to 60°C) for extraction and a condenser were connected to the Soxhlet extractor and cold-water circulation was connected/ put on. The heating mantle was switched on and the heating rate adjusted until the solvent was refluxing at a steady rate. The samples were refluxed for 8 hours in the Soxhlet apparatus. The solvent was recovered and the fat dried in an oven set at 70°C for 1.0 hour. The round bottom flask and fat was then Weighed (W_2). The fat content was calculated thus:

$$\% \text{ Crude Lipid} = \frac{W_2 - W_1}{\text{Weight of sample}} \times 100$$

Carbohydrate

Determination of Carbohydrate (Pearson, 1976) The carbohydrate content was obtained by subtracting the sum total of % Moisture, %Ash, % Protein and % Fat and crude fibre from 100.0. That is [100.0 – (% moisture + % Ash + % Protein + % Fat + % crude fibre)] (AOAC, 2005).

Mineral Analysis

Mineral contents of avocado seed were determined by atomic absorption spectrometry and flame photometry according to the methods of AOAC (2005).

Digestion of sample

For wet digestion of sample, exactly 0.2g of the powdered sample was taken in digesting glass tube. About 12.0 cm^3) of HNO_3 were added to the food samples and mixture was kept overnight at room temperature. Then 4.0 cm^3 perchloric acid ($HClO_4$) was added to this mixture and was kept in the fumes block for digestion. The temperature was increased gradually, starting from 50.0 °C and increasing up to 250.0 – 300.0 °C. The digestion completed in about 70.0 – 85.0 minutes as indicated by the appearance of white fumes. The mixture was left to cool down and the contents of the tubes were transferred to 100.0 cm^3 volumetric flasks and the volumes of the contents were made to 100 cm^3 with distilled water. The wet digested solution was transferred to plastic bottles labeled accurately. The digest was stored and used for mineral determination (AOAC, 2005).

Determination of Sodium (Na) and Potassium (K) Calcium (Ca), Magnesium (Mg) and Iron (Fe), by Flame Photometer

The determination of calcium (Ca), magnesium (Mg), potassium (K), sodium (Na), iron (Fe), and zinc (Zn)

contents was performed according to Instituto Adolfo Lutz,10 using an atomic absorption spectrophotometer flame (Varian® model AA 240FS). Standard solutions of 20, 40, 60, 80 and 100 milli equivalent/L were used both for Na and K. The calculations for the total mineral intake involve the same procedure as given in AAS.

Determination of oxalate

About 1.0g of the sample was weighed into 100.0 cm^3 conical flask. 75.0 cm^3 of 1.5N H_2SO_4 was added and the solution was carefully stirred intermittently with a magnetic stirrer for about 1h and then filtered using Whatman no. 1 filter paper. 25.0 cm^3 of sample extract (filtrate) was collected and titrated hot (80 – 90.0 °C) against 0.IN $KMnO_4$ solution to the point when a faint pink colour appeared that persisted for at least 30.0 seconds (Day and Underwood, 1986).

Determination of Phytate

The Dakare *et al.*, 2014 method was used to determine the Phytate content. This method relies on the solubilization of Phytate by dilute acid and the subsequent precipitation of the Phytate with ferric ion (Fe^{3+}). 4g of the sample was soaked in 100.0 cm^3 of 20.0 % HCI for 3.0 hours and then filtered. About 25.0 cm^3 filtrate was dispensed into a conical flask and 5.0 cm^3 of 0.3 cm^3 ammonium thiocyanate solution was added as indicator. Thereafter, 53.5 cm^3 distilled water was added to the mixture to give it a proper acidity and this was titrated with standard iron (III) chloride solution, which contains about 0.00195g of iron per cm^3), until a brownish-yellow colour persisted for 5.0 minutes.

Determination of tannin

The method described by Rodrigues *et al.*, 2012 was used. About 2.0g of the sample was poured into a beaker containing 50.0 cm^3 distilled water and heated to 60.0 °C. It was thereafter filtered and the residue discarded. 10.0 cm^3 of 4.0% copper acetate solution was added to the hot filtrate and boiled again for 10min. The precipitate was filtered and the filtrate was discarded. The residue was dried using filter paper and the dried sample scraped from filter paper into a pre-weighed crucible. The weight was recorded as W. The crucible (which contained the sample) was incinerated in a muffle furnace at 550.0 °C, cooled in a desiccator and then reweighed as W_1. The difference between the weight of sample before ashing and the residue after incineration represent the tannin content.

Determination of Saponin

The Saponin content was determined using the modified method of Hudson and El-Difrawi (1979). Saponin was extracted with a polar solvent after removal of lipids with petroleum ether.

Results and Discussions

The result of proximate composition of the analyzed Avocado Seeds and Peels are presented in Table1 while the result of minerals present avocado seeds and peels are portrayed in Table 2 and Table 3 presents the result of antinutrients in avocado peels and seeds.

Table 1: The proximate composition of the analyzed Avocado Seeds and Peels

Parameters%	Avocado Peel	Avocado Seed
Moisture content	1.96±0.00	11.39±0.30
Ash content	5.10±0.00	5.77±0.57
Crude protein	6.46±0.03	3.86±0.02
Crude fibre	9.19±0.01	1.81±0.01
Crude lipid	3.04±0.01	9.15±0.00
Carbohydrate	76.21±0.03	77.41±0.50

Results are presented as mean ±standard deviation of triplicate results

Table 2: Mineral result of analyzed Avocado Seeds and Peels

Parameters%	Avocado peel	Avocado seed
Calcium	0.06±0.00	*0.05*±0.00
Potassium	1.25±0.01	*0.22*±0.01
Sodium	0.45±0.00	*0.10*±0.01
Magnesium	0.11±0.01	*0.69*±0.01
Iron	0.13±0.00	*0.29*±0.00

Results are presented as mean ±standard deviation of triplicate results

Table 3: Anti-nutrient Content of the analyzed Avocado Seeds and peels

Parameters%	Avocado peel	Avocado Seed
Oxalate	1.45±0.01	3.65±0.01
Tannin	0.48±0.01	0.54±0.01
Saponin	0.26±0.01	6.53±0.01
Phytate	50.63±0.01	8.76±0.01

The result of the proximate composition of *P. americana* seed presented in Table 1 shows that the carbohydrate in the seed is 77.41±0.30% while it is 76.21±0.03 in the peels which were found to be slightly lower than 80.08±0.15% reported for *P. americana* seed by Damila *et al.*, 2017. Observed carbohydrate in the investigated samples may be an indication that the samples could produce energy to power the cells and tissues of the body on consumption. The seed also presented high lipid content of 9.15±0.00% while the peels present a mean value of 3.04±0.01. These values are lower than 18.77±2.61 reported for *A. persea* seeds by Nnaji and Okereke, 2016 but higher than 0.33±0.00 reported by Damila *et al.*, 2017. Fats have many functions, aside insulation and conservation of body temperature in organisms their fatty acid components such as lauric acid etc. have been reported to improve health (Fite, 2000). The sample presented a protein content of 3.86±0.02 and 6.46±0.03% for the seed and peels respectively. These results compare favourably with 2.76±0.88, 2.64±0.01, reported by Nnaji and Okereke (2016) and Egbuonu *et al.*, (2018) respectively for the seeds of *A. persea.* Aside contributing to diets the relative impact of proteins in body should not be over looked. As chemical compounds, they repair and replace worn-out cells, form structural and globular materials that hold the body and boost immune system (Olusanya, 2008.)

The ash content is the measure of the mineral content present in a plant. The ash content of *Persea americana* in the present study is higher than 1.05±0.14% and 3.82±0.00% reported for seeds by Nnaji and Okereke, 2017 and Egbuonu *et al*., (2018) as well as the value reported by Damila *et al.*, (2017) for the peels (1.50±0.30). The ash content (5.77±0.57% and 5.10±0.00 of avocado seeds and peels respectively indicates the presence of higher mineral content than those reported by other researchers here. The moisture content reported in the present study are 1.96±0.00 and 11.39±0.30 for the peels and seeds respectively. The result shows that the seed is rich in moisture. The fibre content of *Persea americana* is 1.81±0.01% and 9.19±0.01% for the seed and peels respectively. These values are lower than 10.7 2 and 46.9 2.7% for seeds and peels respectively of *A.persea* reported by Damila *et al*., (2017). Diets low in crude fibre is undesirable as it could cause constipation and that such diets have been associated with diseases of the colon like pile (Atasie *et al*., 2009).

The result of the Anti-nutritional composition of *P. americana* presented in Table 3 showed the presence of phytate, oxalate, tannin, Saponin. The removal of the undesirable component is essential to enhance and improve the nutritional quality of *P. americana* seed. The tannin content in seeds and peels are respectively 0.54±0.01 and 0.48±0.01%. These are lower than the reported value of 1.14 0.01% in the seed of *A. persea* by Egbuonu *et al*. (2018). Tannin has been reported to be responsible for decrease in feed intake, growth rate, feed efficiency and protein digestibility in experimental animals. Therefore, foods rich in tannins are considered to be of low nutritional value (Ejiofor *et al.*, 2018). They are known to bind irreversibly to proteins and form insoluble complexes with them and thus rendering them indigestible by intestinal enzymes thereby interfering with their bioavailability (Liener, 1994). The phytate content of avocado in the present study was found to be 8.76±0.01% in the seeds which is lower than the phytate (12.87%) reported in avocado seed by Nguyen (2012) but less than 50.63±0.01 in the peels reported in this work. The anti-nutritional nature of phytic acid lies in its ability to chelate divalent minerals such as iron, calcium, copper, and zinc rendering them biologically unavailable (Talabi *et al.*, 2016). Processing technique (soaking and boiling) can reduce the phytic acid content of avocado as reported by Talabi *et al.*, 2016. The high phytic acid content in raw avocado seed is of nutritional significance. It cannot be broken down by humans and monogastrics (Osagie, 1998).

The Saponin content of *P.americana* in the present study was found to be 0.26±0.01 and 6.53±0.01 in the peels and seeds respectively of *A.persea.* These values are far lower than 8.10±0.01% reported by Egbuonu *et al.* (2018). Saponins binds to various nutrients inhibiting the ability to use them, digestive enzymes have been shown to be inhibited by Saponins causing a decrease in protein digestibility and absorption (Kate, 2015). The Saponin content can be reduced by washing, soaking and blanching (Kate, 2015). Saponin levels in the seed were found to be low and thus could not produce adverse effects on the growth of animals.

The oxalate content of *P. americana* were found to be 3.65±0.01 and 1.45±0.01 in the seeds and peels respectively. The high anti-nutritional factors present in the raw seeds of *P. americana* could be recognized as a potential threat in the use of seeds in animal nutrition, in spite of its nutritional composition. However, the processing technique (boiling and soaking) employed can reduce these natural toxicants greatly (Talabi *et al.*, 2016).

These results have shown that *P. americana* seed in general, has lower content for these minerals: sodium, potassium, magnesium, calcium and iron when compared to values reported in *A.persea* and passion fruit seeds by Damila *et al.* (2017). Potassium is reported to be 0.22±0.01, which is much lower than 1202.6±92.2 and 362.6±84.8 reported respectively for *A. persea* and passion fruit seeds by Damila *et al.* (2017). Sodium was investigated to be 0.10±0.01 in the seed which is lower compared to results in *A.persea* (39.44±11.3), passion fruit (11.2±0.01) reported by Damila *et al*. (2017). Iron, reading 0.29±0.00 in avocado seed for this work compared to results for *A. persea* (3.7±0.2) and passion fruit seeds (6.2±0.5) reported by Damila *et al.* (2017). Magnesium reads 0.69±0.01 in the seeds of avocado as reported in this work whereas Damila *et al.* (2017) reported 55.8±0.2 and 94.8±16.1 in avocado and passion fruits respectively. Calcium was reported to have a mean value of 0.005±0.00 for this work, while Damila *et al.* (2017) reported values of 434.9±39.5 and 332.1±67.4 in avocado and passion seeds respectively.

Conclusion

Avocado peel characteristically contained high level of carbohydrate; this makes it a potential source of carbohydrate for animal feed. With low levels of moisture, ash, crude protein, lipids and crude fibre. The low moisture content is an advantage when the shelf life is considered. The low ash content is indicative of low level of inorganic impurities. Avocado peel was however rich in minerals, which could be utilized as a good source of these minerals (Na, K, Mg, Fe, Ca) in animal feed. The anti-nutrient content present in avocado were low, which could have little or no effect when consumed, except for phytate in the seed (50.63±0.01). This anti nutrient content however, could be further reduced, during processing into animal feed. The seeds have high concentrations of anti-nutritional factors (tannin, Phytate and oxalate) which renders it non useful for human nutrition but could be recommended for animal consumption. The oils yield could be useful in the industry.

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Appendix

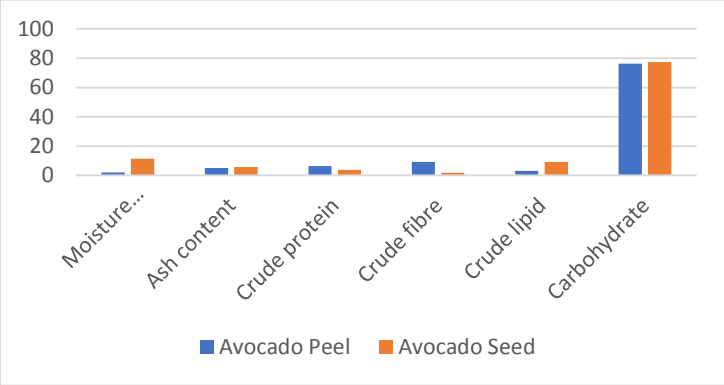

Figure 1: Graphical Representation of the Proximate Analysis of Avocado, Seeds and Peels

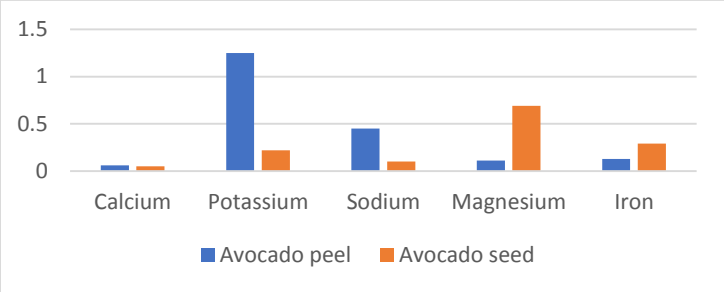

Figure 2: Graphical Representation of Mineral Elements Present in Avocado Seeds and Peels

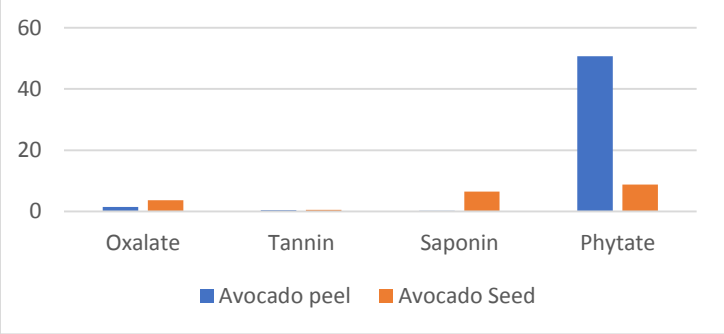

Figure 3: Graphical Representation of the Anti-nutritional composition of Avocado Seeds and Peels