



Comparative Chemical Evaluation of Three Species of Melon (*Cucumis melo*, *Cucurbita moschata* and *Cucumeropsis mannii*) Seeds

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aim: This study evaluates the nutritional composition of three species of melon seeds (*Cucumeropsis mannii*, *Cucumis melo*, and *Cucurbita moschata*). The seeds were obtained from Nasarawa State, Nigeria.

Methodology: Phytochemical constituents and proximate composition was determined by the method of Association of Official Analytical Chemists method (AOAC). Vitamins, amino acids and minerals were determined by standard methods. Oils were extracted from the samples using soxhlet apparatus with n-hexane.

Results: The result of phytochemical analysis revealed the presence of phenol, alkaloids, terpenes, triterpenes, cardiac glycoside, sterols, terpenoids and tannins in the three species. The proximate composition revealed that crude fat is high in all the samples with *C. moschata* having the highest (41.23%) while *C. mannii* have the highest crude protein (26.31%). The result also reveals that all the samples have low carbohydrate (11%, 14% & 13%) for *C. mannii*, *C. melo* and *C. moschata* respectively. The result of mineral composition reveals that potassium is high in all the samples with *C. moschata* having the highest (84.62 mg/100g) while Cadmium is the lowest (0.06mg/100g). The varieties also contain β -carotene, α -tocopherol and Ascorbic acid where β -carotene is the most abundant in the three varieties. The amino acid composition revealed leucine, alanine, phenylalanine, arginine, glutamic acid serine and aspartic acid to be the highest in all the samples.

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The percentage oil yield from the seeds were 32.90%, 31.38%, and 37.28% for *C. mannii*, *C. melo* and *C. moschata* respectively. The physicochemical properties of the oil obtained revealed acid value (mgKOH/g) in the range of 0.38-0.53. Saponification value (mg/KOH/g) 152.5-168.3, Iodine value (g/l₂/100g) 92.7-119.5 free fatty acid (%Oleic) 2.34-3.66. Peroxide value (meqKOH/g) 4.56-6.38 and the pH in the range of 6.09-6.18 for *C. mannii*, *C. melo* and *C. moschata* respectively.

Conclusion: The three melon seeds species contain almost similar nutritional composition. This justified the use of the melon seeds for industrial, food, medicinal and cosmetic purposes.

Keywords: Phytochemicals; proximate; vitamins; amino acids; minerals.

1. INTRODUCTION

“The melon varieties (Cucurbitaceae) are native to the tropical Africa especially in Nigeria where it is grown for food and as a source of oil. The crop is usually grown during the raining season. It is rich in nutrients such as vitamin B complex, potassium, magnesium, and zinc, with health benefits” [1]. The products can also be eaten individually as a snack [2]. Compositional, nutritional, and functional properties are important factors in determining food quality and the nutritive importance of the melon seeds makes it vital for battling nutritional debilitations [3,4]. “It is reported that the kernel of the *Cucumeropsis* seed is 44% oil, 30% protein, 10% carbohydrate, 4% ash and 3% fibre. The oil of this seed is 64.9% linoleic acid, 12.4% oleic acid, 11.8% stearic acid and 10.9% palmitic acid” [5]. “Vitamins; Thiamine, Niacin, B1 and B2 are also prevalent in the seed, as well as many micronutrients” [5]. “Notable minerals include phosphorus, as the largest mineral component, with potassium, magnesium, manganese, sulphur, calcium, iron and zinc to follow” [1]. “The bulk of carbohydrates are starch and soluble sugars. Melon is the perfect complement to the largely starch-rich grain diet of Africa, providing a high-protein and high-energy concentrate” [6].

The wide varieties of melon species coupled with the richly nutritious value of the crops has attracted the attention of numerous researchers especially in this 21st century where diseases associated with malnutrition is increasingly as a result of insufficient or lack of knowledge in the preparations of balance diet from the available plants resources in our society. Despite the crops obvious advantages in its nutritional composition, some varieties such as *C. mannii* and *C. moschata* remains an underutilized crop for nutritional interventions in Africa [7].

There are many varieties of melon used as a source of nutrition in all part of Nigerian. It could

be prepared as soup or oil product and known to be very nutritious. Among these varieties, the knowledge and understanding of their nutritional compositions and variations in relating to the nutritional qualities in Nigeria is little. Therefore, this research is designed to investigate comparative nutritional evaluation of three melon (Cucurbitaceae) seeds species which are commonly grown in Nasarawa state of Nigeria.

2. MATERIALS AND METHODS

2.1 Sample Collection and Preparation

Different melon seeds species were obtained from Nasarawa State, Nigeria and sent for identification in the Department of Crop Science, Faculty of Agriculture, University of Ibadan, Nigeria. Seeds were screened to remove bad ones, dehulled manually. The seeds were then dried to a constant weight in an oven at 40°C, grounded using mechanical blender, put in an air-tight container and stored for further analysis.

2.2 Qualitative Phytochemical Analysis

2.2.1 Test for tannins

“Few drops of 1% lead acetate were added to 5 g of the melon flour in a test tube. A yellow precipitate was formed which indicated the presence of tannins” [8].

2.2.2 Test for saponins

“Exactly 5 g of melon flour was diluted with 2 ml of distilled water and stirred in a test tube for about 15 minutes. The formation of layer of foam showed the presence of saponins” [8].

2.2.3 Test for flavonoids

“Few drops of dilute sodium hydroxide were added to 2 g of melon flour in a test tube. An

intense yellow colour was formed which turned colourless on addition of few drops of dilute acid indicating the presence of flavonoids” [8].

2.2.4 Test for alkaloids

“2 g of melon flour, 2 ml of HCl was added and 1ml of Dragendorff’s reagent was added to the resulting solution. The formation of orange or red precipitate indicated the presence of alkaloids” [8].

2.2.5 Test for terpenoids

“Two ml of the oil extract was mixed in 2 ml of chloroform and concentrated H₂SO₄ (1 ml) added carefully to form a layer. A reddish brown colouration was formed at the interface to show positive results for the presence of terpenoids” [8].

2.2.6 Test for phenols

10 mg extract is dissolved in 2 ml of distilled water. To this few drops of neutral 5% ferric chloride solution are added. A dark green colour indicates the presence of phenolic compound.

2.2.7 Test for steroids

In to 2 g of the melon flour in a test tube, 10 ml of chloroform was added. This was followed by addition of equal volume of concentrated sulphuric acid by the sides of the test tube. The upper layer turns red and the sulphuric acid layer turns yellow with green fluorescence. This indicated the presence of steroids [8].

2.3 Quantitative Phytochemical Analysis

2.3.1 Determination of tannins

Precisely 500 mg of sample was weighed into 100 ml plastic bottle and 50 ml of distilled water was added and stirred for one hour in a mechanical shaker. The resulting solution was filtered into a 50 ml volumetric flask and made up to the mark. Then 5 ml of the filtrate was pipetted into a tube and mixed with 3 ml of 0.1M FeCl₃ in 0.1N HCl and 0.008M potassium ferrocyanide. The absorbance was measured in a spectrophotometer at 120 nm wavelengths within 10 minutes. A blank sample was prepared and the colour also developed and read at the same wavelength. A standard was prepared using tannin acid to get 100 ppm and measured [8].

2.3.2 Determination of alkaloid

Quantitative determination of alkaloid was done according to [8] method. Exactly 200 cm of 10% acetic acid in ethanol was added to each sample of melon flour (2.50 g) in a 250 cm beaker and allowed to stand for 4 hours. The extract was concentrated on a water bath to one-quarter of the original volume followed by addition of 15 drops of concentrated ammonium hydroxide dropwise to the extract until the precipitation was completed immediately after filtration. After 3 hours of mixture sedimentation, the supernatant was discarded and the precipitates washed with 20 cm of 0.1 M of ammonium hydroxide and then filtered using Gem filter paper (12.5 cm). The residue was dried in an oven, weighed using electronic weighing balance Model B-218 and the percentage of alkaloid was expressed mathematically as: % Alkaloids = Weight of Alkaloid/Weight of sample × 100 [8].

2.3.3 Determination of phenol

The total phenolic content (TPC) was carried out according to method of [9] with some slight modifications, using Folin–Ciocalteu’s Phenol Reagent (Sigma Chemical Co, St. Louis, MO, USA). Briefly, a 0.5mL of the sample was mixed with 0.5mL of Folin–Ciocalteu’s phenol reagent for 5 min at 37 °C diluted with 10mL deionized water water), 0.5mL of saturated sodium carbonate solution. “This solution was kept in the dark for 25 min and then, centrifuged for 10 min. Sample absorbance were measured at 725 nm (GENESYS 10 spectrophotometer, Thermo Scientific, Madison, USA). Blank was prepared using distilled water through the same process of sample. Total phenolic were expressed in milligrams of gallic acid equivalent per g of dried sample” [10].

2.3.4 Determination of sterols

“Quantification of sterols was carried out spectrophotometrically (at 597 nm), after isolation of sterols from other unsaponifiable matter using chromatographic method. The stationary phase was made up of silica gel and the mobile phase diethyl ether: n-hexane (1:1)” [8].

2.4 Proximate Composition Analysis

The proximate analyses of the samples of different species of melon were determined for

their moisture, total ash and crude fibre contents using the methods described by [8].

2.5 Determination of Vitamins

The Provitamin A, Vitamin C (Ascorbic acid) and Vitamin E (Tocopherol) in the samples were determined by the official methods of the Association of Official Analytical Chemists [8].

2.6 Amino Acid Analysis

The amino acids present in the samples were quantitatively measured by the method as described by [11], using Applied Biosystems PTH Amino Acid Analyzer. The known sample was dried to constant weight, defatted, hydrolyzed, evaporated in a rotary evaporator and loaded into the Applied Biosystems PTH Amino Acid Analyzer.

The amino acid analysis was carried out by ion exchange chromatography using the Technicum Sequential Multi Sample Amino Acid Analyzer (TSM) (Technicum Instruments Corporation, New York).

2.7 Mineral Analysis

The mineral composition of the sample was analysed by dry-ashing the samples at 550°C to constant weight and dissolving the ash in volumetric flask using distilled deionized water with a few drops of concentrated HCl. The minerals were determined using the flame system of Atomic Absorption Spectrophotometry (Perkin – Elmer model 403, Norwalk CT, London) using NaCl and KCl to prepare the standards. The optimum analytical grade was 0.1 to 0.5 absorbance units with a coefficient variation of 0.87 – 2.20%. The minerals content were reported as mg/kg [8].

2.8 Physicochemical Analysis of the Oil

2.8.1 Determination of acid value

Exactly 25 ml of diethyl ether was mixed with 25 ml of ethanol and 1 ml of 1% phenolphthalein indicator was added to the mixture this was followed by addition of 0.1 M potassium hydroxide to neutralize the solution. Then 2g of the oil was dissolved in the neutralized solvent and titrated with 0.1M KOH while shaking constantly until a pink colour which persisted for 115 seconds was obtained mathematically.

Acid value = $(v_b - v_a) \text{ cm}^3 \times 5.61/\text{weight of the sample used (mg KOH/g)}$

Where v_a = sample titre value, v_b = blank titre value [8].

2.8.2 Determination of peroxide value

Precisely 1g of oil was weighed into a clean dry boiling tube in which 1g powdered potassium iodide was added. The tube was placed on the boiling water bath and boiled for 30 seconds and allowed to boil vigorously for more than 30 seconds. It was then poured into a conical flask containing 20 ml freshly prepared 5% potassium iodide solution. The tube was washed twice with 25 ml portions of water and then added to the conical flask. It was titrated with 0.002 M sodium thiosulphate solution using starch as indicator. The test was carried out in subdued daylight. The indicator used in this reaction is a starch solution where amylose forms a blue to black solution with iodine and is colourless where iodine is titrated.

Peroxide value = $(v_b - v_a) \text{ cm}^3 \times \text{Molarity of titrant/weight of oil} \times 100 \text{ (MeqKOH/g)}$.

Where: v_a = sample titre value, v_b = blank titre value [8].

2.8.3 Determination of saponification value

Exactly 2 g of oil was weighed (using a dropping pipette) into a flask and 25 ml of the alcoholic potassium hydroxide solution was added to the flask. A reflux condenser was attached and the flask was heated on a water bath for 1 hour with occasional shaking. At the end of 1 hour, the flask was removed from the water bath and 1ml of 1% phenolphthalein indicator was added. It was titrated while still hot with the standard 0.5M hydrochloric acid.

Saponification value = $(v_b - v_a) \text{ cm}^3 \times 26.05/\text{weight of oil (mg KOH/g)}$ [8].

2.8.4 Determination of iodine value

Accurately 0.25 ml of the oil (with the acid of a dropping pipette) into a glass stopper flat bottom flask of 25 ml. Then 10 ml carbon tetrachloride was added to the oil to dissolve the resulting solution and 20 ml iodine monochloride (ICI) in glacial acetic acid was added and the stopper which has been moistened with potassium iodide solution was inserted. It was mixed and allowed

to stand in a dark cupboard for 30 minutes. Exactly 15 ml of 10% potassium iodide solution (freshly prepared) and 100 ml of water was added and mixed. The mixture was titrated against 0.1M standard sodium thiosulphate solution using starch as an indicator. Blank was carried out simultaneously without the oil. Iodine value = $(vb - va) \text{ cm}^3 \times n \times 1.269/\text{weight of oil (g)}$.

vb = blank titre value, va = titre value, n = number of moles of sodium sulphate [8].

2.8.5 Determination of Free Fatty Acids (FFA)

One gram of oil sample was accurately weighed into a conical flask. This was followed by the addition of 10cm³ of neutralized 95% ethanol and phenolphthalein. This was titrated with 0.1 M NaOH, while stirring until a pink colour persisted for 30 second.

The percentage free fatty acid was calculated from the equation below: $\text{FFA} = V \times M \times$

$2.82\text{mg}/\text{sample weight (g)}$. Where: V = Volume of NaOH, M = Molarity of NaOH, 2.82 = conversion factor of fatty acid [8].

3. RESULTS

Table 1. Qualitative phytochemical screening of three species of melon seeds

Phytochemicals	<i>C. manni</i>	<i>C. melo</i>	<i>C. moschata</i>
Phenol	+	+	+
Tannin	+	+	+
Saponnin	-	-	-
Terpenes	+	+	+
Triterpenes	+	+	+
Flavonoids	-	-	-
Alkaloids	+	+	+
Cardiac Glycoside	+	+	+
Resins	-	-	-
Sterol	+	+	+

+ = Detected - = Not detected

Table 2. Phytochemical contents of three species of melon seeds

Phytochemical Compositions	<i>C. manni</i>	<i>C. melo</i>	<i>C. moschata</i>
Phenol (mg/g)	2.55±0.01 ^b	2.74±0.01 ^a	2.59±0.21 ^c
Tannin (mg/g)	9.57±0.10 ^b	9.33±0.10 ^c	10.59±0.10 ^a
Alkaloids (%)	8.60±0.01 ^a	8.00±0.01 ^b	7.80±0.01 ^c
Sterols mg/g	0.32±0.10 ^b	0.51±1.00 ^a	0.28±0.10 ^c

Results are presented as Mean ± standard deviation of the means (n = 3)
Mean values with different superscript in the same rows are significantly different (P < 0.05)

Table 3. Proximate composition of three species of melon seeds

Proximate compositions (%)	<i>C. manni</i>	<i>C. melo</i>	<i>C. moschata</i>
Protein	26.31±0.01 ^a	24.31±0.01 ^c	25.26±0.21 ^b
Crude fibre	12.30±0.01 ^a	11.95±0.01 ^b	11.26±0.01 ^c
Crude fat	40.02±0.01 ^b	39.43±0.01 ^c	41.23±0.01 ^a
Moisture	6.25±0.01 ^a	5.98±0.01 ^b	5.23±0.01 ^c
Ash	4.22±0.10 ^a	4.09±1.00 ^b	4.01±0.10 ^c
Carbohydrate	10.91±0.10 ^c	14.25±0.10 ^a	13.16±0.10 ^b

Results are presented as Mean ± standard deviation of the mean (n = 3). Mean values with different superscript in row are significantly different from each other (P<0.05)

Table 4. Vitamin contents of three species of melon seeds

Vitamins	<i>C. manni</i>	<i>C. melo</i>	<i>C. moschata</i>
β-carotene (IU)	76.48±0.01 ^b	117.30±0.10 ^a	47.97±0.01 ^c
α-tocopherol (IU)	6.37±0.00 ^c	6.88±0.00 ^a	6.72±0.00 ^b
Ascorbic Acid (IU)	2.35±0.00 ^c	2.84±0.00 ^b	3.02±0.00 ^a

Results are presented as Mean ± standard deviation of the means (n = 3)
Mean values with different superscript in the same row are significantly different from each other (P < 0.05)

Table 5. Essential amino acid composition of three species of melon seeds

(g/100g protein)	Amino acid		
	<i>C. mannii</i>	<i>C. melo</i>	<i>C. moschata</i>
Threonine	2.60±0.10 ^b	3.10±0.01 ^a	2.40±0.10 ^c
Histidine	0.50±0.01 ^c	1.90±0.10 ^b	2.30±0.10 ^a
Arginine	4.13±2.89 ^b	3.10±0.10 ^c	6.30±0.10 ^a
Isoleucine	2.40±0.01 ^c	3.50±0.10 ^b	4.10±0.10 ^a
Phenylalanine	4.03±0.05 ^b	2.90±0.10 ^c	5.16±0.20 ^a
Valine	0.69±0.01 ^c	2.20±0.10 ^b	3.10±0.10 ^a
Methionine	1.20±0.00 ^b	2.60±0.10 ^a	0.93±0.10 ^c
Leucine	5.10±0.01 ^b	3.40±0.00 ^c	6.40±0.10 ^a
Lysine	1.00±0.01 ^c	2.80±0.10 ^b	3.10±0.00 ^a

Results are presented as Mean ± standard deviation of the means (n = 3)

Mean values with different superscript within the row are significantly different from each other (P < 0.05)

Table 6. Nonessential amino acid composition of three species of melon seeds

(g/100g protein)	Amino acid		
	<i>C. mannii</i>	<i>C. melo</i>	<i>C. moschata</i>
Tyrosine	2.10±0.10 ^c	2.23±1.44 ^b	3.10±0.10 ^a
Aspartate	10.60±0.01 ^b	6.30±0.00 ^c	14.03±0.60 ^a
Glycine	0.90±0.01 ^b	1.13±0.11 ^a	0.50±0.00 ^c
Serine	2.50±1.74 ^c	4.40±0.10 ^a	2.90±0.00 ^b
Alanine	6.10±0.00 ^a	3.83±0.10 ^c	4.30±0.10 ^b
Glutamine	8.40±0.01 ^b	12.0±0.10 ^a	7.00±0.10 ^c
Cysteine	0.80±0.01 ^b	0.40±0.10 ^c	1.20±0.10
Proline	2.50±0.01 ^a	1.80±0.01 ^c	2.10±0.10 ^b

Results are presented as Mean ± standard deviation of the means (n = 3)

Mean values with different superscript in the row are significantly different from each other (P < 0.05)

Table 7. Mineral composition of three species of melon seeds

Mineral (mg/kg)	<i>C. mannii</i>	<i>C. melo</i>	<i>C. moschata</i>
Na	4.91±0.00 ^b	9.22±0.03 ^a	3.82±0.00 ^c
Fe	6.48±0.00 ^a	5.54±0.07 ^b	4.49±0.01 ^c
Ca	23.26±0.01 ^b	21.73±0.02 ^c	26.49±0.01 ^a
Mn	2.50±0.01 ^a	1.95±0.10 ^c	2.04±0.00 ^b
Zn	4.21±0.02 ^a	2.70±0.07 ^b	2.58±0.10 ^c
K	83.81±0.02 ^b	83.60±0.01 ^c	84.62±0.00 ^a
Mg	60.05±0.07 ^b	60.92±0.00 ^a	59.63±0.00 ^c
Cu	2.53±0.04 ^a	1.86±0.00 ^b	1.56±0.00 ^c
P	3.17±0.01 ^b	3.19±0.00 ^a	2.56±0.00 ^c
Cd	0.00±0.00	0.145±0.01 ^a	0.06±0.00 ^b

Results are presented as Mean ± standard deviation of the means (n = 3)

Mean values with different superscript in the same row are significantly different from each other (P < 0.05)

Table 8. Physicochemical composition of the different species of melon seeds

Physicochemical Parameters (mgKOH/g)	<i>C. mannii</i>	<i>C. melo</i>	<i>C. moschata</i>
% oil yield	32.90±0.01 ^b	31.38±0 ^c	37.28±0.01 ^a
PH	6.18±0.01 ^a	6.09±0.01 ^b	6.14±0.01 ^b
Acid value	0.49±0.01 ^b	0.53±0.01 ^a	0.38±0.01 ^c
Peroxide value	5.12±0.01 ^b	6.38±0.01 ^a	4.56±0.01 ^c
Saponification value	152.60±0.10 ^c	161.00±1.00 ^b	168.30±.10 ^a
Iodine value (g/I ₂ /100g)	119.50±0.10 ^a	101.50±0.10 ^b	92.70±0.10 ^c
Free fatty acids	2.34±0.01 ^c	2.97±0.01 ^b	3.66±0.01 ^a

Results are presented as Mean ± standard deviation of the mean (n= 3). Mean values with different superscript in the same row are significantly different from each other (P < 0.05)

4. DISCUSSION

Qualitative phytochemical analysis of the melon seeds showed the presence of seven phytochemicals in the three samples namely: phenol, terpenes, triterpenes, alkaloids, cardiac glycosides, tannin and sterols while saponins, flavonoids and resins were absent. The presence of these phytochemical confers tremendous health benefits in the different species of melons.

Quantitative phytochemical composition of the three *C. species* of melon showed that tannins is significantly higher ($P < 0.05$) in all the samples of *C. species*. The presence of high tannins and alkaloids shows that melon seeds act as natural antioxidants in the body [12].

The proximate composition of the different species of melon seeds are as shown in Table 3. According to the results, the moisture content of *C.manni*, *C. melo* and *C.moschata* were 6.25, 5.98 and 5.23 respectively. All the results were within the standard range between 5.0 and 10% as reported by [8]. "However, these results were in agreement with 5.7% moisture content reported by [13,14] also reported 5.7% moisture content for melon seed". The low moisture content of the three melon seed species revealed that they can be preserved for a longer period.

The percentage ash content of *C. manni*, *C. melo* and *C.moschata* seeds were 4.22, 4.09 and 4.01 respectively. The value fall within the standard range of 2-5% as reported by [8]. The high ash content indicates high concentration of various mineral elements for metabolism, growth and development [15].

The percentage crude fat content of the seed of *C. mannii* is 40.02 while that of *C. melo* and *C. moschata* were 39.43 and 41.23 respectively. The values were within the standard range $\geq 32\%$ according to [8]. The fat content of the seeds of these melons may be considered economical for commercial production of oil in Nigeria. However, there is significant difference observed in oil yield of the three melon seed species ($P < 0.05$) with *C. moschata* having the highest yield (41.23%).

The values for varieties of melon oil seeds which ranged between 47.9 and 51.1% is in agreement with the value obtained for pumpkin seed (47.0%) [16], it is however high when compared

to that obtained for soybean (23.5%) [17]. With the high amount of crude fat obtained from these varieties of melon in this study, melon could be regarded as an oil seed.

The crude protein content obtained in the seeds of *C. manni*, *C. melo* and *C.moschata* were 26.31, 24.31 and 25.10 respectively. This value compares favourably with those of protein rich foods such as soybean, cowpeas, pigeon peas and pumpkin with protein contents ranging between 23.1 and 33.0% [18]. This protein value also is within the recommended daily allowance for children (23.0 – 36.0 g) [2]. There is a significant difference ($P < 0.05$) observed in the crude protein content of the three varieties of melon seeds used in this study with *C. moschata* and *C. melo* having the highest and the least crude protein content respectively. This suggests that *C. moschata* may be better for weaning and malnourished children.

The crude fibre content of *C. manni*, *C. melo* and *C.moschata* melon species were 12.30 11.95, and 11.27 respectively. This is high compared to those of legumes (5.0 - 6.0%) [19]. The high content of crude fibre in the seeds of the different species of the melons could suggest the seeds of these plants may help to keep the digestive tract flowing by keeping the bowel's movements soft and regular.

The carbohydrate content of *C. manni*, *C. melo* and *C.moschata* were 10.91, 14.25 and 13.16 respectively. As observed from the results, the three melon species is low in carbohydrate compared to other legumes which have as high as 20.0-60.0% carbohydrate content [20].

The saponification value of *C. manni*, *C. melo* and *C.moschata* were 152.5, 161.0 and 168.3 mg/KOH/g, respectively. This indicates that the oil in the three species of melon seeds has low molecular weight fatty acid which is below the standard value of 180 mg/KOH/g [8]. This implies that the oil cannot be used in soap making.

Acid value indicates whether the oil is in good non-degradable state or not. The maximum acceptable level for acid value is 4 mg/KOH/g Oil [8]. Therefore, the acid value obtained in this study revealed that oil from *C. manni*, *C. melo* and *C.moschata* seed varieties were good for consumption.

Peroxide value of *C. manni*, *C. melo* and *C. moschata* seed varieties were 5.12, 6.38 and

4.56 meqKOH/g, respectively which is within the standard range of 2-10 meqKOH/g as reported by [8]. This implies that the oil analysed may be more stable to oxidative degradation. The peroxide value obtained is not in agreement with 12 meqKOH/g peroxide value for melon seed oil reported by [16].

Iodine value indicates the reactivity of double bond. The results in Table 8 shows that the three melon seeds species have high iodine value of 119.5, 101.5 and 92.7 gI₂/100g, respectively which is within the standard of 80-100 gI₂/100g [8]. This implies that the oil have high degree of unsaturation, therefore good for consumption especially in hypertensive condition [21]. However, this result is in agreement with [16] who reported 114 gI₂/100g iodine value for melon seed oil.

The pH of oil obtained from the seeds of the different varieties of the melon were 6.18, 6.09 and 6.14 in *C. mannii*, *C. melo* and *C. moschata*, respectively. These pH values shows that fats are acidic in nature and also indicates good lubricating activities [16].

The essential amino acid analysis of the three melon flour is shown in Table 5. The results showed that leucine, phenylalanine, arginine and Isoleucine are the most abundant essential amino acids in all the *C. species* while Histidine and Methionine are the lowest. Leucine, arginine, phenylalanine and Isoleucine being the most abundant essential amino acids (6.40, 6.30, 5.16 and 4.10 (g/100g protein) in *C. moschata* shows that this variety contain the highest amount of essential amino acids while Methionine is the lowest 0.93 (g/100g protein) in *C. moschata*. This observation agreed with the report of the following; [18,19] to the effect that melon seed contains essential amino acids. And these species of melon could serve as a good source of essential amino acids such as arginine, isoleucine and leucine.

The results obtained for the mineral composition of melon are shown in Table 7 potassium, magnesium and calcium were the predominant mineral in the three melon seed varieties. This is in agreement with the observations of [18,19] that potassium was the most abundant mineral in Nigerian Agricultural products. Potassium is the highest, followed by magnesium and calcium. Cadmium is the lowest which is present in *C. melo* and *C. moschata* and absent in *C. mannii*. The high content of potassium shows that melon seed is good for hypertensive

patients [22]. Na, Ca, Mg and K are important minerals which are highly concentrated in melon. Therefore, melon seeds can assist in body functions such as energy production, growing, healing, and fluid balance, blood and bone development, maintaining a healthy nervous system and regulating muscles functions [23].

The vitamins evaluated in the three samples of melon seeds includes: β-carotene, α-tocopherol and Ascorbic acid. β-carotene is predominant in all the varieties followed by α-tocopherol as shown in the table. This agreed with the report of [24,25] that melon is a good source of β-carotene, α-tocopherol and Ascorbic acid.

5. CONCLUSION

The seeds of the three varieties of melon (*C. mannii*, *C. melo* and *C. moschata*) exhibited almost similar chemical compositions. They are consisted of comparatively high amount of oil and minerals which determine their high nutritional value. Melon seed from the three varieties are rich in essential amino acids, such as threonine, histidine, arginine, phenylalanine and lysine as well as non-essential amino acid such as glycine, proline, cysteine, serine and alanine which revealed that the three melon species are good for nutritional and industrial purposes. The physicochemical analysis shows that the oil from the three melon varieties are good for human consumption and also the seeds can be used as an alternative source of food for weaning children. Melon seeds will be effective in health promotion or disease prevention and used as flavour component of soups. The oil can be used in medicine as food additives and in cosmetics as ingredient in facial and body creams due to their observed nutritional composition. Their oil could not be used in soaps industry as their saponification value is lower than the standard. The oil yield suggests that the three melon species could be regarded as oil seeds. The study also showed that *C.manni* did not contain cadmium and this may be concluded as a result of soil composition. Melon seed oils are not widespread in food industry, but this study revealed that the oil from the different species are good as commonly consumed oil in the market such as palm oil, groundnut oil and shea butter oil.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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