



Biochemical and Microbiological Evaluation of the Effect of Processing on *Cucumeropsis mannii* Seed

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Authors' contributions

This work was carried out in collaboration among all authors. Author AOI designed the study. Author TRO performed the statistical analysis. Author AOI wrote the protocol and wrote the first draft of the manuscript. Authors AOI and TRO managed the analyses of the study. Authors AOI, TRO and OAA managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The determination of the effect of processing on nutritional composition and level of undigested oligosaccharide in *Cucumeropsis mannii* seeds was carried out. The dried melon seeds were sorted, cleaned, soaked in 60mL water for 15 min for easy removal and de-hulled to get the cotyledons, which were divided into three portions. The first portion was used unprocessed, the second portion was boiled while the third portion was fermented for analysis. The microbial load, physicochemical analyses, proximate compositions, anti-nutritional factors, antioxidant activity, vitamins, mono and oligosaccharides sugars were determined. Processing led to significant increase in the pH, moisture contents but a reduction in the total titratable acidity. Processing increased protein, fat and ash contents. Significant reduction in anti-nutritional factors of boiled and fermented melon seed was noted. Processing led to significant increase in the antioxidant activity. The saccharide sugars reduced after processing. The study observed that processing increased significantly the nutritional composition of the melon seeds but significantly reduced the anti-nutritional factors.

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1. INTRODUCTION

Cucumeropsis mannii is a species of melon which belong to the family of Cucurbitaceae. It is known as white melon in English and 'egusi-itoo' in Yoruba language. *Cucumeropsis mannii* is a widely cultivated and consumed oil seed crop in West Africa [1]. The white seed melon is grown mostly as an oil rich seed crop and it is also a source of dietary proteins [2]. One of the benefits of the crop is that the crop can thrive in harsh climates and high yields are attainable in barren land. Pests and disease are rarely a problem for farmers of this crop. Further benefits include increased soil quality through ground cover and suppression of weeds. The seeds are obtained either in shelled or unshelled forms in West African markets and are used greatly in soup preparation. The seeds contain high level of fat, minerals, vitamins and it is of great medical importance [3]. They are consumed in 'egusi soup' and melon ball snacks [4]. The oil expressed from the seeds is used for edible purposes [5], while the residual cake is fried and consumed as a snack.

Melon seeds are dried to reduce the water activities in other to prevent the melon seeds from microbial attack [6]. Melon seeds are rich in

proteins but cannot be consumed in their raw state due to their high level of anti-nutritional factors which are naturally occurring compounds in many tropical plants [1]. The anti-nutritional factors cause poor protein digestibility both in man and animals and have been linked with some terminal diseases like stroke and cancers (Omodara and Aderibigbe 2017). To improve the nutritional quality, reduce toxicity, improve organoleptic acceptability and increase the shelf life of this melon seed processing has to be employed (Omodara and Aderibigbe). There are different methods of food processing like roasting, boiling or cooking, fermentation, etc. Boiling is the process of cooking food in boiling water for a period of time. It destroys the organic impurities and transforms raw ingredient into the cooked form. Fermentation is the chemical transformation of organic substrate into simpler compounds by the action of enzymes which are produced by microorganisms such as moulds, yeasts and bacteria (Shurtleff and Akiko, 2007). The aim of this study is to evaluate the effect of processing on nutritional composition and undigested oligosaccharides in *Cucumeropsis mannii*. Fig. 1 is a picture of a matured fruit of *Cucumeropsis mannii* (Egusiitoo) harvested African Comprehensive High School farm, Ikere Ekiti, Nigeria.



Fig. 1. A matured fruit of *Cucumeropsis mannii* (Egusiitoo)
(Picture from African Comprehensive High School farm, Ikere Ekiti, Nigeria)

2. MATERIALS AND METHODS

2.1 Collection of Samples

The *Cucumeropsis mannii* were purchased from Bisi market in Ado-Ekiti, Ekiti state. The seeds were authenticated in the plant science Department of Ekiti State University, Ado-Ekiti, Ekiti State Nigeria.

2.2 Sample Preparation

2.2.1 Raw sample

The melon seeds (50 g) were soaked in 60 mL water for 15 min for easy removal of the seed coat. Then the seeds were dehulled by abrasion. These were then cleaned and separated from grits and poured into a sterile container for analysis.

2.2.2 Boiled sample

The melon seeds (50 g) were soaked in 60 mL water for 15 min for easy removal of the seed coat. The seeds were washed using clean water and cooked at 105°C for 1 h in boiling water using 6-quart Instant pressure pot.

2.2.3 Fermented sample

The melon seeds (50 g) were soaked in 60 mL water for 15 min for easy removal of the seed coat. The seeds were drained using muslin cloth and cooked at 105°C for 1 h in boiling distilled water using 6-quart Instant pressure pot, and allowed to cool to about 30°C. The cooled melon seeds were wrapped in aluminium foil and incubated at 35°C for 5 days.

2.3 Analysis

2.3.1 Microbial load

The total viable count of the seeds were analysed by the method of Olutiola et al. [7] which include isolation of microorganism from the sample, determination of total viable counts (microbial load).

2.3.2 pH determination

The pH was determined according to the method of AOAC [8] using model Accu PH 3. 5 g of each sample was weighed into a sterile mortar and mashed with clean pestle and 50 mL of distilled

water was added. The electrode of the digital pH meter was dipped in the slurry and the pH readings were recorded.

2.3.3 Determination of Total Titratable Acidity (TTA)

Sadler and Murphy [9]. Using Wattsman filter paper for the filtration process, twenty millilitres (20 mL) of filtrate obtained from the determination of pH was titrated against 0.1 M NaOH using phenolphthalein indicator.

2.3.4 Determination of moisture content

Five grams (5 g) of each seed sample was weighed separately into pre-weighed aluminium foil. The foil paper and its content were put in Dynamic heat and mass transfer model electric oven at 80°C overnight and weighed intermittently until a constant weight was achieved. The new weight was subtracted from the weight of the wet sample. The percentage moisture content was calculated [8].

2.3.5 Proximate

The proximate compositions of the fermented and unfermented samples were determined using standard procedures of AOAC [8]. The parameters determined were protein, ash, crude fibre, fat and carbohydrate.

2.4 Phytochemicals Screening

2.4.1 Saponin content

The saponin content of the sample was determined by double extraction gravimetric method [10]. Five grams (5 g) of the powdered seed was mixed with 50 ml of 20% aqueous ethanol solution in a flask. The mixture was heated with periodic agitation in water bath for 90 min at 55°C. The heated mixture was filtered through Whatman filter paper (No.42).

2.4.2 Phytate content

2 g of each seed sample was weighed into 250 mL conical flask, 100 mL of 2% hydrochloric acid was added to the sample in the conical flask and allowed to soak for 3 h. This was filtered through a double layer of hardened filter paper.

2.4.3 Flavonoid

5 g of the pulverized seed was placed into a conical flask and 50 mL of water and 2 mL HCL

solution was added. The solution was boiled for 30 min and allowed to cool before it was filtered through Whatman filter paper (NO. 42). 10 mL of ethyl acetate extract which contained flavonoid was recorded while the aqueous layer was discarded.

2.4.4 Tannin determination

2 g of the powdered sample was mixed with 50 mL of distilled water and shaken for 30 min in the shaker. The mixture was filtered and 5 mL of the filtrate was measured into 50mL volumetric flask and diluted with 3 mL of distilled water. Similarly, 5 mL of standard tannic acid solution and 5 mL of distilled water was added separately. 1mL of Folin-Dennis reagent was added to each of the flask followed by 2.5 mL of saturated sodium carbonate solution. The content of each flask was made up to mark and incubated for 90 min at room temperature. The absorbance of the developed colour was measured at 760 nm wavelength with the reagent blank at zero.

2.4.5 Determination of cardiac glycosides

Cardiac glycoside content in the sample was evaluated using Buljet's reagent as described by El-Olemy et al. [11]. 1 g of the pulverized sample was soaked in 10 mL of 70% alcohol for 2 h, and then filtered.

2.5 Determination of Antioxidant Vitamins

2.5.1 Determination of vitamin A

1 g of the sample was weighed and macerated with 20 mL of petroleum ether. It was evaporated to dryness and 0.2 mL of chloroform acetic anhydride was added and 2 mL of TCA chloroform were added and the absorbance measured at 620 nm. Then concentration of vitamin A was extrapolated from the standard curve.

2.5.2 Determination of vitamin B1 (Thiamine)

5 g of samples were homogenized with 50 mL of ethanolic sodium hydroxide solution. This was filtered into a 100 mL flask. 10 mL of the filtrate was pipetted into a beaker and colour developed by the addition of 10 mL potassium dichromate. The absorbance was read at 360 nm. A blank sample was also prepared and read at the same wavelength. The values are extrapolated from a standard curve [12].

2.5.3 Determination of riboflavin (Vitamin B2)

5 g of each of the samples was extracted with 100 mL of 50% ethanol solution shaken for 1 h. This was filtered into a 100 mL of 30% hydrogen peroxide (H₂O₂) and allowed to stand over hot water bath for 30 min. 2 mL of 40% sodium sulphate added to make up the 50 mL mark and absorbance read at 510 nm in a spectrophotometer [12].

2.5.4 Determination of niacin (Vitamin B3)

5 g of sample was blended and 100 mL of distilled water added to dissolve all nicotinic acid or niacin present. 5 mL of this solution was drawn into 100 mL volumetric flask and make up to mark with distilled water. 25 ppm of Niacin stock solution was prepared. The absorbance of diluted stock solution and sample extract were measured at a wavelength of 385 nm on a spectrophotometer.

2.5.5 Determination of ascorbic acid (Vitamin C)

Vitamin C content was determined according to the method of Baraket et al. [13]. 5 g of the sample was weighed into an extraction tube and 100 mL of EDTA/TCA (2:1) extracting solution were mixed and the mixture shaken for 30 min. This was transferred into a centrifuge tube and centrifuged at 3000 rpm for 20 min. It was transferred into a 100 mL volumetric flask and made up to 100 mL mark with the extracting solution. 20 mL of the extract was pipetted into the volumetric flask and 1% starch indicator was added. These were titrated with 20% CuSO₄ solution to get a dark end point [13].

2.5.6 Determination of vitamin E

1 g of the sample was weighed and macerated with 20 mL of ethanol. 1 mL of 0.2% ferric chloride in ethanol was added, then 1 mL of 0.5% α,α -dipyridyl was also added, It was diluted to 5 mL with distilled water and absorbance was measured at 520 nm.

2.6 Determination of Antioxidant Activity

2.6.1 DPPH

To 0.2 mL of each extracted sample and the standard Trolox solutions, 3.8 mL of 0.1 mM DPPH solution was added in a test tube. The mixtures were shaken for 1 min and then left in

the dark for 30 min after which the absorbance was read using spectrophotometer at 517 nm against the blank.

2.6.2 Total phenolics

The total phenolic content was measured using the FolinCiocalteu reagent [14]. An aliquot of the extract (100 µL) was mixed with 250 µL of Folin Ciocalteu's reagent and incubated at room temperature for 5 min. Then 1.5 mL of 20% sodium bicarbonate was added to the mixture and incubated again at room temperature for 2 h.

3. DETERMINATION OF UNDIGESTED OLIGOSACCHARIDES USING THIN LAYER CHROMATOGRAPHY

3.1 Apparatus

1. Chromatography
2. Glass plates (20 cm x 20 cm) with cellulose F (0.9 mm thick)

3.2 Reagents

1. Developing solvent prepared by mixing 50 mL ethyl acetate, 50 mL pyridine, 10 mL water, 5 mL glacial acetic acid and 5 mL propionic acid.
2. Visualizing reagent, mix 0.05 g diphenylamine, 1 mL aniline and 5 mL 85% orthophosphoric acid and make up to 50 mL with acetone.

3.3 Procedures

Thin layer chromatography was used. 12 g of silica gel G were mixed with 27.6 ml 0.02 M pH 8.0 borate buffer by stirring for 60s. The slurry was coated on 2 glass plates (20 cm x 20 cm) using an applicator. The plates were kept at room temperature until they set and then dried for 2 h at 60°C. They were stored in a desiccator at room temperature before use.

A micropipette was used to spot the samples, and a warm stream of air from a hair dryer was used to dry the spots. The application was carried out by spotting each time, drying and repeating this procedure until the desired volume was put on the plate. The origin was 2 cm above the bottom edge of the plate. The thin layer was broken vertically 2 cm from each side to eliminate edge effects. The plate was allowed to develop by ascending chromatography to a

height of 18 cm in closed glass tanks containing 1-butanol-acetic acid-water (4:1) as solvent system. The average development time at was 3 h. The plate was dried in a hood followed by in oven at 70°C for 15 min and cooled to room temperature. It was returned to the solvent tank for a second run, and then, after being dried as before, sprayed with p-anisidine phosphate reagent (1 % p-anisidine HCl in 100 mL EtOH + 10 mL orthophosphoric acid).The sprayed plate was heated for 15min at 110°C. The sugar appeared as brown spots on a light yellow background. The colours were only stable in the dark at room temperatures.

3.4 Separation of Carbohydrates

The clear reaction mixtures containing sugars were spotted on a thin layer plate. After two successive developments, sugars were located by spraying the plate with p-anisidine phosphate reagent.

3.5 Identification of Sugars

The reaction mixture was applied as a line on a thin layer plate, which was developed and dried according to the method described. The band containing compound R on the unsprayed plate was located by referring the R_f of the spot of standard raffinose, sucrose, starchyose, glucose and verbacose on an index plate which was developed under the same conditions as the above but sprayed with p-anisidine reagent.

The silica gel of the band corresponding to the position of standard undigested oligosaccharides was scraped off the glass plate, collected with suction and placed in a test tube. The sugar adhering on the silica gel particles was extracted with 80% ethanol three times. The extraction was evaporated to dryness, subjected to hydrolysis with 2N HCl (0.1 ml) at 100°C for 3 h neutralized with 2N NaOH and the sugars identified by thin layer chromatography.

3.6 Statistical Analysis

All the data obtained were subjected to statistical analysis using SPSS15.

4. RESULTS AND DISCUSSION

Table 1 shows the microbial load and the physicochemical properties of raw, boiled and fermented melon seed. Two different media,

Table 1. Microbial load and the physicochemical parameters for raw, boiled and fermented melon seed

Samples	Microbial load on NA	Microbial load on PDA	pH	TTA	Moisture content
RM	8.74	7.80	5.81±1.32	2.43 ^a ±1.39	6.50 ^c ±0.02
BM	8.67	7.42	6.62±1.22	0.59 ^b ±0.18	38.49 ^a ±1.72
FM ₂₄	8.64	0	6.35±0.82	0.81 ^b ±0.29	23.00 ^b ±2.61
FM ₄₈	8.92	7.52	6.43±1.36	0.78 ^b ±0.39	27.00 ^b ±2.63
FM ₇₂	8.91	7.80	6.78±0.89	0.81 ^b ±0.59	35.00 ^a ±2.60
FM ₉₆	9.13	8.06	7.34±1.69	1.11 ^b ±0.89	36.00 ^a ±2.67
FM ₁₂₀	9.34	8.31	7.54±1.02	1.35 ^b ±0.49	38.00 ^a ±2.59

Note: Data are expressed in mean ± SD from triplicate experiments (n=3). Values having different superscript letters in a row are differ significantly at p≤0.05

Key: RM-raw melon, BM- boiled melon, fermented melon seed at 96 hours, FM₁₂₀- NA-Nutrient agar, PDA-Potato Dextrose fermented melon at 120 hours. Agar, TTA- Total titratable acidity, FM₂₄- fermented melon at 24 h, FM₄₈- fermented melon at 48 h, FM₇₂- fermented melon at 72 h, FM₉₆- fermented melon at 96 h, FM₁₂₀.fermented melon at 120 h

Table 2. Proximate composition of raw, boiled and fermented melon seed

Proximate (%)	Raw	Boiled	Fermented
Ash content	3.74 ^a ±1.49	3.01 ^a ±0.29	3.52 ^a ±0.89
Crude fibre	2.01 ^a ±0.49	1.92 ^a ±0.39	1.71 ^a ±0.99
Fat content	30.01 ^a ±1.29	30.43 ^a ±1.69	32.29 ^a ±1.59
Protein content	28.47 ^a ±1.59	28.31 ^a ±1.79	29.79 ^a ±1.49
Carbohydrate	35.77 ^a ±0.30	33.43 ^c ±0.03	32.55 ^b ±0.03

Note: Data are expressed in mean ± SD from triplicate experiments (n=3). Values having different superscript letters in a row are differ significantly at p≤0.05

Table 3. Antinutritional factors and antioxidant activity of raw, boiled and fermented melon seed

Antinutritionals	Raw	Boiled	Fermented
Saponin	1.43 ^a ±0.99	0.37 ^a ±0.19	0.61 ^a ±0.29
Trypsin inhibitor	0.50 ^b ±0.19	0.90 ^c ±0.36	ND
Flavonoid	3.44 ^a ±0.89	0.34 ^b ±0.19	0.30 ^b ±0.89
Phytate	0.40 ^a ±0.19	ND	0.10 ^a ±0.05
Cardiac Glycoside	0.07 ^a ±0.44	0.01 ^b ±0.01	0.00 ^b ±0.00
Tannin	0.73 ^a ±0.39	0.08 ^b ±0.03	0.08 ^b ±0.04
Antioxidant activity			
Total phenolics	16.64 ^a ±2.39	19.12 ^a ±1.99	19.12 ^a ±1.29
DPPH scavenging activities	26.64 ^a ±2.49	20.67 ^b ±2.09	28.40 ^a ±2.79

Note: Data are expressed in mean ± SD from triplicate experiments (n=3). Values having different superscript letters in a row are differ significantly at p≤0.05

ND = Not determined

Table 4. Antioxidant vitamins of raw, boiled and fermented melon seed

Antioxidant vitamins	Raw	Boiled	Fermented
Vitamin A	22.00 ^b ±2.19	26.47 ^a ±1.99	29.41 ^a ±2.19
Vitamin B1	0.12 ^a ±0.10	0.05 ^a ±0.04	0.13 ^a ±0.10
Vitamin B2	0.14 ^a ±0.10	0.10 ^a ±0.05	1.14 ^b ±0.69
Vitamin B3	1.76 ^a ±0.79	0.71 ^a ±0.49	1.62 ^a ±1.19
Vitamin C	24.64 ^a ±1.79	13.67 ^b ±1.69	24.64 ^a ±1.79
Vitamin E	21.18 ^b ±1.39	28.14 ^a ±1.49	15.43 ^c ±1.59

Note: Data are expressed in mean ± SD from triplicate experiments (n=3)

Table 5. Mono and oligosaccharide sugars of raw, boiled and fermented melon seed

Sugar	Raw seed	Boiled seed	Fermented seed
Glucose	3.52 ^b ±1.59	2.67 ^b ±1.09	6.67 ^a ±1.89
Sucrose	1.76 ^a ±0.89	1.51 ^a ±0.79	1.56 ^a ±0.69
Raffinose	0.76 ^a ±0.19	0.66 ^a ±0.29	0.61 ^a ±0.39
Stachyose	4.19 ^a ±1.19	3.10 ^a ±1.09	4.33 ^a ±1.49
Verbacose	0.71 ^a ±0.39	0.59 ^a ±0.18	0.67 ^a ±0.49

Note: Data are expressed in mean ± SD from triplicate experiments (n=3)

nutrient agar and potato dextrose agar were used for the growth of bacteria. The physicochemical properties expressed the PH, Total Titratable Acidity and the Moisture content of the seed all at different hours within the interval of 5 days that completed the fermentation period.

Table 2 presents the proximate composition of the raw, boiled and fermented seed of *Cucumeropsis mannii*. The ash, crude fibre, fat, protein and carbohydrate content of the seeds were evaluated. The parameters were accessed on the seed at the end of each processing (boiling and fermentation) period except for raw seed.

Table 3 present a two in one results. Anti-nutritional factors and antioxidant activity of the raw, boiled and fermented seed of *Cucumeropsis mannii*. The Anti-nutritional factor accessed saponin, Trypsin Inhibitor, Flavonoid, Phytate, Cardiac Glycoside and Tannin while the antioxidant activities were accessed on Total Phenolics and 2,2-diphenyl-1-picrylhydrazyl (DPPH) scavenging potential. All the parameters were accessed on the seed at the end of each processing (boiling and fermentation) period except for raw seed.

Table 4 shows the result of antioxidant and some B-Complex vitamins of *Cucumeropsis mannii* seed in their raw, boiled and fermented state. The analysis was carried out after processing except for the raw seed.

Table 5 is the outcome of the analysis of glucose, sucrose and undigested oligosaccharide sugars accessed in the *Cucumeropsis mannii* seed after processing except for the raw seed analysis.

4.1 Discussion

From Table 1 the microbial analysis of fermented seed sample at 120 h had the highest microbial load compared to raw and boiled samples. This

could be due to the natural fermentation process that occurred in the samples because of different micro flora that are present in the medium. The fermented melon samples at 120 h also have the highest fungal count. On boiling the sample, the microbial load reduced which might definitely be the thermal effect on the microbes. There was a linear increase in the number of fungi count as the hour progressed in fermentation process from 24 h to 120 h while a clear fluctuation was experienced in the microbial load from the beginning of the fermentation through the concluded hour. This may indicate that fermentation could increase the fungi load in the melon samples. This outcome corroborated the discovery of Yong and Wood [15] who observed fluctuation in microbial load during the fermentation of soy sauce. As a general observation on the media used in this research, nutrient agar (NA) allows the growth of more microorganisms than potato dextrose agar (PDA) which implies that under the same condition NA may be preferred over PDA for the growth of microorganism. This is in accordance with the work of Ileola et al. [16].

Further on Table 1 the result of physicochemical properties showed that the pH of fermented melon seed at 120th h (FM₁₂₀ h) was quite higher compared to raw and boiled melon seed. This might indicate that the fermented sample of *Cucumeropsis mannii* seed is weakly alkaline while the raw and boiled seeds has the least value indicating that the seeds were weakly acidic. Similar finding was reported by [14,18] they discovered increase in pH during fermentation.

Moreover, the moisture content of the boiled melon seeds has the highest value which indicated that processing, like boiling, will increase the moisture content of the seed which might partly be due to imbibition of water by the tissues during process of boiling. Similar observation was reported by Omafuvbe et al. [19] that the increase in moisture contents of the fermented products may be as a result of the

decomposition of the fermenting bacteria on the products.

From Table 2, the ash, fat and protein of fermented seed were higher than the boiled seed. This difference may be attributed to the processing method which might probably have involved the decomposition of compounds in boiled seed. The effect of heat treatment on the proximate composition of *Cucumeropsis mannii* seed was observed. The ash content was observed to reduce with boiling. The raw sample has the highest ash content. This may imply that processing of *Cucumeropsis mannii* seed will definitely reduce the deposit of inorganic substances in the body when consumed. It was also observed that the protein content in fermented sample is higher than observed in both raw and boiled seed, therefore, the seed is better consumed fermented as a weapon against kwashiorkor and marasmus in protein deficient communities. However, as the seed cannot be consumed raw [1], processing is therefore inevitable. Nonetheless, processing (boiling and fermentation) does not in any way front the presence of crude fibre in the seed and as such could not be a good bulk in digestion process to defray constipation.

From Table 3, Trypsin Inhibitor could not be traced in fermented seed while phytate could also not be detected in boiled seed. The highest value of anti-nutritional factor found in the processed seed is trypsin inhibitor in boiled seed. This is followed by saponin in fermented seed. Generally, from Table 3, processing the seed will break down/deplete the antinutritional factors (except trypsin inhibitor) which otherwise inhibit protein digestibility. This is in agreement with the work of Awoyinka et al, [20] where malted legumes showed a decreased level of phytochemicals. Further on Table 3, the total Phenolics and DPPH increased after processing. This is an inverse result juxtaposing the work of Awoyinka et al. [21]. This might probably suggest that the level of phenolics and DPPH availability in samples is processing type dependent are better tapped when the seed is processed. These are powerful antioxidants implicated in prevention of some terminal diseases.

From Table 4, observations showed that the high level of vitamins A, C and E evaluated when processed boiled or fermented [22] would cede attraction to *Cucumeropsis mannii* seed consumption by animals and man, even though it cannot be consumed unprocessed because of

the high level of its phytochemicals. Vitamin A projects the seed further as it has the highest quantity when processed especially when fermented. Vitamin A prevents night blindness in animals. Vitamin B1 (thiamine) has the least quantity when processed which implies that *Cucumeropsis mannii* seed may not be a good food source projecting thiamine to bring about oxidative decarboxylation of α -keto acid and transketolase reaction. Vitamin C (Ascorbic acid) is needed for performance in activities of fibroblasts, and osteoblasts, and intercellular cement substance of capillaries [23].

Vitamin E is the most powerful natural antioxidant. [24]. Vitamin E also protects erythrocytes from hemolysis by preventing peroxidation. Vitamin E reacts with the lipid peroxide radicals formed by peroxidation of polyunsaturated fatty acids, acting as antioxidant for mopping up free radicals [25].

From Table 5 the glucose level of the fermented seed is twice as high in raw seed and thrice as high in the boiled seed signifying that much glucose could be harvested in fermented sample of *Cucumeropsis mannii* seed juxtaposing raw and boiled seeds. The sucrose level in the raw seed was slightly higher than the quantity found in boiled and fermented seed that has approximately equal quantity. This implies that processing will surely deplete the sucrose level of *Cucumeropsis mannii* seed. This might likely be linked to thermal decomposition of sucrose to its monomeric units (two glucose molecules). Raffinose is significantly lower in *Cucumeropsis mannii* seed compared to sucrose, the raw seed having higher raffinose in comparison with the boiled and fermented seed which has the same quantity. Stacheose and verbacose were partially higher in fermented *Cucumeropsis mannii* seed than observed in the raw seed but significantly higher than found in boiled seed. This implies that processing may not reduce flatulence in relation to raffinose but will well assist to reduce flatulence due to starcheose and verbacose. Gases like hydrogen, carbon monoxide and carbon dioxide, methane and some organic acids are the products of oligosaccharide fermentation by pathogenic and harmful bacteria, contributing to the flatulence problem associated with the seed consumption (Tomamatsu, 1994).

However, Martín-Cabrejas et al. [26] reported that germination, a form of processing, removes Raffinose Family Oligosaccharides (RFOs) in legumes. This may be explained that RFOs

(undigested oligosaccharide) removal/reduction in food may be dependent on the type of processing.

5. CONCLUSION

Proximate composition of raw, boiled and fermented melon seed showed that *Cucumeropsis mannii* melon seeds are nutritious especially in protein and fat but not a good source of B-Complex Vitamin. Further, the study found that processing increases the nutritional composition but reduces the antinutritional factors of the melon seeds. Generally, fermented *Cucumeropsis mannii* seed has the highest saccharide content while glucose is significantly different among other sugars analysed. Hence the findings of this research showed that *Cucumeropsis mannii* melon seeds, though underutilized, can be good substitutes in food formulations.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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