Proximate Composition, Heavy Metals and Microbial Quality of Ground Melon Seed Sold in Some Open Markets in Abeokuta, Ogun State

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ABSTRACT

***Background:** Processing, handling and distribution practices of ground melon seed normally sold along the street and open markets in Nigeria may constitute a major source of health hazard.*

***Objective:** This study assessed the variations in proximate composition, heavy metals and microbial quality of ground melon seed sold in some open markets in Abeokuta, Ogun State, Nigeria.*

***Methods**: Ground melon seed samples were collected from three vendors from five different major markets (Osiele, Itoku, Kuto, Omida and Lafenwa) in Ogun State, Nigeria. The samples were transported ascetically in polythene bags to the laboratory for further analysis. Unshelled melon seeds purchased from Osiele market was cleaned, shelled, washed with distilled water, sundried and milled using a laboratory blender. This served as control. The proximate composition, heavy metals (copper, lead, iron and cadmium) concentrations and microbial {total fungi count (TFC), total coliform count (TCC) and total viable count (TVC)} quality were determined by standard laboratory procedures.*

***Results**: There were significant differences ($p<0.05$) in the proximate composition, heavy metal contents, TVC, TFC and TCC of all the samples. Sample from Omida market had the highest contents of all heavy metals except cadmium while the sample from Osiele market had the highest content of TVC, TCC and TFC.*

***Conclusion**: Ground melon seed sold in all the markets were unsafe for human consumption due to its high microbial loads while the concentrations of heavy metals are comparable and within the acceptable limits of WHO/FAO CODEX food standard.*

Keywords: Melon, open markets, proximate composition, heavy metals, microbial quality

INTRODUCTION

Melon (*Colocythis citrullus L.*) is a widely cultivated and consumed oil seed in West Africa, especially in Nigeria, Togo and Ghana [1]. Melon grows in gourds which are mainly cultivated for their seeds as the flesh is neither sweet nor edible. It is an annual herbaceous, monoecious plant which is creeping but non-climbing [2]. The seeds are small and flat with one end rounded while the other is tapered. Melon seeds are commonly called *egusi* in the western part of Nigeria. According to Norman [3], the name *egusi* applies generally to the several similar looking seeds from *Curcurbitaceae* family including seeds of cucumber, water melon, squash and pumpkin. The seed contains about 53% oil, 28% protein and some appreciable amount of mineral, vitamins and energy. It is also rich in essential amino acids, tocopherols and phenolic compounds [1, 4, 5]. Melon seed contain a fairly high amount of poly unsaturated fatty acids and phospholipids [6] suggesting a possible

hypocholesteremia. The ground seed is used as thickener in *egusi* soup, melon ball snack and *ogiri* (a fermented condiment) [1, 5].

Ground melon seed which is obtained by milling dried melon seeds, has been reported to deteriorate quickly in storage due to its susceptibility to fungal infection [7, 8]. This could lead to decrease in nutritive value, change in colour, increase in peroxide value, reduced seed germination and mycotoxin production as reported by Bankole *et al*. [9]. The quality of the ground melon seed is directly dependent on the quality of the dried seed used as well as the handling of the seed during drying and storage. Moisture content plays a vital role in the maintenance of seed quality in stores. Bankole *et al*, [5] observed that a 1% decrease in moisture doubles the shelf-life of the seeds. To reduce quality loss in stored seeds, rapid drying to low moisture is often emphasized, because all scenario leading to mould contamination and subsequent damage relate to non-maintenance of stored products at safe moisture content [10, 11].

Most African farmers spread their harvests to dry under the sun, which requires longer duration for the products to attain "safe" moisture level. Conditions of high ambient relative humidity particularly during the period of the first season harvest (July to September) [9] often result in extended drying times, which may affect the quality of the products. This often results in dust and foreign matter contamination as well as chemical contamination of the produce which may affect the quality of ground melon seed available in open markets.

Moreover, the handling and distribution practices of ground melon seed normally sold along the street and open markets of Western Nigeria may affect the heavy metals constituents of the product. Most vendors of ground melon seed display this product in bowls or tray without covering thereby exposing the products to high temperature and atmospheric or environmental deposits. According to Rai *et al*. [12], the spread of heavy metals is now a great challenge to the populace because of its potential health hazards. Some heavy metals such as arsenic, cadmium, lead and mercury classified as non-essential to metabolic and biological activities in the body are harmful to health [12]. Reports from Rai *et al*. [13] indicated that such metals have been included in the top 20 list of dangerous substances by the United States Environmental Protection Agency as well as the Agency for Toxic Substances and Disease Registry. Hence, this study was aimed at assessing the proximate composition, heavy metals concentration and microbiological quality of ground melon seed displayed for sale in five major markets in Abeokuta, Ogun state.

Materials and Methods

Sampling and sample preparation

Ground melon seed samples were aseptically collected from three vendors, in each of the five different markets (Osiele, Itoku, Kuto, Omida and Lafenwa) in Ogun state, Nigeria. The samples were transported in polythene bags to the laboratory for further analysis. Unshelled melon seed was also purchased from Osiele market. The unshelled melon seed was cleaned, shelled, washed, sundried and milled using a laboratory blender (Philip, HH2020/50 UK). The milled sample was also packaged in a polyethylene bag (as the control sample) for further analysis.

Determination of proximate composition

Moisture, protein, fat, ash and crude fibre contents of the samples were determined using AOAC [14] method while carbohydrate content was determined by difference.

Determination of Heavy metals concentration

Heavy metals {(Iron (Fe), Cadmium (Cd), Copper (Cu) and Lead (Pb)} were determined using the dry ashing method of AOAC [14] for the atomic absorption spectrophotometry (AAS) analysis.

Microbiological analysis

Total Viable Count, Total Coliform Count and Total Fungal Count were carried out according to standard laboratory procedures of AOAC [14]. Nutrient agar, MacConkey agar and Potato dextrose agar (PDA) was used, respectively for enumeration of bacteria, coliform and mould and yeasts. One gram of the sample was weighed into 10 ml of sterilized distilled water in a Mac Conkey bottle. Then, 1 ml of the sample was sucked into a second bottle after which 1 ml of the sample was sucked from the second bottle into the third, the dilution continued until the tenth bottle had been diluted. Appropriate dilution was used for the plating of the sample. Also,1 ml of the diluents was dispensed into a petri dish under aseptic condition then the molten agar was poured into the petri dish and mixed immediately

by rotating the petri dishes sufficiently to obtain evenly dispersed colonies after incubation. The petri dish was covered and left for 15 min to solidify before incubation. The petri dish was inverted to avoid condensed water on the cover of the petri dish from dropping on the medium, thereby disturbing and diluting the medium. The petri dishes were incubated at 37 °C for 48 h for TVC, 37 °C for 24 h for TCC and 30 °C for 72 h for TFC, after which the colonies were counted using a colony counter. The presence of coliform was noted by pink colonies. Presence of mould was noted by whitish hairy mass while yeast was noted by creamy colonies.

Statistical Analysis

All analyses were done in triplicate. Data obtained were subjected to statistical analysis of variance (ANOVA) using the Statistical Package for Social Sciences (SPSS) version 21.0. Duncan Multiple Range Test was used to determine significant differences among treatment means.

Results

Proximate composition

The result of the proximate analysis of the six samples of ground melon seed is presented in Table 1. There were significant ($p<0.05$) differences in moisture, protein, crude fibre and carbohydrate contents while the ash and fat contents were not significantly ($p>0.05$) different. Moisture, protein, crude fibre and carbohydrate ranged from 2.76 to 4.92%, 10.43 to 22.44%, 4.50 to 10.0% and

Values are means of triplicate determinations. Mean values with different superscripts within the same column are significantly different ($p<0.05$).

0.84% to 16.19%, respectively. The control sample had the highest moisture content, protein and crude fibre contents. However, the ash content was not significantly ($p<0.05$) except for the value obtained from Kuto sample and the control sample. The ash content ranged between 3.82 and 5.49%, The value of the fat content ranged between 58.2 and 61.8%. Sample from Osiele market had the highest fat content while the control sample had lowest fat content.

Heavy metals

Table 2 shows the levels of the heavy metals determined in the ground melon samples from the study area. There were significant ($p\leq0.05$) differences in Cu, Pb and Fe concentrations. The values obtained for Cu, ranged from 0.0027 to 0.0056 mg/100g. The sample from Omida had the highest while the control sample had the least. The Pb and Fe contents of the samples ranged from 0.0013 to 0.0043 mg/100g and 0.0081 to 0.0266 mg/100g, respectively. Also, Omida's market sample had the had the highest content of both Pb and Fe contents while the control sample had the least. The value of Cd ranged between 0.0059 and 0.0143 mg/100g. The concentration of Cd did not vary significantly ($p<0.05$) among the samples except for sample obtained from Itoku which had the highest concentration of cadmium.

Microbial counts

The total microbial counts of ground melon seed sold in Abeokuta are shown in Table 3. Total viable counts ranged from 5.10 to 7.73 logcfu/g, sample from Kuto had the highest bacteria counts (7.73 logcfu/g) while the control sample had the lowest counts (5.10 logcfu/g). Samples obtained from Kuto and Osiele markets were not significantly ($P>0.05$) different. The amount of coliform counts found in the samples ranged between 3.01 and 3.85 logcfu/g. Also, Sample from Kuto had the highest coliform counts (3.85 logcfu/g) while the lowest count (3.01 logcfu/g) was found in sample from Osiele market. However, there was no significant (P.0.05) among Osiele. Itoku and Omida samples. No coliform bacteria were found in the control sample. There fungal counts were significantly ($p<0.05$) different among samples except for Omida and Kuto samples which are not significantly different. The fungal counts ranged from 2.00 logcfu/g to 3.68 logcfu/g. The highest fungal counts (3.68 logcfu/g) was obtained from Omida's sample while the control sample had the lowest fungal counts (2.00 logcfu/g).

Table 1: Proximate composition Specify [g/100g (%)] of ground melon seed sold in some major markets in Abeokuta

Sample	Moisture content	Ash content	Protein content	Fat content	Crude Fibre	Carbohydrate
Lafenwa	3.17 ± 0.06^{ab}	5.15 ± 0.18^{a}	10.43 ± 0.34^{a}	58.8 ± 0.00^{a}	6.50 ± 0.50^{b}	16.19 ± 1.19^{d}
Kuto	3.14 ± 0.12^{ab}	4.30 ± 0.33^{ab}	20.34 ± 0.00^{cd}	60.2 ± 2.20^{a}	6.50 ± 0.50^{b}	5.09 ± 1.44^{b}
Itoku	3.09 ± 0.41^{a}	4.30 ± 1.99^{a}	18.79 ± 2.94^{bc}	61.0 ± 0.60^{a}	8.00 ± 0.00^{c}	4.21 ± 0.86^{b}
Osiele	2.76 ± 0.03^{a}	4.99 ± 0.33^{a}	17.05 ± 0.09^{b}	61.8 ± 0.60^{a}	4.50 ± 0.50^{a}	9.36 ± 1.52^{c}
Omida	3.90 ± 0.22^{b}	5.49 ± 0.83^{a}	17.09 ± 0.00^{b}	60.6 ± 0.20^{a}	8.50 ± 0.50^{c}	3.95 ± 1.56^{b}
Control	4.92 ± 0.22^{c}	3.82 ± 1.51^{b}	22.44 ± 0.65^{d}	58.2 ± 0.60^{a}	10.00 ± 0.00^{d}	0.84 ± 0.15^{a}

Table 2: Some heavy metals (mg/100g) of ground melon seed sold in some major markets in Abeokuta

Sample	Copper (Cu)	Lead (Pb)	Iron (Fe)	Cadmium (Cd)
Lafenwa	0.0044^{c}	0.0019^{bc}	0.0175^{bc}	0.0088^{a}
Osiele	0.0032^{b}	0.0015^{ab}	0.0141^{b}	0.0091^{a}
Itoku	0.0052^{d}	0.0015^{ab}	0.0217^{d}	0.0143^{b}
Kuto	0.0042^{c}	0.0025^{c}	0.0191^{cd}	0.0066^{a}
Omida	0.0056^{d}	0.0043^{d}	0.0266^{e}	0.0059^{a}
Control	0.0027^{a}	0.0013^{a}	0.0081^{a}	0.008^{a}

Table 3: Microbial quality (log CFU/g) of ground melon seed sold in some major markets in Abeokuta

Sample	Total fungal count (TFC)	Total coliform count (TCC)	Total viable count (TVC
Lafenwa	3.25^{b}	3.18^{b}	7.25^{b}
Osiele	3.47^{c}	3.85^{c}	7.73^{d}
Itoku	3.40^{bc}	3.72^{c}	7.42^{bc}
Kuto	3.48^{c}	3.01^{b}	7.66^{d}
Omida	3.68^{d}	3.68^{c}	7.62^{cd}
Control	2.00^{a}	0.00^{a}	5.10^{a}

DISCUSSION

Proximate composition

There were variations in the proximate composition indices of samples of ground melon seed obtained for this study. The amount of moisture in foods (especially for flours and powders) determines their quality and acceptability [1]. The relatively low moisture content of the samples obtained in this study could make samples less liable to microbial attack and then shelf stable. The values obtained were in agreement with the findings of Ojieh *et al*. [15] who reported a range of 4.3 to 4.9%. The values recorded in the control sample (4.92%) is in agreement with the findings of Ojieh *et al*. [15] who reported 4.6% for the moisture content of *citrullus lanatus*, while moisture for samples from Itoku. Osiele, Lafenwa and Omida are 3.09, 3.14, 3.17 and 3.90%, respectively. The values

are lower than the values (4.27% and 4.6%) reported by Obasi *et al*. [16] and Ojieh *et al*. [15], respectively. The variation in the ash content may be due to different environmental condition during cultivation and varietal differences. However, values obtained are in agreement with the findings of Abiodun *et al*. [17] and Arthur et al. [1] who reported a range of 3.35 to 4.89% and 3.51 to 4.04 respectively, for the ash content of some melon seed and powder.

Protein content compared favourably with those of protein rich food such as soy bean, cowpea, pigeon peas and pumpkin with protein content ranging between 23.1% and 33.0% [15]. The value obtained from Lafenwa's sample is similar to the findings of Obasi *et al*. (16) who reported 10.57% for the protein content. Samples from Osiele, Omida and Itoku which has 17.05, 17.09 and 18.79% respectively, are in agreement with those reported for seeds of *Gnetum africana* (17.5%), *solanum nigrum L. var. virgrinicum* from Afikpo (17.63%), *solanum nigrum L.* from Congo Brazzaville (17.04%), *amaranthus hybridus* var. 1 and var. 2 (17.60 and 18.99% respectively) by Obasi *et al*. (16). Fibre plays a significant role in prevention of constipation, irritable colon, cancer and diabetes and many more [18,19]. Fibre consumption also softens stool and lower plasma cholesterol in the body hence, the consumption of melon is of great nutritional benefits especially to low income earners. The high fat content observed in the ground melon makes it a suitable source of nutrient that can improve the energy density of man and animal. It can also be regarded as an oil seed [15].

Heavy metals

The variations in heavy metals concentrations amongst the market samples obtained for the study compares to other previous studies could be due to different level of contamination through the soil during cultivation and long exposure to atmospheric deposits. According to Zhuang *et al*. [20], the major sources of heavy metals is through the soil, environment and atmospheric deposition. The values from this study is observed to be lower than the findings of Manzoor *et al*. [21] and Lanre-Iyanda *et al*. [22] who reported 4.78 mg/kg for *Citrullus colocynthis*, 29.9 mg/kg for *Euphorbia cornigera* and 18.29 mg/kg for *Rhazya stricta,* respectively. It is also lower than the values obtained from the findings of Lanre-Iyanda *et al*. [22] who reported a range of 0.07 to 0.47 mg/kg. These values obtained for copper were lower than the findings of Ojieh *et al*. [15] who reported copper concentration in *egusi* flour as 0.4 mg/100g. Ibrahim *et al*. [23] also reported copper concentration of 2.0 mg/100g in *colocynthis citrullus*. The values obtained from this study were lower than that reported by Manzoor *et al*. [21] who obtained 9.34 mg/kg from *Citrullus colocynthis*. The values obtained in this study are lower than the value (4.0 mg/100g) reported by Ibrahim *et al*. [3] and 1.3 mg/100g reported by Ojieh *et al*. [15]. The result for cadmium and lead from this study shows that the samples are safe for consumption because all the values are lower than the standard limit set by WHO/FAO [24] as 0.2 mg/kg for lead in cereals legumes and pulse, 0.1 mg/kg for cadmium in cereals and 0.05 mg/kg in vegetables and fruits.

Microbial quality

According to ICMSF [25], the maximum recommended bacteria count for good quality products is 5.0×10^5 (5.7 log CFU/g) and the maximum for marginally acceptable quality products is 10^7(7 log CFU\g). The total bacterial counts from all market samples were higher than the maximum recommended bacteria count as well as the maximum for marginally acceptable quality products. This indicates that the melon samples from the five markets can be regarded as unsafe for human consumption due to its high bacteria counts.

Conclusions

Significant differences were observed in the proximate composition (except fat content), heavy metals and microbial levels of the ground melon seed. The control sample had the lowest microbial count with no observable coliform count. However, the ground melon seed sold in all the markets were unsafe for human consumption due to high microbial loads while the values obtained for the heavy metals were within the acceptable limits of WHO/FAO standard for plant and crops.

Authors' contributions

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

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Ethics approval and consent to participant

Not applicable

Conflicts of Interest
Authors declared that they have no conflict of interest

Availability of data and materials
All data related to this manuscript are presented within the text.

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