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DETERMINING THE PHYSIOCHEMICAL AND PHYTOCHEMICAL PROPERTIES OF LOCAL NIGERIAN WHITE MELON SEED FLOUR

Peter Anyigor Okorie *[1]
[*1] Department of Food Science and Technology Ebonyi State University, Abakaliki, Nigeria

Abstract

The functional properties, proximate composition and phytochemical characteristics of a local Nigerian white melon seed flour was determine in this study. Foaming capacity, emulsion capacity, oil absorption, water absorption, and bulk density tests were conducted. The moisture, protein, fat, fibre, ash, carbohydrate, flavonoid, saponin, carotenoid and alkaloid contents of the flour were determined. The results show that the functional properties of the flour are: foaming capacity 0.03 %, emulsion capacity 60.50 %, oil absorption capacity 34.10 %, water absorption capacity 18.60 % and bulk density 1.62 g/ml. The proximate composition of the flour are: carbohydrate 58.43 %, protein 32.55 %, moisture 1.70 %, fat 29.00 %, crude fibre 6.15 % and ash 0.85 %. The flour has the following phytochemical composition: flavonoid 3.13 %, saponin 4.88 %, carotenoid 1.80 % and alkaloid 5.90 %. The analysis revealed that the flour could be used in soup making and infant food formulation. It could also be useful for prevention and cure of heart related diseases.

Keywords: Physiochemical Properties; Phytochemical Properties; Melon Seed Flour; White Melon.

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1. Introduction

Melon seed is a cucurbit crop with fibrous and shallow root system that belongs to the cucurbitaceae family. It is a tendril climber or crawling annual crop, mostly grown as a subsidiary crop interplant with maize and yam in some savannah belt of Nigeria of West Africa. Melon is a major food crop with several varieties (Milind and Kulwant, 2011), which serve as a major food source (Mabalaha et al., 2007). It is also cultivated widely in other part of West African countries like Cameroun (Fomekong et al., 2008; Achigan-Dako et al., 2008).

The white melon (ahu ocha in Abakaliki) variety (cucumeropsis manni) is a specie of melon native to the tropical Africa especially in Akakaliki town of 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

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vitamin B, potassium, magnesium, and zinc, with health benefits (Tadimalla, 2018). Melon has many species across different towns and tribes of West Africa. The wide variety of white melon specie coupled with the richly nutritious value of the crop has attracted the attention of numerous researchers.

Oyeleke, Olagunju and Ojo (2012) evaluated the functional and physicochemical properties of watermelon seed and seed-oil peculiar to the Osun people of the Yoruba land in the Southwest part of Nigeria. Their findings revealed that the functional properties of the melon seed have oil and water absorption capacities of 123.5 ± 0.5 % and 116.3 ± 0.1 %, foaming capacity and stability of 23.5 ± 0.1 % and 62.5± 0.2 % after two hours and emulsion stability of 0.325 ± 0.001 %. The seed contains iodine, acid, and saponification values of 148.5 ± 0.5, 74.5 ± 0.5 and 3.4 ± 0.1 as the physicochemical properties. The peroxide value of the oil and the specific gravity were 2.8± 0.1meq/kg and 0.91, which make the oil suitable for human consumption.

Oluba et al. (2008) studied the physicochemical properties and fatty acid composition of citrullus lanatus (egusi melon) seed oil. It was discovered that the egusi melon oil has a specific gravity and refractive index of 0.93 and 1.45. The finding indicates that the oil is less thick relative to most drying oils with refractive indices between 1.48 and 1.49. The acid, iodine, peroxide and saponification values of the oil were 3.5 ± 0.3, 110 ± 8.2, 8.3 ± 4.6 and 192 ±4 3.7, which are values within recommended range for edible oils.

Qayyum et al. (2017) assessed the impact of watermelon seed flour on the physiochemical and sensory characteristics of ice cream. The results showed that the fat, protein, total solids, solid-not-fat, and ash contents increased with increase in melon seed flour proportion. The acidic and pH values of the flour decreased from 0.149 % to 0.141 % and 7.05 ± 0.02 % to 6.65 ± 0.03 %.

Although researchers have studied the physiochemical and phytochemical properties of some melon species in the past, there is little literature on the physiochemical and phytochemical properties of the local Nigerian white melon specie that is peculiar to the Abakaliki people in the Igbo land of the Southeast of Nigeria. Therefore, the present study seeks to determine the physiochemical and phytochemical properties of the Abakaliki oriented white melon seed flour that is normally grown in the Southeast part of Nigeria.

2. Materials and Methods

The white melon seed was used for the study. It was sourced from the local farms at Ngbo town in Ohaukwu local government area of Ebonyi state, Nigeria.

2.1. Sample Preparation

The white melon samples were de-husked, sieved and screened to remove bad ones through manual cleaning to ensure that they were free from dirt. They were sun-dried and then grinded using a mechanical grinder. The flours obtained were stored in an airtight polyethylene bag put inside containers and labelled in order to prevent insect or rodent infestation and reduce water absorption before laboratory test.

2.2. Analytical Methods

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2.2.1. Functional Properties

The test for foam capacity and stability were conducted using 2 g of white melon flour sample that was blended with 10 ml distilled water. The suspension was whipped at 1600 rpm for 5 minutes. The mixture was poured into a measuring cylinder and the volume was recorded after 30 seconds. Foam capacity was expressed as a percentage increase in volume using the formula below in line with Abbey and Ibeh (1988).

$$\% \text{ whipability} = \frac{\text{volume after whipping} - \text{volume before whipping}}{\text{volume before whipping}} \text{ x } 100$$

The foam was recorded at 15, 30, 60 and 120 minutes after whipping to determine the foam stability according to Ahmad and Chmidt (1979).

$$\text{Foam stability} = \frac{\text{foam volume after time } 't'}{\text{initial foam volume}} \text{ x } 100$$

The emulsification capacity was determined using 2 g of the flour sample that was blended with 25 ml distilled water at room temperature for 39 seconds in a warring blender at 1600 rpm. After complete dispersion, 25 ml vegetable oil was added gradually and the blending was continued for another 30 seconds. The product was transferred into a centrifuge tube at 1600 rpm for 5 minutes. The volume of oil separated from the sample after the centrifuge was read directly from the tube. The emulsion capacity was expressed as the amount of oil emulsified and held per gram of sample according to Padmashree et al. (1987).

$$\text{Emulsion capacity} = \frac{\text{height of emulsified layer}}{\text{height of whole solution in the centrifuge tube}} \text{ x } 100$$

The water/oil absorption capacity was determined using the method described by Onwuka (2005). 5 g of the sample was put into a clean conical graduated centrifuge tube and mixed thoroughly with 10 ml distilled water/oil using a mixer for 30 seconds. The sample was then allowed to stand for 30 minutes at room temperature after which it was centrifuged at 1600 rpm for 30 minutes. The volume of the free water (supernatant) or oil was read directly from the graduated centrifuge tube. The absorbed water/oil was converted to weight (in grams) by multiplying by their densities (1 g/ml/0.92 g/ml of water/oil). The water and oil absorption capacities were expressed in grams of water/oil absorbed per gram of the sample.

$$\text{Water absorption capacity} = \frac{\text{volume of water absorbed}}{\text{weight of sample}} \text{ x } 100$$

$$\text{Oil absorption capacity} = \frac{\text{volume of oil absorbed}}{\text{weight of sample}} \text{ x } 100$$

The bulk density was determined using the method described by Onwuka (2005). About 5 g of the sample was filled in a 10 ml graduated cylinder and its bottom tapped on the laboratory bench until there was no decrease in volume of the sample. The volume was recorded thus:

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$$\text{Bulk capacity (g/ml)} = \frac{\text{weigth of sample}}{\text{volume of sample}}$$

2.2.2. Chemical Analysis

The moisture content of the sample was determined according to AOAC (2000). The empty petri dish was washed and dried in an oven at 100 ℃ for 10 minutes and cooled in desiccators. The dried and cooled dish was weighed. 5 g of the prepared sample was weighed and dried in an oven with air circulation at 105 ℃ for 3 hours, cooled in desiccators and then weighed. The percentage amount of moisture was calculated using the formula.

$$\text{Moisture (\%)} = \frac{W2 - W3}{W2 - W1} \text{ x } 100$$

Where W1 = weight (g) of petri dish, W2 = weight (g) of petri dish + sample before drying, W3 = weight (g) of petri dish + sample after drying.

The ash content was determined in line with AOAC (2000). The crucible was washed and dried in a muffle furnace at 550 ℃ for 10 minutes, and cooled in desiccators for 10 minutes. About 2 g of the sample was weighed with lid and charred on a hot plat until the smokes disappear. The charred sample was put in the muffle furnace at 550 ℃ and burned to ashes for 3 hours. The ashes was weighed after cooling for 1 hour. The amount of ashes was calculated by using the formula.

$$\text{Ash (\%)} = \frac{W3 - W1}{W2 - W1} \text{ x } 100$$

Where W1 = weight (g) of crucible, W2 = weight (g) of crucible + sample before burning to ashes, W3 = weight (g) of crucible + sample after burning to ashes.

The crude protein content was determined according to AOAC (2000). 1 g of the sample was weighed in a clean testator flask. 6 ml of concentrated sulphuric acid was added and left to stand for 24 hours. After 24 hours, 3.5 ml of H2O2 (30 %) was added step by step. When the violent reactions stopped it was shaken and left in the rack. 3 g of accelerated reagent (a mixture of copper sulphate pent hydrate and anhydrous potassium sulphate) was added and left for 15 minutes. The mixture was digested in a digest, stored at 37 ℃ for 4 hours. After digestion, it was cooled in a hood on the rack and 25 ml of distilled water was added to dissolve the precipitate, 25 ml of 40 % NaOH was added to the digested sample and placed in the distiller. 25 ml of saturated solution of boric acid (H3BO3), 25 ml of distilled water and 3 drops of methyl red were added in the 250 ml conical flask and placed in the distiller. After distillation, about 150 – 200 ml distillate was collected and titrated with 0.1 M HCl. The amount of protein was calculated using the formula.

$$\text{Protein (\%)} = \frac{\text{titre value x } 0.0014 \text{ x } 6.25}{\text{weight of sample}} \text{ x } 100$$

The crude fat content was extracted according to AOAC (2000). The cleaned flask and the boiling chips were dried in the drying oven at 100 ℃ for 1 hour, cooled in the desiccators for 3 minutes and weighed. 2 g of sample was weighed in a thimble containing fat free cotton. The thimble was

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placed in the thimble holders. 50 ml of petroleum ether (boiling range of 60 – 90 ℃) was poured into the flask and the thimble immersed in the petroleum ether and heated at 80 ℃ in the fat determination apparatus for 1 hour. The thimble was hanged and heated at the same temperature for 2 hours and then the solvent was recovered for 15 minutes. The heater was switched off and the flask dried in the drying oven at 90 ℃ for 30 minutes, cooled in the desiccator for 15 minutes and then weighed together with the extract. The amount of extracted fat was calculated by using the formula.

$$\text{Weigth of fat (Wf)} = \frac{\text{Wa} - \text{Wb}}{\text{W}} \text{ x } 100$$

Where W = weight (g) of sample, Wa = weight (g) of extraction flask after extraction, Wb = weight (g) of extraction flask before extraction.

The crude fibre content was determined using the method of AOAC (2000). 0.5 g of the sample was transferred into a 600 ml beaker and 200 ml of 1.25 % sulphuric acid was added and boiled for 30 minutes. Recording took place by placing a watch glass over the mouth of the beaker. After 30 minutes heating by gently keeping the level constant with distilled water, 20 ml of 25 % KOH was added and again boiled gently for 30 minutes, then the solution was filtered through sintered glass crucible. Subsequently, washing was done with hot distilled water, 1 % NaOH solution and finally with acetone. It was latter filtered and dried in electric oven at 130 ℃ for 2 hours. Furthermore, it was transferred to a muffle furnace and burnt to ashes for 30 minutes at 550 ℃. Finally, it was cooled again and reweighed. The crude fibre content was determined by using the formula.

$$\text{Crude fibre content (\%)} = \frac{\text{W1} - \text{W2}}{\text{W3}} \text{ x } 100$$

Where W1 = weight (g) of crucible after drying, W2 = weight (g) of crucible after burning to ashes, W3 = weight (g) of sample.

The carbohydrate content was determined using the method of Cordenunsi and Lajolo (1995) and by applying the arithmetic difference method. The carbohydrate was calculated and expressed as the nitrogen free extract as shown.

$$\text{Carbohydrate (\%)} = 100 - \text{a} + \text{b} + \text{c} + \text{d} + \text{e}$$

Where a = % protein content, b = % fat content, c = % ash content, d = % crude fibre content, e = moisture content.

2.2.3. Phytochemical Analysis

The flavonoid content was determined according to the method proposed by Harborne (1973). 5 g of the sample was boiled in 50 ml of 2 M HCl solution for 30 minutes under reflux. It was allowed to cool and then filtered through Whatman number 1 filter paper. A measure volume of ethyl

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acetate starting with drop was added. The flavonoid precipitate was recovered by filtration using weighed filter paper. The resulting weight difference gives the weight of flavonoid in the sample.

The saponin content was determined by double solvent extraction gravimetric method proposed by Harborne (1973). 5 g of the powdered sample was mixed with 50 ml of the 20 % ethanol and both extract was pooled together. The combined extract was reduced at about 40 ml at 90 ℃ and transferred to a separating funnel where 40 ml of diethyl ether was added after shaking vigorously.

For carotenoids determination, measured weight of sample was homogenized in methanol using a laboratory blender. The homogenate was filtered to obtain the initial crude extract, 20 ml of ether was added to the filtrate to take up the carotenoid, and it was mixed well and then treated with 20 ml of distilled water in a separating funnel. The ether layer was recovered and evaporated to dryness at low temperature (35 ℃ – 50 ℃) in a vacuum desiccator. The carotenoid was taken up. The dry extract was then saponified with 20 ml of ethanoic potassium hydroxide left over might in a dark cupboard. The next day, the carotenoid was taken up in 20 ml of ether and was washed with two portions of 20 ml distilled water. The carotenoid extract was dried in a desiccator and was treated in a light petroleum and was allowed to stand overnight in a freezer at 10 ℃. The next day, the precipitate steroid was removed by centrifugation and the carotenoid extract was evaporated to dryness in a weighed evaporation dish, cooled in a desiccator and then weighed. The weight of carotenoid was determined and express as a percentage of the sample weight.

The alkaloid determination was done by the alkaline gravimetric method described by Harborne (1973). A measured weight 5 g of the sample was dispersed in 10 % acetic acid solution in ethanol to form a ratio of 1:10. The mixture was allowed to stand for 4 hours at 28 ℃. It was later filtered via Whitman number 1 grade of filter paper. The filtrate was concentrated to one quarter of its original volume by evaporation and treated with drop wise addition of concentrated aqueous NH4OH until the alkaloid precipitate was received in a weighed filter paper, washed with 1 % ammonia solution and dried in an oven at 80 ℃. Alkaloid content was be calculated and expressed as a percentage of the weight of the sample.

3. Results and Discussions

The results of the functional properties, proximate composition and phytochemical composition of the local Nigerian melon seed floor are presented in Tables 1, 2 and 3. Table 1 shows that the foaming capacity is 0.03 %. The low foaming capacity could be attributed to the inadequate electrostatic repulsions, less solubility and excessive protein-protein interactions (Kinsella et al., 1985). The foaming capacity value is lower from the value recorded by Arawande and Borokini (2010), who submitted that melon seed flour has a foaming capacity of 23.5 %. The difference in result could be due to the uniqueness of the local white melon seed that is peculiar to the Abakaliki people of the southeast Nigeria.

Table 1: Functional properties of white melon seed flour

Foaming capacity (%)	Emulsion capacity (%)	Oil absorption capacity (%)	Water absorption capacity (%)	Bulk density (g/ml)
0.03	60.50	34.10	18.60	1.62

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The emulsion capacity of the local white melon seed flour is 60.50 %, which is higher than the value recorded by Olaofe et al. (2009) for calabash seed flour (a type of melon) with 23.20 % as the emulsion capacity. Geographical region difference coupled with alteration in climate condition could be the cause of the variation of the results. The oil absorption capacity is 34.10 %, which is close to the value submitted by Olorode et al. (2014) who reported a value of 39.05 % as the oil absorption capacity of melon seed flour. It implies that the seed flour could serve as a good aroma agent, flavour retainer and be used to improve mouth feels of food. The bulk density is 1.62 g/ml. It is higher than the value submitted by Fagbemi et al. (2006) who reported a bulk density of 0.42 g/ml for fluted pumpkin. The difference could be due to the veritable difference among the species investigated. The water absorption capacity is 18.60 %. The result shows that the flour might be useful in confectionary products where hydration to improve handling is desired (Mepha et al., 2007).

Table 2 shows that the moisture content of the local white melon is 1.70 %. Sanful et al. (2013) pointed out that the higher the amount of moisture in a flour, the higher the rate of spoilage. It implies that the local white melon that has a low moisture content might have a long shelf life, which is a desirable advantage of product stability when packaged and stored properly. The protein content is 32.55 %, which is within the range reported by Fokou et al. (2004). The high protein value indicates that it could be used as food.

Table 2: Proximate composition of white melon seed flour

Carbohydrate (%)	Protein (%)	Moisture (%)	Fat (%)	Crude Fibre (%)	Ash (%)
58.43	32.55	1.70	29.00	6.15	0.85

The crude fibre content is 6.15 %, which is higher than the values (1.66 – 2.16 %) reported by Abiodun and Adeleke (2010) for different varieties of melon seed flour, probably due to variety and climate condition differences. The high crude fibre content implies that the seed flour contains indigestible materials, which can reduce constipation by increasing bowl movement. The fat content is 29.00 %, which is within the range submitted by Mabalaha et al. (2007) who reported fat content value range of 24.80 – 30.00 % for melon seed flours. The result shows that the local white seed flour is a good source of dietary oil. The ash content is 0.85 %, which is lower than the value (2.81 – 5.00 %) recorded by Fokou et al. (2004). The carbohydrate content is 58.43 %. Although it is not a wonderful source of carbohydrate relative to cereals with carbohydrate range of 72 – 90 % (Adewusi et al., 1995), it could serve as an alternative in a cereal scarce area.

Table 3 shows a flavonoid content of 3.13 %. It is higher than flavonoid content of 1.00 % for African eleme pulp reported by Ekoh (2009). It implies that the flour is a good source of flavonoid, which helps protect blood vessels from rupture or leakage. The saponin content is 4.88 %. The flour could be a good source of saponin for the treatment of hyper calcium in hum (Shi et al., 2004). The alkaloid content is 5.90 %. Food with high content of alkaloid has negative effect on humanity (Kalu et al., 2011; Gemede and Ratta, 2014); it should be cooked very well to reduce the alkaloid content before consumption. The carotenoid content is 1.80 %. The result suggests that the local white flour could lower the risk of cardiovascular disease since it has some carotenoid content (Schunemann et al., 2002).

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Table 3: Phytochemical composition of white melon seed flour

Flavonoid (%)	Saponin (%)	Carotenoid (%)	Alkaloids (%)
3.13	4.88	1.80	5.90

4. Conclusion

The outcome of the functional properties of the local Nigerian white melon seed flour shows that the flour could be used in soup making and infant food formulation. The presence of phytochemicals in the flour indicates that the flour has disease preventive and curative properties. The nutritional composition of the flour shows that the flour is a good source of energy, protein, fat and carbohydrate. It is suggested that research be conducted on the properties of other species of local Nigerian melon in the future.

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*Corresponding author.
E-mail address: paokorie@ yahoo.com