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Chemical and Physicochemical Properties of Moringa Flours and Oil

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Abstract - This work evaluates the chemical and physic-chemical properties of moringa seed flour and oil. The moringa seed were divided into two portions. The first portion was milled into flout while the second portion was defatted using soxlet extraction method. The moringa cake was milled into flour. Proximate, mineral, anti-nutritional compositions were carried out on the flour samples while the physico-chemical properties of the oil were evaluated. The moisture content of the moringa seed cake was slightly higher than that of raw moringa flour. It ranged from 4.70-5.03% . The moringa seed cake also had higher values in the ash, crude fibre, protein and carbohydrate contents. The undefatted moringa seed flour had higher fat content of 45.84 %. Moringa cake flour had higher values in all the mineral contents determined. The phytate, oxalate and tannin contents of the defatted moringa seed flour were higher than the undefatted flour. Acid, peroxide and saponification values were 7.09 mg/g, 5.96 Meq/kg and 80.31 mg/g respectively. The lower iodine value signifies low degree of unsaturation and the lesser the liability of the oil to become rancid by oxidation. The defatted cake could be used in fortification of other food materials.

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Chemical and Physicochemical Properties of Moringa Flours and Oil

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Abstract - This work evaluates the chemical and physic-chemical properties of moringa seed flour and oil. The moringa seed were divided into two portions. The first portion was milled into flout while the second portion was defatted using soxlet extraction method. The moringa cake was milled into flour. Proximate, mineral, anti-nutritional compositions were carried out on the flour samples while the physico-chemical properties of the oil were evaluated. The moisture content of the moringa seed cake was slightly higher than that of raw moringa flour. It ranged from 4.70-5.03% . The moringa seed cake also had higher values in the ash, crude fibre, protein and carbohydrate contents. The undefatted moringa seed flour had higher fat content of 45.84 %. Moringa cake flour had higher values in all the mineral contents determined. The phytate, oxalate and tannin contents of the defatted moringa seed flour were higher than the undefatted flour. Acid, peroxide and saponification values were **7.09 mg/g, 5.96 Meq/kg** and **80.31 mg/g** respectively. The lower iodine value signifies low degree of unsaturation and the lesser the liability of the oil to become rancid by oxidation. The defatted cake could be used in fortification of other food materials.

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I. Introduction

Moringa oleifera Lam belongs to a single genus family Moringaceae which has fourteen species (Morton, 1991). It is commonly called ben oil tree and locally known as Zogeli among the Hausa speaking people of Nigeria. It is grown and widely cultivated in the northern part of Nigeria and many countries in tropical Africa (Anjorin et al., 2010). The tree is rather slender, with drooping branches that grow to approximately 10m in height. In cultivation, it is often cut back annually to 1-2 meters and allowed to re grow so the pods and leaves remain within arm's reach. The leaves, fruits, flowers and immature pods of this tree are edible and they form a part of traditional diets in many countries of the tropics and sub-tropics (Siddhuraju & Becker, 2003). The plant seeds contain hypotensive activity, strong antioxidant activity and chelating property against arsenic toxicity (Arabshahi et al., 2007; Ghasi et al., 2000; Mehta et al., 2003; Santos et al., 2009). Seed flour from Moringa oleifera is widely used as a natural coagulant for water treatment in developing countries (Santos et al., 2005). It has an impressive range of medicinal uses with high nutritional value. Different parts of this plant contain a profile of important minerals, and are a good source of protein, vitamins, beta-carotene, amino acids and various phenolics (Anwar et al., 2007). Mature seeds yield 38–40% edible oil called ben oil from its high concentration of behenic acid. The refined oil is clear, odorless and resists rancidity. The seeds oil can also be used as a natural source of behenic acid, which has been used as an oil structuring and solidifying agent in margarine, shortening, and foods containing semi-solid and solid fats, eliminating the need to hydrogenate the oil (Foidl et al., 2001).The seed cake remaining after oil extraction may be used as a fertilizer (Rashid et al., 2008). In developing countries, moringa has potential to improve nutrition, boost food security, foster rural development, and support sustainable land care (National Research Council, 2006). Moringa seed had been known to combat malnutrition in infant and nursing mothers. Despite the usefulness and nutritional value, the seeds are still among the lesser known crop and are under-utilized. There are limited information on the chemical, anti-nutritional contents of the flour and characterization of the oil extracted from the seeds. Therefore, this work evaluates the chemical and physico-chemical properties of moringa seed flour and oil.

II. Materials and Methods

a) Materials

Moringa seeds were collected from Ministry of Agriculture, Ibadan, Oyo State. The seeds were dried and divided into two portions. Portion A was milled into flour while the oil was extracted from portion B. The defatted moringa seed cake were milled into flour.

b) Proximate composition

The methods of the Association of Official Analytical Chemists (AOAC, 1990) were used for proximate analysis. Moringa flour samples (5 grams) was used for determination of moisture content by weighing in crucible and drying in oven at 105°C, until a constant weight was obtained. Determination of ash content was done by ashing at 550°C for 3h. The Kjeldah method was used to determine the protein content. The crude fibre content of the samples was determined by digestion method and the fat was done by Soxhlet extraction method. All determinations were done in triplicate.

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c) Mineral contents

Flour sample (0.5 g) was weighed into a clean ceramic crucible. A blank was prepared with empty crucible. The crucible was placed in a muffle furnace at 500 oC for 4 hr. The sample was allowed to cool down in the oven after which it was removed carefully. The ashed sample was poured into already labeled 50 ml centrifuge tube. The crucible was rinsed with 5 ml of distilled water into the centrifuge tube. The crucible was rinsed again with 5 ml of aqua regia. This was repeated to make a total volume of 20 ml. The sample was mixed properly and centrifuged (IEC Centra GP8) for 10 min at 301.86 g. The supernatant was decanted into clean vials for mineral determination. The absorbance was read on atomic absorption spectrophotometer (Buck Scientific Model 200A) at different wavelength for each mineral element (Zn-213.9 nm, Ca-422.7nm, Fe-248.3 nm, Mg-285.2 nm, Mn-279.5 nm, Na-589 nm and K-766.5 nm) (Novozamsky et al., 1983).

d) Tannin determination

Milled samples (200 g) was extracted in 10 ml 70% aqueous acetone for 2 hours at 30°C in a water bath. A Gallenkamp orbital shaker at 120 rpm was used. Diethyl ether containing 1% acetic acid was used to extract the fats and the pigments in the sample. Tannin was then determined as total phenols in 0.05 ml aliquot in test-tubes by the addition of distilled water to 1ml mark and the addition of 0.5 ml Folin Ciocalteau reagent (Sigma) and 2.5 ml sodium carbonate. The absorbance of the solution was measured at 725 nm after 40 minutes using the method of Makkar and Goodchild (1995). The tannin equivalent in the form of phenol will be calculated from a standard curve.

e) Phytate determination

The phytin content was quantified by adding 8 g of the milled sample soaked into 200 ml of 2% HCl and allowed to stand for 3 hours. The extract was filtered through a double layer filter paper and 50 ml of the duplicate samples of the filtrate was pipette into 400 ml beaker. Ammonium thiocyanate (0.3%w/v) (10 ml) was used as an indicator and distilled water (107 ml) was added to obtain a pH of 4.5. Ferrous chloride solution containing 0.00195 gm Fe/ml was titrated against the solution of the tests samples until a brownish yellow colouration persisted for 5 minutes. Phytin phosphorous was determined using the relationship that each milligram of iron is equivalent to 1.19 mg of phytin phosphorous. The phytin content was calculated by multiplying by a factor of 3.55 according to Dairo, (2008).

f) Oxalate determination

Oxalate content was determined using the method of Nwinuka et al. (2005). The flour sample (1.0 g) was extracted thrice by warming (40°C - 50°C) and stirring with a magnetic stirrer for 1 h with 20 ml of 0.3 N HCl. The combined extracts was diluted to 100 ml with water and used for the total oxalate estimation. About 5 ml of each extract was made alkaline with 1ml of 5 N NH_4OH. This was then made acidic with glacial acetic acid and phenolphthalein indicator (2 to 3 drops) was added, excess decolourizes. Then, 1 ml of 5% calcium chloride was added and the mixture was allowed to stand for 3 h after which it was centrifuged (IEC Centra GP8) at 140.868 g for 15 minutes. The supernatant was discarded while the precipitate was washed thrice with hot water, with thorough mixing and centrifuging each time. Then, to each tube, 2 ml of 3 N H_2SO_4 was added and the precipitate was dissolved by warming in a water bath at 70°C - 80°C for 30 min. The content of each tube was titrated with freshly prepared 0.01N potassium permanganate solution. Titration was done at room temperature (29°C) until the first pink colour appeared throughout the solution. The solution was allowed to stand until it was colourless. It was warmed to 70°C - 80 °C and titration continued until a pink colour persisted for at least 30 s.

$$\% \text{ Oxalate content} = \frac{W \times 100}{5}$$

W = Mass of oxalate in 100 ml of extract

g) Physico-chemical properties of the oil

The oils were extracted using Soxhlet extractor and the physico-chemical properties (saponification value, acid value, peroxide value, smoke point, iodine value and free fatty acid).of the oil were carried out using the method described by AOAC (1990).

h) Statistical analysis

All analyses were carried out in triplicates. The mean and standard deviation of the data obtained were calculated.

III. Results and Discussion

The results of the proximate composition of moringa flour and moringa cake flour are shown in Table 1. The moisture content of the moringa seed cake was slightly higher than that of raw moringa flour. It ranged from 4.70-5.03% with the defatted flour having the highest value. This may be as a result of the oil that was displaced in the moringa seed cake. The moisture contents of the two flour samples were higher than the values reported for baobab seed flour (4.20%) (Adubiaro et al 2011) and lower than bambara nut flour (10.54 %) reported by Abiodun and Adepeju (2011).

Table 1: Proximate composition of moringa flours.

Parameter	Moringa flour	Moringa cake flour
Moisture content (%)	4.70 ± 0.05	5.03 ± 0.10
Ash content (%)	4.10 ± 0.14	10.00 ± 0.21
Crude fibre content (%)	7.73 ± 0.35	12.96 ± 0.40
Crude fat content (%)	45.84 ± 0.17	3.06 ± 0.11
Crude protein content (%)	28.04 ± 0.67	50.80 ± 0.45
Carbohydrate content (%)	10.59 ± 0.22	18.15± 0.22

Mean ± Standard deviation (n=3)

The moringa seed cake had higher values in the ash, crude fibre, protein and carbohydrate contents. The higher values were also as a result of the displacement of oil from the seed flour thereby increasing other parameters. These values were higher than the values observed by Anwar et al., (2006) for moringa flour. The high protein content of these flour samples give an indication of their usefulness in human diet and as livestock feed. The undefatted moringa seed flour had higher fat content of 45.84 %. The value was higher than the value (42%) reported by Ogunsina et al., (2011) and 30.36-35.20% by Anwar et al., (2006) for moringa seed flour. The fat content was also higher than the values reported for melon seeds (17.36-25.06%) reported by Ebuchi and Avwobobe (2006) and (24.8 to 30.0%) for Citrillus lanatus and C. colocynth species respectively (Mabaleha et al 2007). The moringa seed oil was within the range 41.0-56.6% recorded by Madaan and Lai (1984). The variation in values may be due to method of analysis and species and climatic conditions.

Table 2 : Mineral composition (mg/kg) of moringa seeds flours.

Parameters	Moringa flour	Moringa cake flour
Na	155.00 ± 0.11	184.10 ±0.20
K	479.00 ± 0.54	570.30 ± 0.48
Mg	220.10 ± 0.23	258.10 ± 0.17
Ca	203.85 ± 0.61	249.85 ± 0.44
Fe	31.03 ± 0.12	37.32 ± 0.19
Zn	8.08 ± 0.33	12.09 ± 0.45
Mn	3.00 ± 0.16	4.48 ± 0.20

Mean ± Standard deviation (n=3)

The mineral analysis is presented in Table 2. Moringa cake flour had higher values in all the mineral contents determined. Nzikou et al. (2009) reported calcium, magnesium, potassium and sodium values of 83.75 mg /100 g; 251 mg /100 g; 36.53 mg /100 g and 22.5 mg /100g, respectively. The Na content was higher than the value (8.42 mg/100g) reported by Adubiaro et al. (2011) for baobab seed while the Ca, K, Fe and Mg contents were higher than that of moringa seeds. Mn and Zn in moringa flour samples were lower than the values observed by Compaoré et al. (2011) for seeds. Differences observed between results can be attributed to geographical, soil composition, cultivation climate, ripening stage, the harvesting time of the seeds and the extraction method used Compaoré et al. (2011). Minerals are required for normal growth, activities of muscles and skeletal development, cellular activity and oxygen transport, chemical reaction in the body and intestinal absorption, fluid balance and nerve transmission, as well as the regulation of acid-base balance (Ogbe and Affiku, 2011).

The antinutritional composition is shown in Table 3. The phytate, oxalate and tannin contents of the defatted moringa seed flour were higher than the undefatted flour. The levels of phytate and tannin were low when compared to the values reported for moringa seed leaves (Ogbe and Affiku, 2011). Oxalate content observed in moringa seed flour samples were higher than that reported for moringa leaves as reported by Ogbe and Affiku, (2011).

Table 3 : Anti-nutritional contents (mg/kg) of moringa seeds flours.

Parameters	Moringa flour	Moringa cake flour
Phytate (mg/g)	0.59± 0.10	1.49 ± 0.15
Oxalate (mg/g)	4.12 ± 0.04	5.31± 0.08
Tannin (mg/g)	0.13± 0.20	0.45 ± 0.17

Mean ± Standard deviation (n=3)

Table 4 showed the physico-chemical properties of moringa seeds oil. Acid value was 7.09(mg/g). The acid value was higher than the Codex standard value for virgin vegetable oils. The peroxide value was 15.96 Meq/kg. The value was higher than the codex standard value (10Meq/kg) for refined vegetable oil and lower than the maximum value (20Meq/kg) allowed for unrefined olive oil (FAO/WHO, 1993). This implies that the moringa seeds oil have lower degree of rancidity. Also, iodine value was very low when compared to oil from other oil seeds. Mabaleha et al., (2007) reported iodine values of 95.8 Wijs in Tsama melon and 124.0 Wijs in Desert melon. The lower iodine value signifies low degree of unsaturation and the lesser the liability of the oil to become rancid by oxidation. The saponification value (180.31 mg/g) was low when compared with the values recorded for moringa oil (190.4-191.2 mgKOH/g) (Ogundina et al., 2011), soyabean, Peanut and cotton seed oil (Codex, 1993). The lower the saponification value of an oil the lower the lauric acid content of that oil. The lauric acid content and the saponification value of anoil serve as important parameters in determining the suitability of an oil in soap making (Asuquo et al., 2010). The refractive index at 25 °C (1.47) and specific gravity (0.91) were slightly lower than the values obtained for shea butter oil. The refractive index of moringa oil was slightly higher than the value reported by Anwar and Rashid (2007) at 40°C. Both the refractive index and specific gravity of moringa seed oil were similar to that of palm oil and groundnut oil reported by Ebuchi et al (2006). The smoke point was 138.00°C. This value was low when compared with canola oil (220-230°C) (Przybylski et al., 2005). This provides a useful characterization of its suitability for frying.

Table 4 : Physicochemical properties of moringa seed oil.

Parameters	Moringa flour
Acid value (mg/g)	7.09 ± 0.21
Iodine value (g/100g)	55.02 ± 0.15
Peroxide value (Meq/kg)	15.96 ± 0.13
Saponification value (mg KOH/g)	180.31 ± 0.31
Refractive Index 25°C	1.47 ± 0.12
Specific gravity	0.91± 0.31
Smoke point °C	138.00 ±12

Mean ± Standard deviation (n=3)

IV. Conclusion

The analyses carried out on moringa seed flour showed that the seed is nutritious above an average seed that is being consumed in this part of the world. The defatted cake has more nutrients than the undefatted flour. Anti-nutrients in the flour are generally lower and these could be eliminated during processing. The flours are rich in mineral contents and physico-chemical parameter of the oil are comparable to other edible oil. Therefore, flour from moringa seeds could be employed in fortification of other food materials.

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