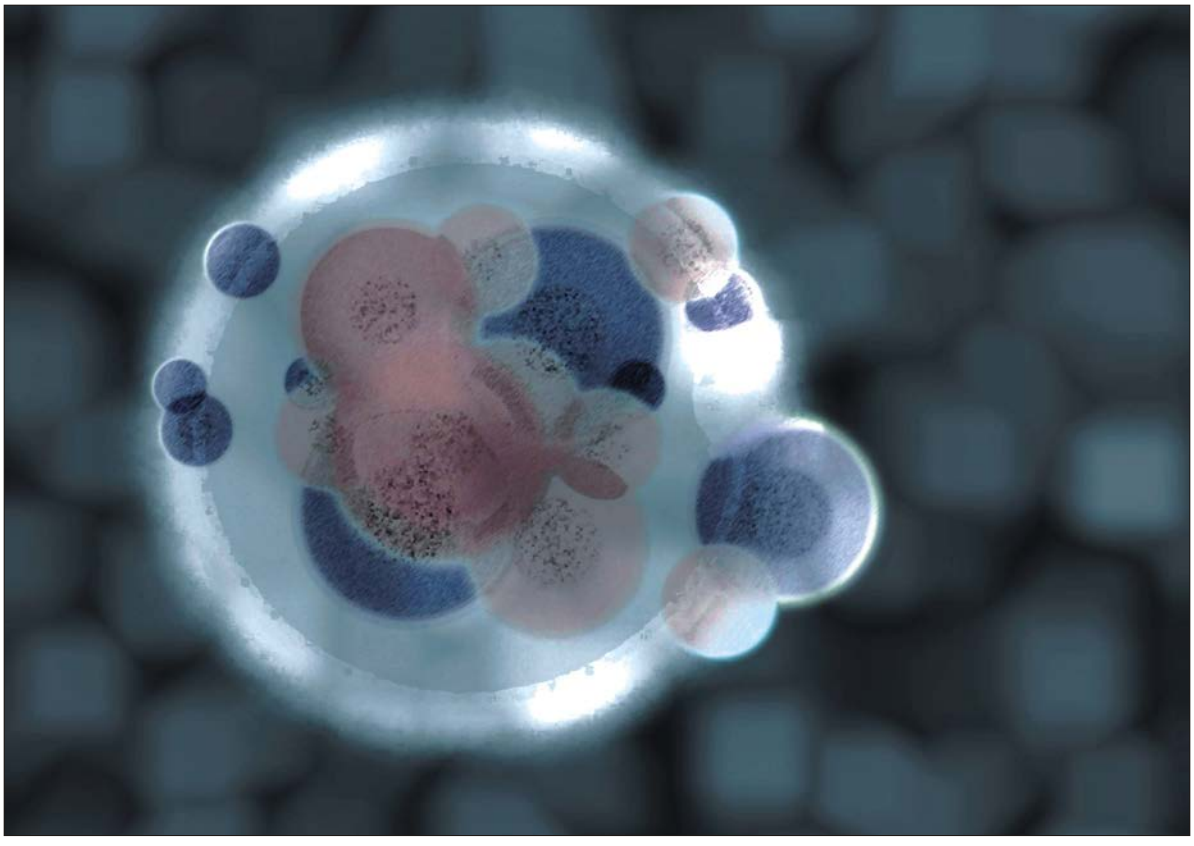

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Chemical Studies of the Seeds *of Moringa oleifera* (Lam) and *Detarium microcarpum* (Guill and Sperr)

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Abstract: The seeds of *Moringa oleifera* Lam (family: Moringaceae) and *Detarium microcarpum* Guill and Sperr (family: *Caesalpiniodeae*) were analysed for nutritional and antinutritional contents and chemical properties of the oils extracted from the seeds were also determined. The concentrations (mg g^{-1}) of the essential elements, potassium, calcium, magnesium, sodium, sulphur, phosphorus and iron were 77.4, 20.50, 1.19, 2.999, 3.75, 1.365 and 1.4, respectively for *M. oleifera* and 105.00, 23.0, 0.22, 2.36,16.25, 1.25 and 3.12 for *D. microcarpum*, respectively. *Moringa oleifera* contained higher amount of proteins and lipids (40.19 and 41.58%, respectively) than in *D. microcarpum* that contained 11.24 and 35.94% of protein and lipids, respectively. The amount of carbohydrate was highest in *Detarium microcarpum* (42.20%) than *M. oleifera* (9.11%). *Moringa oleifera* contained higher concentration of phytate (10.18 mg/100 g), hydrogen cyanide (0.58 mg/100 g) and saponin (2.052%) than *D. microcarpum.* The iodine values of the oils in *M. oleifera* and *D. microcarpum* were 59.48 and 58.02, respectively. Saponification values were in the range of 179-220.66. The acid value, free fatty acid and peroxide values were low (less than 9.0). The ester values of the oils ranged from 173.57-212.54. The high elemental composition, protein, lipid and carbohydrate contents of the seeds suggests that they could serve as supplementary sources of essential nutrients to man and livestock, provided the anti-nutritional content of the seeds are considerably reduced or eliminated.

Key words: *Moringa oleifera*, *Detarium microcarpum*, oils, nutritional and anti-nutritional factors

INTRODUCTION

Moringa oleifera belongs to a monogeneric family of shrubs and trees, moringaceae[1]. The tree originated from Agra and Oudh in Northwestern region of India, south of the Himalayan Mountain. The tree has spread to almost all tropical belt because it is a drought resistance[2]. According to Odee[3], the leaves, fruits, flowers and immature pods are edible and they form part of traditional diets in many countries of the tropics and sub-tropics. The oil obtained from the seeds is pale yellow, sweet and edible. It is almost odourless and possesses a bland appreciable test[4]. *Detarium microcarpum* belongs to the family *Caesalpiniodeae* and it is found mostly in savannah forest of the drier type[1]. The fruit is edible, the kernels are deep purple brown and more or less oily and also edible[2].

In most developing countries like Nigeria, food shortage is becoming evident as a result of population growth, competition for fertile land and poverty. In addition to these, restriction on the importation of certain foods, up-surge in prices of available staples, unstable governmental policies on agriculture, lack of agricultural inputs, poor loan scheme and incentive are responsible for food shortage[5].

The diet of many rural and urban dwellers is deficient in protein and high in carbohydrates, the implication is high incidence of malnutrition and increase in dietary diseases; a situation in which children and especially pregnant and lactating women are most vulnerable[5]. While every measure is being taken by various levels of government to boost food production by conventional agriculture, a lot of interest is currently being focused on the possibilities of exploiting the vast numbers of less familiar plants resources of the wild[6]. Baumer[7] stated that many of such plants have been identified, but lack of data on their chemical composition has limited the prospect of their utilization. Many reports on some lesser known, unconventional seeds and fruits indicate that they could be good sources of nutrient for both man and livestock[8,9]. The present study, report the nutritional, anti-nutritional and some chemical studies of the oils of the seeds of the

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wild *Moringa oleifera* and *Detarium microcarpum* obtained in Zaria, Nigeria.

MATERIALS AND METHODS

The seeds were collected from villages around Samaru-Zaria, Kaduna State, Nigeria. The flowers, leaves, pods and seeds of the plants were identified at the Herbarium of the Department of Biological Sciences, Ahmadu Bello University, Zaria. The seeds were dried at 60°C in an air-circulated oven for 48 h, ground with porcelain mortar and pestle to fine particles and stored in screw-capped plastic containers.

Elemental analysis: Pellets of 19 mm diameter and weight 0.2843 g (*M. oleifera*) and 0.3150 g of *D. microcarpum*, were made from ash samples using three drops of an organic binder (10% solution of styropore in toluene). The pelletisation was done using a pressure of about 10 tons on a hydraulic press. The pellet were introduced into the x-ray fluorescence (XRF) generator (model SL12170) and analysed[10]. Measurements are performed using an annular 25 mCi ^{109}Cd as the excitation source, that emits Ag-K X-rays (22.1 keV) and ^{55}Fe that emits Mn-K X-rays (5.89 keV), in which case all elements with lower characteristic excitation energies are accessible for detection in the samples. The spectra for the samples are collected for 3000 s with the ^{109}Cd source and the spectra were then evaluated using the AXIL-QXAS program[11]. Sodium and magnesium were analysed by Atomic Absorption Spectrometer (Unicam 969 AAS), while sulphur and phosphorus were analysed by standard colorimetric procedures[12].

Proximate analysis: The samples were analyzed for proximate composition (crude fat, crude protein, soluble carbohydrate and crude fibre). The oils were extract with petroleum ether (40-60°C) using a soxhlet extractor for six hours. The micro Kjedhal procedure was adopted for the determination of protein while the Anthrone procedure was used for the determination of soluble carbohydrates[13,14].

Hydrogen cyanide determination: The alkaline titration procedure was adopted[13]. Ten gram of ground sample was soaked in a mixture containing 200 cm^3 of distilled water and 10 cm^3 of orthophosphoric acid. The mixture was left for 12 h to release bounded hydrocyamic acid. The mixture was then distilled until 150 cm^3 of the distillate was collected. 20 cm^3 of distillate was taken into a conical flask containing 40 cm^3 of distilled water. 8 cm^3 of 6 mol dm^{-3} Ammonium hydroxide and 2 cm^3 of 5% potassium iodide solutions were added. The mixture was titrated with 0.02 mol dm^{-3} silver nitrate until faint but permanent turbidity was obtained.

Phytate determination: The Reddy and Love[15] method was adopted. Four gram of each ground sample was soaked in 100 mL of 2% hydrochloric acid for 5 h and filtered. 25 cm^3 of the filtrate was placed in a conical flask and 5 cm^3 of 0.3% Ammonium thiocyanate solution was added. The mixture was titrated with standard iron (III) chloride solution until a brownish-yellow colour persisted for five minute.

Determination of tannins: Tannins were determined by the vanillin-HCl procedure, which was based on an acid-calatysed addition of vanillim to flavonols. These reactions are determined colorimetrically at 500 nm[16].

Determination saponins: Ten grams of the ground sample was mixed with 100 cm^3 of 20% aqueous ethanol in a beaker and agitated with a magnetic stirrer for 12 h at 55°C. The solution was filtered using Whatman No.1 filter paper, the residue was re-extracted with 200 cm^3 of 20% aqueous ethanol. The extracts were mixed and reduced to about 40 cm^3 under vacuum. The extract and 20 cm^3 diethyl ether were poured into a 250 cm^3 separating funnel and shaken vigorously. The aqueous layer was discarded. The process of purification continued until a colourless aqueous extract was obtained. The pH of the remaining aqueous solution was adjusted to 4.5 by adding 4 g of NaCl and the solution was then shaken successively with 60 and 30 cm^3 portions of n-butanol. The butanolic extract was washed twice with 10 cm^3 of 5% aqueous sodium chloride, then evaporated to dryness in a fume cupboard, to give the saponin which was weighed and expressed as percentage[17].

Chemical analysis of the oil: The oil extracted from the seeds were analysed for iodine number, acid value, free fatty acid, peroxide value, saponification value and ester value using standard procedure described by AOAC[13] and Pearson[14].

Statistical analysis: Means were compared using student t-test and the level of significant difference was determined at $p<0.05$[18].

RESULTS AND DISCUSSION

The result of elemental analysis (Table 1) showed that *D. microcarpum* contained higher amount of potassium (105.0 mg g^{-1}), calcium (23.0 mg g^{-1}),

Table 1: Essential elements of the seeds of *M. oleifera* and *D. Microcarpum* (concentration in mg g^{-1})

	Moringa oleifera	*Detarium microcarpum*
Potassium	77.40±2.4	105.00±2.99
Calcium	20.50±2.0	23.00±2.69
Magnesium	1.19±0.33	0.22±0.02
Sodium	2.99±0.07	2.38±0.27
Sulphur	3.75±0.004	16.25±0.02
Phosphorus	1.36±0.007	1.25±0.004
Iron	1.48±0.09	3.12±0.14

Table 2: Nutritional and anti-nutritional composition of the seeds of *M. oleifera* and *D. microcarpum*

	Moringa oleifera	*Detarium microcarpum*
Oil	41.58±0.32	11.24±0.09
Protein	40.31±0.94	35.94±0.06
Carbohydrate (%)	9.11±0.13	42.20±0.25
Crude fibre (%)	3.28±0.42	3.42±0.28
Phytate	10.18±0.46	5.57±0.03
Hydrogen cyanide (mg/100 g)	0.58±0.04	0.25±0.04
Tannins (%)	2.13±0.14	4.75±0.12
Saponins (%)	2.25±0.07	0.20±0.01

Values are mean±SE, Levels of significant (student t-test) $p<0.05$

sulphur (16.2 mg g^{-1}) and iron (3.12 mg g^{-1}); while *M. oleifera* contained higher amount of magnesium (1.19 mg g^{-1}), sodium (2.99 mg g^{-1}) and phosphorus (1.365 mg g^{-1}) than *D. microcarpum*. These elements are needed in significant quantities by the body. They form part of the rigid body structure, soft tissue and body fluids. According to Reddy and Love[15] these essential element are needed for growth, production of bones, teeth, hair, blood, nerves, skin, vitamins enzymes and hormones. The healthy functioning of nervous, transmission, blood circulation, fluid regulation, cellular integrity, energy production and muscle contraction are influence by essential elements and too little of any essential element can lead to deficiency disease and too much of any can be toxic[19].

The oil content of *M. oleifera* was higher (41.58%) than that of *D. microcarpum* (11.24%) (Table 2). There was significant difference ($p<0.05$) in the oil content of these plants. The low oil content of *D. microcarpum* relegates it as a source of oil commercially. According to Dreon *et al.*[20], lipids are essential because they provide the body with maximum energy, approximately twice that for an equal amount of protein or carbohydrate. In addition, lipids facilitate intestinal absorption and transport of fat-soluble vitamins A, D, E and K[6].

The protein content of *M. oleifera* was higher (40.31%) than that of *D. microcarpum* (35.94%). This appreciable protein content of the seeds establishes it as a supplement to other plant protein because it compares favourably with protein content of soya beans (*Glycine max*) 51.4% and groundnut (*Arachis hypogaea*) 51.3%[4]. A significant difference ($p<0.05$) was observed in the protein content of these seeds. Protein deficiency causes growth retardation, muscle wasting, edema, abnormal swelling of the belly and collection of fluids in the body[21].

The carbohydrate content of *D. microcarpum* was 42.20% while *M. oleifera* had 9.11%. There was a significant difference ($p<0.05$) in the carbohydrate composition of these seeds. Barker[22] stressed that carbohydrate deficiency causes depletion of body tissue. Fibre content of *M. oleifera* and *D. microcarpum* was 3.29 and 3.42%, respectively. It was observed that there was no significant difference in the fibre content of the seeds. Fibre diet promotes the wave-like contraction that move food through the intestine, high fibre food expand the inside walls of the colon, easing the passage of waste, thus making it an effective anti-constipation; it also lowers cholesterol level in the blood, reduces the risk of various cancers, bowel diseases and improve general health and well being[23].

Table 2 shows that the phytate content of *M. oleifera* (10.18 mg/100 g) was higher than that of *D. microcarpum* (5.57 mg/100 g). There was a significant difference ($p<0.05$) in the phytate composition of these seeds. According to Thompson[24] a phytate diet of 1-6% over a long period of time decreases bioavailabilty of minerals in monogastric animals. Similarly, Reddy *et al.*[25] and Erdman[26], stated that phytic acid bind to phosphorus and convert it to phytate, while other mineral elements like calcium, zinc, manganese, iron and magnesium are converted to the phytic complexes, which are indigestible substances, thereby decreasing the bioavailability of these elements for absorption. Phytic acid also have a negative effect on amino acid digestibility, thereby posing problem to non ruminant animals due to insufficient amount of intrinsic phytase necessary to hydrolyze the phytic acid complex[27,28].

Hydrogen cyanide composition of the seeds was low. *Moringa oleifera* had 0.58 mg/100 g while *D. microcarpum* had 0.25 mg/100 g. Significant difference was observed in HCN composition of the seed ($p<0.05$). According to Makkar and Becker[27] the FAO/WHO recommended safe limit of HCN for human consumption is 10 mg kg^{-1}. Jansz and Uluwaduge[29] reported that people eating food that contains low level of cyanide for a long time develops damage to the central nervous system and the thyroid gland, while Kamalu[30] stressed that it can lead to deafness, vision problems and loss of muscle co-ordination and that the effect on the thyroid gland causes cretinism (retarded physical and mental growth in children) or enlargement and over activity of the gland. Other effects of cyanide include, pancreatic diabetes, vitamin B12 deficiency and decrease in iodine uptake[27]. Liver inflammation and heamorrhage, kidney,

Table 3: Chemical properties of the oils *M. oleifera* and *D. microcarpum*

	Moringa oleifera	*Detarium microcarpum*
Iodine	59.48±0.22	58.03±0.22
Acid value	6.25±0.10	8.12±0.04
Free fatty acid	3.53±0.06	4.58±0.02
Peroxide value (mg kg^{-1})	2.35±0.01	2.18±0.01
Saponification value	179.75±0.47	220.66±0.62
Ester value	173.51±0.55	212.54±0.62

Values are mean±SE, Levels of significant (student t-test) $p<0.05$

adrenal, myocardial and testicular lesion have been observed in dogs that consumed cassava containing low concentrations of cyanide[31].

Higher tannin content was observed in *D. microcarpum* (4.75%) than in *M. oleifera* (2.13%). Though this considered as low in the seeds, but tannin in grains import an astringent taste that affect palatability, reduce food intake and consequently body growth[27]. Tannin has also been implicated as a binder to both exogenous and endogenous proteins, including enzymes of the digestive tract, thereby affecting the utilization of protein[16]. Studies on rats, chicks and livestock revealed that high tannin in diet adversely affects digestibility of proteins and carbohydrates, thereby reducing growth, feeding efficiency, metabolizable energy and bioavailability of amino acids[32,33].

The saponin content of *M. oleifera* and *D. microcarpum* were 2.25 and 0.20%, respectively. Student's t-test showed significant difference ($p<0.05$) in the saponin content of the seeds. The status of saponins in nutrition is devious while saponins causes gastroenteritis, manifested by diarrhoea and dysentery in man. On the other had, Oakenfull and Sidhu[34] reported that it reduces the body cholesterol by preventing its re-absorption, increasing its excretion, thereby reducing blood pressure. It is also suppresses rumen protozoa by reacting with cholesterol in the protozoan cell membrane, causing it to lyse.

The iodine values of the oils of *M. oleifer*a (59.48) and *D. microcarpum* (58.03) seeds were less than one hundred (Table 3). This implies that the oils are non-drying. Non-drying oils are slow to oxidation and remain as liquid for a long time; this is a useful property required in the soap, cosmetics, lubricants, leather (for dressing) and candle industries. These oils are also used in the manufacture of wool (especially carding), in making tin plate and in foundry works[35].

Detarium microcarpum had higher acid value (8.12) compared to *Moringa oleifera* (6.25) (Table 3). These values are lower than the minimum safe limit (15%) meant for consumption. These suggest that the oils have low deteriorating rate and can therefore be stored for relatively long period. Table 3 shows that *M. oleifera* and *D. microcarpum* had free fatty acid content values of 3.53 and 4.58, respectively. Free fatty acid values indicate the deteriorating conditions and edibility of oil. The obtained low values of free fatty acid content in oils of the seeds insinuate that they have low deteriorating rate and high edibility. High free fatty acid value is associated with high deteriorating rate and low edibility values resulting in the development of objectionable flavour and odour[35].

The peroxide values of the oil obtained from *M. oleifera* and *D. microcarpum* were 2.35 and 2.18, respectively (Table 3). According to Ekpa and Ekpe[35], peroxide value is an indication of the oxidation rancidity of oil. High peroxide values are associated with higher rate of rancidity. The low peroxide values of these oils indicate that they are less liable to oxidative rancidity at room temperature. *Detarium microcarpum* had higher saponification value (220.60) than *M. oleifera* (196.12). These results compared favourably with saponification values of palm oil (196-205), olive oil (185-196), soya bean oil (193), cottonseed (193-195), butter (220-233) and linseed oil (193-195)[7]. The high saponification value in the oil of *D. microcarpum* suggests that it contain high proportion of lower molecular weight of fatty acids. The ester value of *D. microcarpum* was higher (212.54) than that of *Moringa oleifera* (173.51). This is opined that high proportions of the glyceride are intact and that the oils are of appreciable quality.

This study confirms that the wild *M. oleifera* and *D. microcarpum* seeds of Zaria, Nigeria, are rich in nutrients and can serve as potential sources of food nutrient for man and livestock. The anti-nutritional levels of the seeds are generally low but further processing would reduce their concentration. The oils obtained from the seeds have low oxidative rancidity, a desired property in oils meant for consumption and industrial purposes.

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