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CHARACTERIZATION OF MORINGA (BEN) SEED OILGROWN IN EGYPT

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ABSTRACT

Ben (Moringa) is a sub tropical plant grown in upper Egypt and Sinai for many decades and the most known species are M. oleifera and M. peregrina. Nowadays, much attention was given to the nutritional value of Moringa plant and there is an increasing interest in spreading these species in the newly reclaimed land in an attempt to decrease the gap in oil production.

Results showed that the percentage of hulls to kernels and percentage of oil differed in the two tested species, being 45.65, 52.27% and 27.70, 42.58% of total seed weight of M. pregrina and M. oleifera, respectively. Total pigments, phenols, flavonoids, carotenoids and vitamin C content were determined using the colorimetric method in seeds (hulls and kernels) of both M. pregrina and M. oleifera.

Oil from the two species was extracted using four different methods; cold press (CP), solvent extraction using either n-hexane (H) or with a mixture of chloroform :methanol (50:50) (C:M) and water extract (W). Physical characteristics; density, specific gravity, and refractive index (at 25C) were determined. Chemical characteristics i.e. peroxide and iodine values, unsaponifiable matters, absorption at 232 nm and 268 nm and tocopherols (by HPLC) were also determined. Fatty acids profile of the extracted oils using four extraction methods were followed by GLC and their resistance toward oxidation at

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100°C was measured by Rancimat method. High resistance toward oxidative rancidity may be due to their fatty acids profile. The dominant unsaturated fatty acid was oleic acid and the dominant saturated fatty acids were Palmitic (C16:0) and Behenic (C22:0) acids. Major sterols determined by GlC showed high content of β-Sitosterol.

The two species of Moringa seed oils showed higher stability, than cotton seeds oil (CSD), lower degree of unsaturation and similar fatty acids profile (apart from C18:2, C18:3 and long chain fatty acids; C20:0, C22:0, C24:0) and physicochemical characteristics similar to that of olive oil. These suggested that Moringa seeds oil could be used as a valuable edible oil.

INTRODUCTION

The Moringaceae family consists of 10 species that belong to only one genus called *Moringa*. All *Moringa* species are native of India from where they have been introduced into many warm countries. The most common species are M. peregrina and M. oleifera and the best known and most widely distributed species is M. oleifera which is a native of the western and sub-Himalayan tract, (India) and other countries in Asia, Africa, Middle East and other warm climate places. In some parts of the world, M. oleifera is referred to as "drumstick tree" or the "horseradish tree", whereas in others is known as the "kelor tree" (Anwar et al. 2005). In River Nile valley, the tree is called "Shagarat al Rauwaq" which means "tree for purifying" (Von Maydell 1986). In Egypt M. oleifera have been grown for decades in Aswan and North Sinai and have been a subject for research to increase the cultivated land, M. peregrina also, is cultivated in other few places.

The tree height ranges from 5 to 10 m and sometimes 15 m. The tree grows rapidly even in poor soil and is little affected by drought. The leaves, flowers, fruits (which are called "pods") and roots of the tree are used as vegetables, while the trunk is used in paper industry. The fruits are usually 25 to 45 cm long and they contain about 20 seeds which are globular, about 1 cm in diameter, 3-winged with wings.

Characterization of Moringa seed oil

As a traditionally important food commodity, M. olerifera has been received much attention as a, "natural nutrition of the tropic". The leaves, flowers, fruits, and roots of this multipurpose tree are esteemed as a vegetable in Pakistan (Qaiser 1973 and Siddhuraju and Becker 2003). M. oleifera also has surprising medicinal attributes and is used in the treatment of ascites, rheumatism, venomous bites, and as a cardiac and circulatory stimulant (Dahot 1988). Moringa can rebuild weak bones, enrich anemic blood and enable a malnourished mother to nurse her starving baby. It has the calcium of four glasses of milk, vitamin C of seven oranges and potassium of 3 bananas (Ram 1994, Oliveira et al. 1999 and Samah 2008).

The seeds can be consumed either fresh as peas or roasted and eaten like peanuts, or pressed into sweet, non desiccating oil (ben oil) of high quality (Bianchini et al. 1981). This oil is used in art, salads, soap, smoke-free lamp fuel, and hairdressing; as a fine lubricant or purgative; and as a fixative for volatile odourous substances in perfumery. The seed presscake, which contain polypeptides have the ability to serve as natural coagulants for water treatment (Gassenschmidt et al. 1995).

Although over the years researchers showed interest in the composition of M. oleifera seeds and the extracted oil, known commercially as "ben oil" or "behen oil", little is known about the use of the seeds in the production of an edible oil. Ben oil has been used extensively in the enfleurage process, whereby delicate fragrances are extracted from flower petals (Anwar et al, 2005).

Ndabigengeser and Narasiah (1998) and Oliveria et al. (1999) described composition and nutritional attributes of Moringa seeds and suggested that these antipyretic, acrid, and bitter seeds could be used for purification of contaminated water. Somali et al (1984) also reported the chemical composition and characteristics of M. peregrina seed oil. Tsaknis et al. (1999) investigated M. oleifera seed oil (Mbololo variety) from Kenya and found that oil content varied from 25 to 35.7%, depending on extraction method. The oil was found to contain a high level of oleic acid (up to 75%), β-sitosterol (up to 50%), and different tocopherol isomers. Lalas and Tsaknis (2002) described

the M. oleifera seed oil variety Periyakulam-1 and compared the physical and chemical characteristics of oils by different methods with those of seed oil from the variety Mbololo. Lalas et. al. (2003) studied the characterization of different species of Moringa grown in Kokwa. Anwar et al. (2005) examined the interprovenance variation in the composition of M. oleifera oil seeds from Pakistan.

In Egypt, Ibrahim et al. (1974) was the first to investigate oil content and physicochemical characteristics of M. oleifera seed which was grown in small area (plants gardens either in Aswan or Giza governorate). The interest in further investigations began since Samah (2001) shed the light on the oil content and physicochemical properties, oxidative stability and fatty acid composition as one of the untraditional sources of high oleic acid oils grown in Egypt.

Physical characteristics and chemical composition of Moringa seeds and a full characterization of the extracted oil from the two common Moringa species grown in Egypt (M. oleifera and M. peregrine) using different extraction methods have not been reported. Therefore, the extracted oils were compared with extra virgin olive oil and cotton seed oil.

MATERIALS AND METHODS

Materials:

Seeds of M. oleifera were obtained from Desert Research Center, North Sinai station. Seeds of M. peregrina were purchased from local shops for herbs and spices. Extra virgin olive oil was also purchased from local market.

Methods:

Physical characteristics of Moringa seeds. A randomly 100 seeds from M. peregrina and M. oleifera were picked up, weighed and dehulled. Hulls and kernels percentages were calculated by weighing the separated hulls and kernels.

Characterization of Moringa seed oil

Chemical composition of Moringa seeds. Oil, moisture, fiber and ash content were determined according to the methods described by A.O.A.C. (2000).

Crude protein was determined by measuring total nitrogen following the method described by A.O.A.C. (2000) and calculated by multiplying total nitrogen value by 6.25 factor.

Carbohydrate content of seeds were calculated by difference [100-(M%+ Oil% + Crude protein + Fibre% + Ash%)].

Determination of antioxidants compounds

Vitamin C content. The most satisfactory chemical methods for estimating ascorbic acid based on the reduction of 2,6-dichlorophenol indophenol by ascorbic acid (A.O.A.C, 2000) was used.

Total Pigments. Chlorophyll-A, Chlorophyll-B and carotenoids were extracted from Moringa seeds (kernels and hulls) according to the methods of Fedtke (1973) by grinding dried samples in a mortar with 80% acetone in the presence of washed sand. The homogenate was centrifuged for 5 min at 5000 rpm. The supernatant was made up to a known volume with 80% acetone (50 ml). The optical density of the diluted supernatant was determined using UV-Visible spectrophotometer at 662 nm, 644 nm and 440 nm. The concentration of Chlorophyll-A, B total Chlorophyll and Carotenoids were calculated by means of Wettstein's formula (Wettstian, 1957).

Total Phenols. were determined calorimetrically as described by Daniel and George (1957). Sample (5 g) was mixed with 50 ml methanol in a dark bottle at 5C for 72. Three methanol extracts were obtained by changing the methanol every 24. The extracts were combined after filtration and made up to a known volume with methanol (50 ml) and the color was developed by Folin-Coacullus reagent and determined at 730 nm.

Total Flavonoids. Flavonoids were determined according to the methods of Snell and Snell (1954). The flavonoids ethanol extract were estimated with aluminum chloride reagent. Five ml of extract were added in test tube then 3 ml (ALCL3, 2.4%) and potassium acetate (9.8%) were added. After 5 min, the yellow color was

measured at 420 nm against a blank reagent. Pure Rutin (flavonal glycosides) served as standard compound was used for preparing the calibration curve.

Oil Extraction:

After removal of seed coat, seeds of M. peregrina and M. oleifera were ground and divided into four portions and the oil was extracted by cold press (CP), extraction using 2 solvents; hexane and a mixture of chloroform : methanol (50:50) and the use of boiling water.

Cold press extraction: was carried out by pressing ground Moringa seeds using Carver hydraulic press.

Solvent extraction: seeds were soaked in hexane and mixture of chloroform : methanol over night and solvent were collected and evaporated under vacuum. Oil was collected and dried over anhydrous sodium sulphate and packed in brown bottle and kept at -4C till analysis.

Water extraction, ground seeds were boiled in hot water 1:5 w/v for 5 min and filter using filter paper, Watman No. 1. The filtrate was cooled at room temperature for over night and oil was separated using separator funnel. Oil was collected and dried over anhydrous sodium sulphate and packed in brown bottle and kept at -4C till analysis.

Physical and chemical characteristics of the extracted oils:

Refractive index at 25C, density at 25C, specific gravity and smoke point were determined according to the A.O.C.S. (1998). Acid, peroxide, iodine and saponification values were also determined according to the methods described by A.O.C.S. (1998) compared to those of extra virgin olive oil and cotton seed oil.

The susceptibility to oxidation with the Rancimat method:

Five grams of extracted oils from the two Moringa species and olive oil were accurately weighed into each of the six reaction vessels, and the following procedure was carried out according to the method described by Tsakins et al, (1999). The Metrohm Rancimat 679 was switched on until the temperature of the oil reached 100C. Then 60 ml distilled water was placed into each of the six conductivity cells, and the airflow was set at 20L/h. The temperature was checked to ensure that it had a constant value. The air supply was connected to the tubes

containing the oils samples, and the chart recorder was started. The determination continued automatically until conductivity reached its maximum value and the induction period was recorded.

Tocopherol content:

Tocopherol content of all extracted oils were determined using High Performance Liquid Chromatography (HPLC) according to the method described by A.O.C.S. (1998)

Sterols composition:

The identification and determination of sterols for the extracted oils were determined using gas-liquid chromatography according to the method described by Stahel (1967).

Fatty acid composition:

Fatty acids composition for all extracted oils and olive oil were determined using gas-liquid chromatography according to the method described by Stahel (1967).

RESULTS AND DISCUSSION

Physical characteristics and chemical composition of Moringa seeds

Physical characteristics of the two species of Moringa seed; peregrina (MP) and oleifera (MO) were studied and the results are shown in Table 1. The data showed a big differences between the two species. The weight of 100 seed was 60.00 g and 24.60 g in case of MP and MO, respectively. Kernels represented 54.35% in case of MP while, it represented 72.30% of total seed weight for MO. Consequently, hulls represented 45.65% in case of MP, while it represented only 27.70% of total seed weight in case of MO. Chemical composition also differed; oil, moisture, protein, carbohydrates, fiber and ash content were 52.27, 2.77, 22.20, 16.60, 3.70 and 2.46%, respectively for MP and 42.58, 6.18, 21.80, 23.71, 2.85 and 2.88, respectively for MO.

Oil content of MO (42.58%) was considerably higher than those reported for M. oleifera seeds from Kenya (Tsaknis et al. 1999), India (Lalas and Tsaknis, 2002) and Pakistan (Anwar et al. 2005) (35.70, 38.3, 33.23-4090%, respectively).

Also, oil content of M. peregrina (52.27%) was higher than that reported for MP seeds from Saudi Arabia (Al-Kahtani and Abou-Arab

1993 and Tsaknis 1998). Chemical composition of Moringa seeds is in accordance with those reported by Somali et al. (1984) and Al-Hussain and Al-Othman (2003) for MP, whereas Anwar et al. (2005) reported almost the same protein, moisture and oil contents of MO grown in Sindh, Pakistan.

Table 1: Physical characteristics and chemical composition of Moringa peregrina and Moringa oleifera seeds*

Characteristics	*M. peregrina*	*M. oleifera*
Weight of 100 seeds (g)	60.00	24.60
Kerenls %	54.35	72.30
Hulls %	45.65	27.70
Oil %	52.27	42.58
Moisture %	2.77	6.18
Protein %	22.20	21.80
Carbohydrate %	16.60	23.71
Fiber %	3.70	2.85
Ash %	2.46	2.88

*Values are means of duplicate determinations.

Antioxidant constitute of Moringa seeds:

Lipid peroxidation is a critical problem as it affects food quality and stability (Samah and Mohamed 2002). Antioxidants are utilized to prevent or to delay the oxidation. Because of the hazard effects of synthetic antioxidants, scientists allover the world are seeking and searching for new sources of natural antioxidants.

Moringa seeds were investigated after dehulled (kernels and hulls) for their content of antioxidant compounds and results are shown in Table 2. MP kernels are rich in the compounds that have been considered as natural antioxidants like total flavonoids, total phenols and vitamin C and constituted 691.94 mg/100g as rutin, 480.00 mg/100g as tannic acid and 100.80 mg/100g ascorbic acid, respectively. It also contained total chlorophyll (0.3467 mg/g) and

carotenoids (0.1188 mg/g), compared with MO kernels which contained 180.64 mg flavonoids/100g as rutin, 290.00 mg phenols/100g as tannic acid and 57.60 mg vitamin C /100g as ascorbic acid. It also contained 0.3508 mg total chlorophyll and 0.1631 mg carotenoids. While Moringa hulls were rich in vitamin C, they contained 86.40, 105.60 mg/100g ascorbic acid for MP and MO hulls, respectively.

Table 2: Antioxidant consitute of Moringa peregrina and Moringa oleifera seeds*

Antioxidant compounds	*M. peregrina*		*M. oleifera*	
	Kerenls	Hulls	Kerenls	Hulls
Flavonoids (mg/100g as rutin)	691.94	16.71	180.64	10.96
Phenols (mg/100g as tannic acid)	480.00	38.00	290.00	90.00
Chlorophyll (mg/g)	0.3467	0.2379	0.3508	0.4836
Carotenoids (mg/g)	0.1188	0.2138	0.1631	0.2706
Vitamin C (mg/100g ascorbic acid)	100.80	86.40	57.60	105.60

*Values are means of duplicate determinations.

Physical characteristics of the extracted oils:

Physicochemical characteristics of the extracted oils were determined compared with those of extra virgin olive oil (OO) and cottonseed oil (CSO) (data were obtained from previous investigations; Mohamed et al., 2001 and Samah and Fyka 2002) Results in Table 3 show that refractive index, density, specific gravity for all extracted oils were slightly higher than those of olive oil and cotton seed oil. Meanwhile, smoke point of oils, depends on the extracted technique and the specie of Moringa seeds, can be higher; with oils extracted by cold press (CP) and hexane (H), or equal with oils extracted by chloroform:methanol (C:M) or lower with oils extracted by water extraction (W) than smoke point of OO and CSO. Oils extracted by boiling water had the lowest smoke point and this may be attribute to the increase in the rate of triacylglycerol hydrolysis as a result of long contact of seeds and oil with water during the

extraction process resulting in the increase of free fatty acids (Table 4) and that brought a considerable decrease in smoke point.

Table 3: Physical characteristics of oils extracted* from Moringa Seeds, extra virgin olive and cottonseed oils**

Samples / Parameters	CP		H		C:M		W		Olive oil	CSO***
	MP	MO	MP	MO	MP	MO	MP	MO		
Density (g/cm) (25°C)	0.9530	0.9620	0.9250	0.9470	0.9540	0.9630	0.9380	0.9580	0.9190	--
Specific gravity	0.9033	0.9125	0.8768	0.8974	0.9043	0.9134	0.8883	0.9353	0.8693	--
Refractive index (25°C)	1.4628	1.4660	1.4634	1.4659	1.4630	1.4661	1.4629	1.4663	1.4620	1.4721
Smoke point (°C)	210	213	208	210	200	203	198	200	208	220

* Oils were extracted using cold press (CP), Hexane (H), Chloroform : methanol (C:M) and water extraction (W) techniques

** Moringa peregrina (MP), Moringa oleifera (MO)

*** Data were obtained from Samah and Fyka (2002)

Values are means of duplicate determinations

Chemical characteristics of the extracted oils:

Results in Table 4 show that, Moringa peregrina had higher acid and peroxide values and lower oxidative stability than M. oleifera regardless the method of oil extraction. This can be attributed to that MP seeds were stored in local shops at unproperate storage conditions, under high temperature and level of humidity (not vandalized place) whereas MO were brought from it place of origin after harvesting.

Table 4 also shows that, acid value (as oleic acid) of the extracted oils was higher or equal, depends on the method of extraction and specie of Moringa seeds, than extra virgin olive oil and cottonseed oil. Oils extracted by water extraction had the highest acid and peroxide values possibly due to the long contact with boiling water under the normal atmosphere and high temperature than the other methods and that also explained the low oxidative stability at 100°C than the other

extracted oils and cottonseed oil had the lowest oxidative stability (5.73 hr) among the other tested oils.

Table 4: Chemical characteristics of oils extracted* from Moringa seeds, extra virgin olive and cottonseed oils**

Samples / Parameters	CP		H		C:M		W		Olive oil	CSO***
	MP	MO	MP	MO	MP	MO	MP	MO		
AV as oleic acid	1.01	0.71	1.70	0.81	1.88	0.70	2.01	1.10	0.70	0.16
PV meq/kg oil	0.39	0.00	0.71	0.00	0.83	0.00	0.98	0.08	2.88	3.13
IVgI/100g oil	82.89	82.98	82.98	82.82	82.69	82.49	82.58	82.89	95.83	105.0
SVmgKOH/g oil	188.09	183.40	186.79	186.47	184.37	188.58	186.17	189.01	190.83	--
UNSAP%	1.43	0.60	1.55	0.45	1.48	0.49	1.52	0.58	0.98	--
E232 nm	1.404	1.231	1.504	1.560	1.648	1.681	1.807	1.707	2.00	--
E268 nm	0.485	0.036	1.617	0.076	0.703	0.065	0.763	0.081	0.15	--
Stabilityat 100°C	120.00	199.80	118.26	198.80	115.98	193.70	90.95	112.89	28.70	5.73

* Oils were extracted using cold press (CP), Hexane (H), Chloroform : methanol (C:M) and water extraction (W) techniques

** Moringa peregrina (MP), Moringa oleifera (MO)

*** Data were obtained from Samah and Fyka (2002)

Values are means of duplicate determinations

A very low content of free fatty acid for the different extracted MP and MO oils is indicated of their highly resistance to hydrolysis.

Iodine value of all extracted oils was lower compared to OO and CSO and that could be due to their fatty acid content (Table 7), unsaturated fatty acids; (linoleic and linolenic acids) were much less (0.42-0.88%) than those of olive oil (13.09%) and cottonseed oil (49.75%). There was slight difference in iodine values for oils extracted from the same species of Moringa seeds but MP had higher iodine value than MO regardless the method of extraction and that was because of its high content of oleic acid (18:1) (81.00%) compared with MO (72.50%). These results are within the range of previously reported data of Tsaknis (1998), Tsaknis et al. (1998, 1999), Samah (2001) Anwar and Bhanger (2003) and Anwar et al. (2005). The saponification values are in line with those reported previously and somehow near the value of olive oil. Unsaponifiable matter content

(UNSAP%) revealed that UNSAP% of MP was higher than MO regardless the extraction method. Also, MO had a lower UNSAP% than that of extra virgin olive oil. Absorbance at 232 nm as indication of conjugated diene was lower for all extracted oils than olive oil. The conjugated diene and triene seemed to follow the same trend with peroxide value, where the oil extracted by CP had the lowest absorbance at 232 and 268 nm and the oil extracted by water technique had the highest absorbance.

Induction period measurements (Table 4) demonstrated a great resistance to oxidative rancidity. The oxidative stability of the Moringa oils is related to some extent to α,γ and δ tocopherols (Table 5) which are natural antioxidants and possibly to other constituents of the non glyceride fraction of the oil, which posses antioxidant properties, (Tsaknis et al. 1998).

The induction periods (by the Rancimat method at 100C) which were used to characterize the oxidative stability (Anwar et al. 2003) ranged from 90.90-120.00 and 112.89-199.80 h for MP and MO depending on the extraction method. Oils extracted with boiling water technique had the least induction periods (90.90 and 112.89 h) for MP and MO, respectively, whereas oils extracted by cold press method had the highest induction periods (120.00 and 199.80 h) for MP and MO, respectively. The low oxidative stability of water extracted Moringa seeds oils could be attributed to the long period that seeds and oil were remained in contact with water and under high temperatures. Oxidative stability of Moringa seeds oils was approximately 3 to 7 folds of extra virgin olive oil taking into account the specie of Moringa and the method of extraction, While cottonseed oil had the lowest induction period (5.73 hr) compared with the other tested oils.

The high oxidative stability of M. peregrina and M. oleifera seed oils compared with conventional vegetable oils (Anwar et al. 2003), could be attributed to the presence of a high content α, γ and δ-tocopherols, specially, δ-tocopherol, which exhibits higher antioxidant activity than that of γ-, β- and α-tocopherol. Moreover, the high resistance of Moringa seeds oils to oxidation might be attributed to the

high level of monounsaturated fatty acids (Table 7) (75.81-84.61%), particularly, oleic acid (72.35-80.14%) of the total fatty acids, depending on the Moringa specie and method of extraction. Meanwhile, olive oil had a high content of polyunsaturated fatty acids like linoleic and linolenic acids (13.09%) compared to Moringa seed oils which contained (0.42-0.88%) depending on Moringa specie and method of extraction.

Samah (2001) reported that, the ability of any fat to resist oxidation was related to linoleic and linolenic acids content. For example, the rates of oxidation of C18 fatty acids are approximately 1:10:100:200 for 18:0, 18:1, 18:2 and 18:3 fatty acids, respectively. Oleic acid is more resistance to the peroxidizing cell processes compared to the polyunsaturated fatty acids, and gives rise to a reduced formation of free radicals.

Tocopherol composition was determined in all oils extracted from two species of Moringa seeds; peregrina and oleifera and results are shown in Table 5. Moringa seeds oils had a high content of tocopherol consisting of α, γ and δ-tocopherol. Oil extracted with cold press (CP) had the highest content of tocopherols. This result is in accordance with that reported by Tsaknis et al. (1998). Most oils contain γ-, β- and α-tocopherols. δ-tocopherol exists in few oils like cottonseed, peanut, wheat germ, soybean and castor oil. The oxidative stability of olive oil is related to some extent to the presence of α-tocopherols, Moringa seed oils had higher content of tocopherol despite of extraction method, than olive oil and that explain in part their high resistance to oxidation rancidity (Kiritsakis 1988).

Table 5 : Tocopherol content of oils extracted* from Moringa Seeds**

Samples / Tocopherol	CP		H		C:M		W	
	MP	MO	MP	MO	MP	MO	MP	MO
αTocopherol	123.29	140.42	120.26	128.89	118.89	132.38	105.02	120.24
γTocopherol	40.58	56.17	40.12	36.81	47.56	42.70	52.61	48.09
δTocopherol	94.84	108.01	92.51	99.09	91.45	101.81	80.78	92.49

* Oils were extracted using cold press (CP), Hexane (H), Chloroform : methanol (C:M) and water extraction (W) techniques.

** Moringa peregrina (MP), Moringa oleifera (MO)

Values are means of duplicate determinations.

Major sterol composition of the extracted oils analysed by GLC is shown in Table 6. Sterol fraction of Moringa seeds (peregrina and oleifera) oil constituted mainly β-sitosterol, stigmasterol and campesterol.

β-sitosterol was the predominant sterol ranging from 21.69-23.01, 35.68-36.87 followed by stigmasterol from 10.49-11.83, 11.98-12.09 and campesterpl from 6.77-7.12, 8.03-8.31 for M. peregrina (MP) and M. oleifera (MO), respectively depending on method of extraction. Results in Table 6 reveal that, there was no much difference in sterol composition of oils extracted with different extraction methods. These results are in line with those reported on Moringa oleifera grown in Kenya (Tsaknis et al. 1999) and those grown in Pakistan (Anwar et al. 2005). While Moringa oleifera grown in Malawi had different amount of sterol fraction as β-sitosterol was the most predominant sterol followed by campesterol and stigmasterol with a lesser amount (Tsaknis et al. 1998).

Table 6: Major Sterols of oils extracted* from Moringa seeds**

Samples / Sterols	CP		H		C:M		W	
	MP	MO	MP	MO	MP	MO	MP	MO
Campesterol	6.77	8.03	6.89	8.31	7.02	8.27	7.16	8.19
Stigmasterol	11.60	12.01	10.67	12.09	10.49	11.98	11.83	11.99
β-Sitosterol	23.01	36.87	22.18	35.96	21.69	36.79	22.89	35.68

* Oils were extracted using cold press (CP), Hexane (H), Chloroform: methanol (C:M) and water extraction (W) techniques.

** Moringa peregrina (MP), Moringa oleifera (MO)
Values are means of duplicate determinations.

Table 7 shows fatty acids composition of the extracted oils compared with those of olive and cottonseed oils. Moringa seed oils had higher content of monounsaturated fatty acids (MUSFA) specially oleic acid than olive oil. Oleic was the predominant MUSFA followed by palmitoleic (16:1) and arachidonic (20:1).

Table 7: Fatty acid of oils extracted* from Moringa seeds, extra virgin olive and cottonseed oils **

Samples / Fatty Acids	CP		H		C:M		W		Olive oil	CSO***
	MP	MO	MP	MO	MP	MO	MP	MO		
16:0	8.01	6.28	8.07	6.67	8.00	6.66	8.09	6.70	16.09	26.42
16:1	2.00	1.74	2.00	1.57	2.02	1.53	2.11	1.79	0.05	–
18:0	4.47	4.90	4.62	5.72	4.49	5.73	4.02	4.97	0.62	1.33
18:1	81.00	72.43	80.10	72.35	80.14	72.51	81.00	72.40	70.15	22.74
18:2	0.47	0.64	0.50	0.69	0.42	0.59	0.41	0.67	12.49	47.84
18:3	0.11	0.12	–	0.19	–	0.19	0.13	0.16	0.60	1.91
20:0	1.10	3.41	1.20	3.56	1.26	3.49	1.14	3.31	–	–
20:1	1.50	2.11	1.50	1.89	1.56	1.99	1.50	2.00	–	–
22:0	1.34	7.24	1.50	6.38	1.54	6.33	1.60	6.82	–	–
24:0	–	1.13	0.51	0.98	0.57	0.98	–	1.18	–	–
SFA	14.92	22.96	15.90	23.31	15.86	23.19	14.85	22.98	16.71	27.75
MUSFA	84.50	76.28	83.60	75.81	83.72	76.03	84.61	76.19	70.20	22.74
PUSFA	0.58	0.76	0.50	0.88	0.42	0.78	0.54	0.83	13.09	49.75

* Oils were extracted using cold press (CP), Hexane (H), Chloroform : methanol (C:M) and water extraction (W) techniques

** Moringa peregrina (MP), Moringa oleifera (MO)

*** Data were obtained from Mohamed et al. (2001),Samah and Fyka (2002) Values are means of duplicate determinations

Moringa oleifera (MO) was distinguished by its high content of behenic acid (22:0) (6.33-7.24%) which was the predominant saturated fatty acids followed by palmitic (16:0) (6.28-6.70%), stearic (18:0) (4.90-5.73%), arachdic acid (20:0) (3.31-3.56%) and lignoceric acid (24:0) which was found in a minute amount (0.98-1.18%).

Moringa peregira (MP) had a higher content of MUSFA (83.60-84.61%) than MO which had (75.81-76.28%) depending on the method of extraction.

MO had a higher content of saturated fatty acids (22.96-23.31%) than MP which had (14.85-15.9%) depending on the extraction technique. Moringa seed oil had a minute content of polyunsaturated fatty acid (PUSFA) (0.42-0.88%) depends on the specie of Moringa and method of extraction, whereas olive oil had a high content of PUSFA as linoleic acid (12.49%). Palmitic acid was the predominant saturated fatty acids in olive and cottonseed oils (16.09, 26.42%), respectively.

Somali et al. (1984) reported the same fatty acids profile of M. peregrina and mentioned that, for the chemical composition and fatty acid profile of MP it therefore has potential as a new source of fat and protein.

Fatty acids composition of MP and MO seed oils was nearly to that of olive oil. Therefore the oil could be useful for edible purposes and for industrial applications. This agreed with Morton (1991), who reported that Moringa oil can be an acceptable substitute for olive oil.

The long history of beneficial and medical records of Moringa seeds could be attributed in part to its high content of oleic acid. Oleic acid and other MUSFA were in part responsible for the increase of the plasma HDL (high density lipoprotein)-cholesterol and aproprotein B. For this reason MUFA played a role in the prevention of the cardiovascular diseases (arteriosclerosis, myocardium infarct ictus, etc.) which are the main causes of mortality in the industrialized countries. Oleic acid also reduces thrombogenesis, VII haemostatis factor, and blood platelet aggregation, contributes to the stabilization of arterial pressure and glycaemia (hematic insulin level), and even stimulates the growth of bones. Therefore, monounsaturates become of interest in product development where oxidative stability and nutritional value are important concerns (Samah 2001).

CONCLUSION

The two Moringa seed species (kernels and hulls) are rich of antioxidant compounds like flavonoids and phenols compounds, total pigments (chlorophyll, carotenoids) and vitamin C.

The extracted oils by using four different extraction methods from the two Moringa species grown in Egypt showed their low acid and peroxide values and good physical and chemical characteristics and a long shelf life.

Physical and chemical characteristics of Moringa seeds oils showed that this oil can be utilized successfully as source of edible oil for human consumption. It contains high ratio of monounsaturated to saturated fatty acids, and might be acceptable substitute for highly monounsaturated oils such as olive oil in diets Compared to CSO.

Characterization of Moringa seed oil

Except for water extraction there was no big differences in the physicochemical characteristics of the extracted oil; acid and peroxide values were the highest, oil stability was the least compared to those extracted by other methods and this may be attributed to the high temperature used and the long period that seeds and oil were remained in contact with boiling water during extraction process. Consequently, water extraction technique cannot be used as a reliable method for extraction a high quality edible oil.

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Characterization of Moringa seed oil

خصائص زيت بذور المورينجا المنزرعة في مصر

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يزرع نبات المورينجا (نبات نصف استوائي) والذي ينمو في صعيد مصر وسيناء منذ عصور عديدة واكثر الاصناف الشائعة هي مورينجا اوليفيرا ومورينجا بيرجرينا. يوجد هذه الايام اهتمام عالمي للأهمية التغذوية لنبات المورينجا واهتمام متزايد لنشر زراعته في اراضي الاستصلاح الجديدة في مصر لتقليل الفجوة الزيتية في إنتاج الزيت.

تختلف نسبة % للقشور: النواة في نوعي المورينجا تحت الدراسة فهي تمثل (٤٥,٦٥، ٥٢,٢٧%) ، (٢٧,٧، ٤٢,٥٨%) من وزن البذرة لكل من المورينجا البيرجرينا، الاوليفيرا علي التوالي.

تم تقدير محتوي الصبغات، الفينولات، الفلافونيدات والكاروتينات الكلية وفيتامين ج باستخدام الطرق اللونية في كل من بذور نوعي المورينجا (قشور ونواة).

تم استخلاص الزيت من كلا النوعين بواسطة ٤ طرق استخلاص مختلفة: الضغط علي البارد، استخلاص المذيبات (الهكسان او مخلوط من الكلوروفورم : الميثانول (٥٠:٥٠) والاستخلاص بالماء.

تم تقدير الخصائص الطبيعية (كثافة، وزن نوعي، معامل انكسار علي درجة حرارة ٢٥م) والخصائص الكيميائية مثل رقم البيروكسيد، اليودي، المواد غير قابلة للتصبن، الامتصاص علي طول موجي ٢٣٢، ٢٦٨ نانوميتر. كما تم تقدير محتوي التوكوفيرولات. وقد تم دراسة تركيب الاحماض الدهنية للزيت المستخلص باربع طرق استخلاص وثباتهم الاكسيدي علي ١٠٠م. ووجد ان مقاومتهم العالية للأكسدة التزنخية بالمقارنة بزيت بذرة القطن ترجع الي تركيب الاحماض الدهنية حيث ان حمض الاوليك هو الحمض الدهني السائد وحمض البالميتيك والبهينيك هما الحمضين الدهنيين المشبعين السائدين. وكان البيتاسيتوستيرول هو الاستيرول الشائع في الزيوت.

اظهر تركيب زيت نوعي المورينجا تحت الدراسة ثباتهم العالي والمحتوي المنخفض من الاحماض الدهنية غير المشبعة والمشابه في تركيب وخصائص زيت الزيتون البكر الممتاز. ولهذا التشابه يمكن استخدام زيت بذور المورينجا كزيت غذائي عالي القيمة الغذائية مثل زيت الزيتون.