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PHYSICAL AND CHEMICAL STUDIES ON MORINGA KERNEL SEEDS OIL

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ABSTRACT: Physical and chemical characteristics for crude *Moringa peregrina* and *Moringa oleifera* kernel oils were studied compared with extra virgin olive oil, fatty acid composition, unsaponifiable matter components (hydrocarbons and sterols) and oxidative stability were also studied. The results indicated that crude *Moringa peregrina* and *Moringa oleifera* kernel seeds oils contained high percentage of oleic acid (mono unsaturated fatty acid) as extra virgin olive oil. It were 77.48%, 81.77% and 72.36% respectively. The results indicated also that the unsaponifiable matter of the studied seed oils varied from 1.40%, 1.44% and 1.17% respectively. The hydrocarbons fraction amounted 59.40% for crude *Moringa peregrina* to 49.55% for *Moringa oleifera* compared with extra virgin olive oil 48.40%. C_{23} compound was the major hydrocarbon (47.12, 31.21 and 2.75%) respectively. The sterol fraction constituted (40.60%, 50.45% and 51.60%). β sitosterol was found to be predominant (22.80%, 30.30% and 48.23%) for crude *Moringa peregrina* , *Moringa oleifera* and virgin olive oil respectively. The results also indicated that crude *Moringa* kernel seed oil for two cultivars were more resistant to oxidation deterioration due to the presence of natural antioxidants, the shelf life were 131.40, 193.86 and 18.80 months at ambient temperature for crude *Moringa peregrina* , *Moringa oleifera* kernel seed oil and extra virgin olive oil respectively. Furthermore, the results indicated that addition of crude *Moringa peregrina* or *Moringa oleifera* kernel seed oil to sunflower oil improved the shelf life which increased from 8.99 to

11.36, 11.87 and 13.05 months at 25 ºC, but it increased from 8.99 to 10.01, 10.57 and 12.74 months at 25 ºC when 10, 20 and 30% of crude *Moringa peregrina* or *Moringa oleifera* kernel seed oil was added to sunflower oil. Also addition of crude *Moringa peregrina* or *Moringa oleifera* kernel seed oil to corn oil improved the shelf life which increased from 16.05 to 16.40, 18.19 and 20.13 months at 25 ºC but increased from 16.05 to 19.77, 20.02 and 20.79 months at 25 ºC when 10, 20 and 30% of crude *Moringa peregrina* or *Moringa oleifera* kernel seed oils were added to corn oil respectively. The results suggest that using *Moringa* kernel seeds oil as new additive source for vegeTable oil to improve its stability. As a result of increasing oleic acid percentage (mono unsaturated fatty acid).

Keywords: **Moringa seeds, chemical and physical properties.**

INTRODUCTION

The *Moringaceae* family consists of 10 (Somali *et al.*, 1984) or 12 (Morton, 1991) species that belong to only one genus called *Moringa*. All *Moringa species* are native to India, from where they have been introduced in to many warm countries (Sengupta and Gupta, 1970). The best known and most widely distributed spices is *Moringa oleifera* (Morton,1991).

Benerji *et al.*, (2003) determined the oil potential and composition of *Moringa oleifera* seeds then from viethan and compare with those of two Indian colons of *Moringa oleifera* (Barahmasi and Mo8), *Moringa concanensis* and those of olive and avocado oils. The oil from each sample was purified and refined. The iodine

and saponification values of all the oils ranged from 80.3 to 86.7 and from 195.8 to 197.2 respectively, oleic acid was the major fatty acid in all oils (79.4 to 85.0%) and the other fatty acid in the oils were palmitic, palmitoleic, stearic, linoleic and arachidic acids, palmitic acid content ranged from 9.1 to 9.7% in the oils of the Indian colons. The oils from *Moringa spp.* compared well with olive oil and avocado oil in terms of oleic acid content.

The *Moringa peregrina* kernel contained 1.8% moisture, 54.3% oil. The composition and characteristics of the extracted oil were determined. Gas liquid

chromateography of methyl esters of the fatty acids showed the presence of 14.7% saturated fatty acids and 84.7% unsaturated fatty acids. The fatty acid composition was as follows: palmitic 9.3%, palmitoleic 2.4%, stearic 3.5%, oleic 78%, linoleic 0.6%, linoleic 1.6%, arechidic 1.8% and behenic 2.6%, (Somali et al., 1984).

Tsaknis *et al.*, (1999) indicated that the oil from *Moringa oleifera* variety was extracted using three different procedures including cold press, extraction with n-hexane and extraction with a mixture of chloroform / methanol (50:50). The oil was found to contain high levels of unsaturated fatty acids, especially oleic (up to 75.39%). The oil was also found to contain high levels of β sitosterol (up to 50.07%), stigmasterol (up to 17.27%), and campesterol (up to 15.13%). α-, γ- and δ tocopherols were detected up to levels of 105.0, 39.54 and 77.60 mg/kg of oil, respectively. The induction period (at 120 C) of *Moringa oleifera* seed oil was reduced from 44.6 to 64.3% after degumming. The *Moringa oleifera* seed oil showed high stability to oxidative rancidity. The results of all the above determinations were compared with those of a commercial virgin olive oil.

This study aims to determine the physical and chemical properties, fatty acid composition, hydrocarbons and sterols composition of *Moringa peregrina*, *Moringa oleifera* kernel oils compared with extra virgin olive oil.

MATERIALS AND METHODS

Materials:

1-*Moringa peregrina* seeds:

Moringa peregrina seeds were obtained from Marsa Alm, Alkosir province, Egypt.

2- *Moringa oleifera* seeds:

Moringa oleifera seeds were obtained from North Sinai Desert Station for Research and Extension.

3- Olive oil:

Extra virgin olive oil was obtained from Elsalheya olive oil mill – Elsalheya Elgededa City, Egypt.

4- Refined sunflower and corn oils:

The refined sunflower and corn oils were obtained from Arma Food Industries Company – industrial zone – B_2 10^{th} of Ramadan City, Egypt.

Methods:

1- Extraction of the oil:

The *Moringa peregrina* and *Moringa oleifera* kernel seed were pressed with laboratory-type of 'carver' hydraulic press under 10.000 Ib/in^2 (psi) pressure for 1h at room temperature according to the methods of Ustun *et al.*, (1990). The produced oil was filtrated and kept in dark bottles in the refrigerator at 5 ºC until analysis.

2- Physical and chemical analysis:

Determination of refractive index at 25 ºC, color, peroxide, acidity values, iodine number, and unsaponifiable matter percentage were determined according to A.O.A.C. (2000).

Designation of induction period by Rancimat: 679 Rancimat (metrohm Ltd. CH-9100 Herisa, Swizerland) was used for the determination of oxidative and thermal stabilities of (*Moringa peregrina* and *Moringa oleifera* kernel seed oils), (refined sunflower and corn oils), extra virgin olive oil and mixtures of these oils as shown in fig (2).

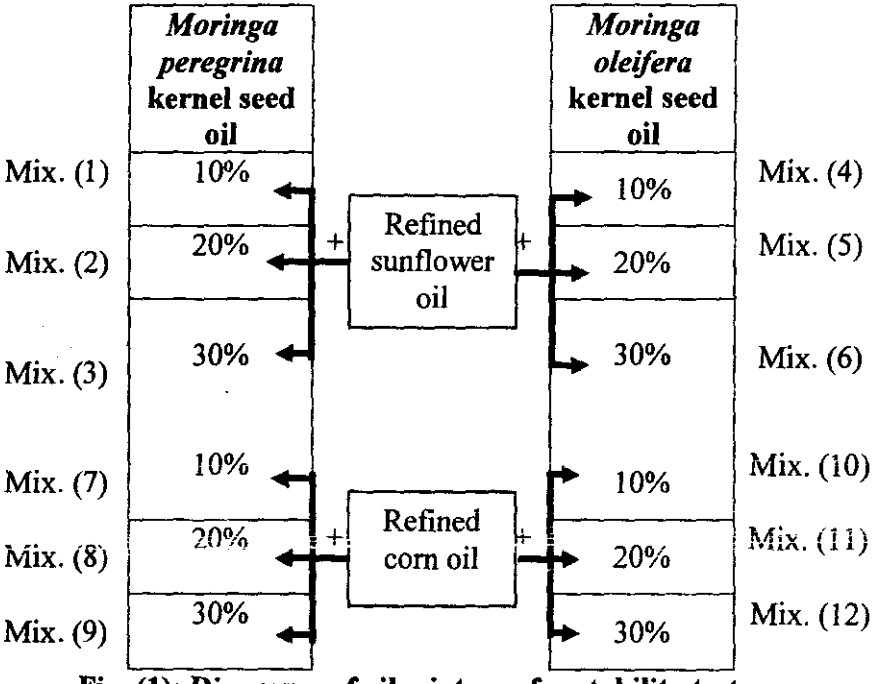

Fig. (1): Diagrame of oil mixtures for stability test.

Analysis of unsaponifible matter by GLC:-

The unsaponifible matter was separated from the oil at room temperature according to the method outlined in A.O.A.C (2000). Then the hydrocarbons and sterols compounds were identified using a Hewlett packard gas chromatograph model 5890 equipped with a flame ionization detector. The column used for separating the unsaponifiable matter components was 25X0.2 m

ID fused silica capillary column coated with dimethylsilicon fluid.

Chromatographic condition:

Split ration 200/1, sample size 1M1, carrier gas nitrogen at a flow of 1ml/min, injection part temperature 250؛ C, oven programmed from 100 to 280؛ C at 5؛ C/min followed by 20 min at 280؛ C, detector temperature 300؛ C, auxiliary (detector make up) gas nitrogen flow rate at 20 ml/min; hydrogen and air flow rates were 30 ml/min, and 400 ml/min, respectively.

The authentic sample hydrocarbons C_{12} C_{13} C_{14} C_{15} C_{16} C_{18} C_{20} C_{21} C_{22} C_{26} C_{28} C_{30} squalene, cholesterol, campesterol, stigmasterol and β-sitosterols were also injected under the same condition and the relative retention time (R.R.T) (retention time of peak/retention time of B-sitosterols) were calculated. Retention time were determined using Hewlett-packard 3392 integrator.

Identification of the fatty acids:

The fatty acids of oil were converted to methyl esters by using sodium methoxide according to the method of Hougen and Bode (1973).

The methylesters were injected in gas liquid chromatography **(GC)** apparatus. (Perkin Elmer instruments Auto system XL) under the following conditions

1- Column : FAPP.

2- Carrier gas: Hellium at flow rate 2 ml/min .

3- Detector: FID.

* Oven temperature program:

I- Initial temp. 100؛ C (Hold for 1 min).

II- Rate 5؛ C/min to 200 C (Hold for 1 min).

III- Rate 6؛ C/min to 250 C (Hold for 1 min).

RESULTS AND DISCUSSION

Physical and chemical properties of *Moringa peregrina, Moringa oleifera* and Extra virgin olive oils:

Data in Table (1) represents the major physical and chemical properties of *Moringa peregrina, Moringa oleifera* and Extra virgin olive oils. The refractive index were 1.4663, 1.4663 and 1.4677 respectively. Results were generally in accordance with the that of Tsaknis *et al.*, (1999) and Somali *et al.*, (1984). From the results in Table (1) it is clear that the red color of *Moringa peregrina, Moringa oleifera* were similar value (2.1) and the color of extra virgin olive oil was characterized by a higher degree of red units and blue units. Indicate the presence of a large amount of pigments. On the other hand, the *Moringa oleifera* and *Moringa peregrina* were slightly colored than that of olive oil. These agree with Tsaknis *et al.*, (1999) and Somali *et al.*, (1984).

The iodine value showed a similar trend in *Moringa peregrina* and *Moringa oleifera* (74.7 and 71.0 respectively). It showed somewhat increase in olive oil (88.8). The saponification values were 184.3, 181.2 and 194 for *Moringa peregrina* ,*Moringa oleifera* and olive oil respectively. Results in Table (1) also revealed that the peroxide value of *Moringa peregrina, Moringa oleifera* was zero but the peroxide value of extra virgin olive oil was 12.7 which showed a highest value. Results in Table (1) indicated also that the kernel oil of *Moringa peregrina, Moringa oleifera* and extra virgin olive oil had the lowest acidity, it were 0.1, 0.1 and 0.58% respectively, it should be stated that the acid value should be considered as one of the properties characterized for edible oils especially olive oil. Furthermore, the unsaponifiable matter of the *Moringa peregrina* and *Moringa oleifera* kernel oils varied from 1.40% to 1.44% similar results were reported by Somali et al., (1984) for *Moringa peregrina* kernel oil and by Tsaknis *et al.*, (1999) and Lalas and Tsaknis (2002) for *Moringa oleifera* kernel oil and for extra virgin olive oil.

Physical and chemical properties of refined sunflower and corn oils are given in Table (2). It should be noticed that the refractive index of the above oils

were 1.4735 and 1.4730, peroxide values were 0.99 and zero, in addition acidity were 0.04 and 0.06 respectively. On the other hand, iodine value of the above oils were 135.37 and 132.78 suggesting that these oils are categorized as semi drying oils. The changes in refractive index and iodine value are due to the degree of unsaturation of the fatty acids. The saponification values were 192 and 189.9 for sunflower oil and corn oil respectively. It refers to the high molecular weight of the fatty acids in their triglycerids El-Kalyoubi and Mostafa (1992).

From the results in Table (2) it is clear that the color of corn oil was characterized by a higher degree of red units. Similar results were mentioned by El-Kalyoubi and Mostafa (1992) for refined sunflower oil and Hallabo (1977) and El_Nikeety (1981) for refined corn oil.

Unsaponifiable matter of *Moringa peregrina, Moringa oleifera* kernel oils and Extra virgin olive oil are shown in Table (3). From the results presented in Table (3) it could be observed that C_{23} is the major hydrocarbon in *Moringa peregrina* and *Moringa oleifera* kernel oils, it amounted to 47.12% and 31.21% respectively, and it was 2.75% for extra virgin olive oil but squalene is the major hydrocarbon for the extra virgin olive oil (30.85%). As the sterols, β sitosterol is the main sterols in *Moringa peregrina, Moringa oleifera* kernel oil and extra virgin olive oils. It were 22.8%, 30.30% and 48.23% respectively. Similar results were mentioned by Tsaknis *et al.* (1999), Bianchini *et al.* (1981) and Lalas and Tsaknis, (2002).

The unsaponifiable matters extracted from refined sunflower and corn oils were fractionated by Gas-liquid chromatography. The obtained results are shown in Table (4). From these results, it could be noticed that the unsaponifiable matter consisted mainly of two groups (hydrocarbons and sterols).

The first group (hydrocarbons) represented at ratios of 41.54% and 39.53% from the total unsaponifiable matter for the above mentioned oils, respectively and from these results, indicated that C_{23} and C_{28} were the major components of the total hydrocarbons in the above oils, respectively. Mean while, the second group (sterols) represented at ratios of 58.46% and 60.47% from the total unsaponifiable

matter in the above oils, respectively. However, β-sitosterol was the major component of the total sterols. Similar results were reported by Fedeli (1977) and Ismael (1991) for refined sunflower oil and EL_Nikeety (1981) for refined corn oil.

Gas liquid chromatography analysis of fatty acids of *Moringa peregrina, Moringa oleifera* kernel oil and Extra virigin olive oil are presented in Table (5). From these data it can be stated that the saturated fatty acids contents were 18.61, 14.97 and 15.85 for the above mentioned oils while the unsaturated fatty acids were 81.39, 85.03 and 84.15 respectively. The major fatty acid in all samples was oleic acid. Increasing of oleic acid in the oil and increasing its levels in the diet is recommended nutritionally and is of unquestionable interest in preventive medicine Jacotot, (1994) and it is suggested that dietary oils with a greater proportion of mono unsaturated fatty acids may provide the best balance for lowering cholesterol levels and reducing the susceptibility for lipid peroxidation damage (Jacob, 1994). The results in Table (6) indicate the fatty acid composition of sunflower and corn oils. From these results, it can be noticed that the total unsaturated fatty acids represented 89.11% and 88.09% of the oils respectively. From these fatty acids amounted to high amount of linoleic acid (essential fatty acid) 68.69% and 61.55% respectively. While, sunflower and corn oils contains low amount of saturated fatty acid 10.89% and 11.91% respectively, the same results were reported by Ismael (1991) and Kiritsakis (1991) for refined sunflower oil and Hallabo (1977) for refined corn oil.

Oxidative stability:-

The results tabulated in Table (7) shows the shelf life of (*Moringa peregrina* and *Moringa oleifera* kernel oils), (refined sunflower and corn oils) and (Extra virgin olive oils) at ambient temperature, which were 131.40, 193.86, 18.80, 16.05 and 8.99 months respectively. The high resistance to oxidation of crude *Moringa oleifera* and *Moringa peregrina* kernel oils, may be attributed to other constituents of the non-glyceride fraction of the oil, which possess antioxidant properties. In addition, Tsaknis *et al* (1999) observed that 42-73% reduction in induction period of crude *Moringa oleifera* oil, may be attributed to oil degumming.

The results tabulated in Table (8) shows that the addition of crude *Moringa peregrina* kernel oils to refined corn oil improved slightly the shelf life of the oil. The degree of effectiveness was dependent on the concentration used since the shelf life increased from 16.05 month to 16.40, 18.19 and 20.13 month by adding (10, 20 and 30%) of crude *Moringa peregrina* kernel oils. Rady (1981) noticed that using of crude unsaponifiable matter of rice bran oil increased the oxidative stability of corn oil. Also the results tabulated in Table (9) shows the addition of crude *Moringa peregrina* kernel oils to refined sunflower oil increased the shelf life of the oil. The shelf life increased from 8.99 month to 11.36, 11.87 and 13.05 month by adding 10%, 20% and 30% of crude *Moringa peregrina* kernel oils. These results are agreement nearly with those reported by Simone and Esam (1999). On the other hand, from the results summarized in Table (10) it can be seen that the addition of crude *Moringa oleifera* kernel oil to refined corn oil improved the shelf life of the oil. Also the addition of crude *Moringa oleifera* kernel oil to refined sunflower oil as shown in Table (11) increased the shelf life of the refined sunflower oil, from 4.10 month to 4.57, 4.82 and 5.81 month by adding 10%, 20% and 30% of the crude *Moringa oleifera* kernel oil. These results tabulated in Table (7) are agreement nearly with those reported by Simone and Esam (1999). The oil samples were tested using the Rancimat at 100 ºC and the results were calculated at 25 ºC using the temperature coefficient of 2.2 for each 10 degree increase in temperature (Hadorn and Zurcher, 1974) and the coefficient of 2.5 as established by Pardun and Kroll (1972) for the oxidation reaction for organic reaction rates.

Conclusion:

The characterization of the oil from the kernels of the seeds of *Moringa peregrina* and *Moringa oleifera* showed that this oil could be utilized successfully as an edible oil for human consumption. It contains a high ratio of mono-unsaturated to saturated fatty acids which may be an acceptable substitute for highly mono-unsaturated oils such as olive oil in diets. This would certainly offer a partial solution for oil deficiency in Egypt.

Table (1): Physical and chemical properties of *Moringa peregrina*, *Moringa oleifera* kernel oils compared with Extra virgin olive oil.

Characteristics	*Moringa peregrina* kernel oil	*Moringa oleifera* kernel oil	Extra virigin olive oil
Refractive index at 25 °C	1.4663	1.4663	1.4677
*Color units			
Yellow	35	35	35
Red	2	2.1	3.1
Blue	-	-	1.2
Acidity % (as oleic acid)	0.1	0.1	0.58
Peroxide value (m.equiv.O_2/kg sample)	zero	zero	12.7
Iodine value (Huns)	74.7	71.0	88.8
Saponification value (mg KOH/g sample)	184.3	181.2	194
Unsaponifiable matter%	1.40	1.44	1.17

*Using lovibond tintometer on 5.25 cell.

Table (2): Physical and chemical properties of refined sunflower and corn oils.

Characteristics	Sunflower oil	Corn oil
Refractive index at 25 °C	1.4735	1.4730
Color units		
Yellow	35	35
Red	1.0	2.1
Blue	0.4	0.4
Acidity % (as oleic acid)	0.040	0.060
Peroxide value (m.equiv.O_2/kg sample)	0.994	Zero
Iodine value (Huns)	135.37	132.78
Saponification value (mg KOH / g oil)	192	189.9
Unsaponifiable matter%	1.15%	1.21%

*Using lovibond tintometer on 5.25 cell.

Table (3): Relative percentages of unsaponifiable matter components (hydrocarbons and sterols) of *Moringa peregrina, Moringa oleifera* kernel oils compared with Extra virgin olive oil.

Components	Unsaponifiable matter (%)		
	Moringa peregrina kernel oil	*Moringa oleifera* kernel oil	Extra virigin olive oil
Hydrocarbons			
C_{14}	0.39	0.13	0.43
C_{16}	*N.D	N.D	N.D
C_{18}	0.09	N.D	N.D
C_{19}	0.07	N.D	N.D
C_{20}	0.18	0.11	0.04
C_{21}	0.51	0.10	0.26
C_{22}	0.84	0.87	1.32
C_{23}	47.12	31.21	2.75
C_{24}	N.D	N.D	N.D
C_{26}	2.84	0.65	2.90
C_{27}	2.07	N.D	3.93
C_{28}	1.16	14.40	2.93
C_{30}	4.13	2.08	N.D
Squalene	N.D	N.D	30.85
C_{32}	N.D	N.D	2.99
Sterols			
Cholesterol	0.08	0.11	0.17
Brassicasterol	N.D	N.D	N.D
Campesterol	7.36	8.23	2.9
Stigmasterol	10.36	11.81	0.30
B- sitosterol	22.8	30.30	48.23
Total hydrocarbon	59.40	49.55	48.40
Total sterol	40.60	50.45	51.60
Total compounds	100.00	100.00	100.00

***Not detected**

Table (4): Relative percentages of unsaponifiable matter components (hydrocarbons and sterols) of refined sunflower and corn oils.

Components	Unsaponifiable matter (%)	
	Refined sunflower oil	Refined corn oil
Hydrocarbons:		
C_{14}	N.D*	N.D
C_{16}	N.D	N.D
C_{18}	0.17	0.07
C_{19}	0.56	0.11
C_{20}	0.32	0.14
C_{21}	0.34	0.19
C_{22}	0.26	1.94
C_{23}	13.84	14.35
C_{24}	6.83	3.12
C_{26}	0.62	0.82
C_{27}	N.D	N.D
C_{28}	15.07	13.79
C_{30}	0.98	2.64
Squalene	0.25	0.60
C_{32}	2.30	1.76
Sterols		
Cholesterol	N.D	N.D
Brassicasterol	N.D	N.D
Campesterol	6.6	5.70
Stigmasterol	6.2	4.80
B- sitosterol	45.66	49.97
Total hydrocarbon	41.54	39.53
Total sterol	58.46	60.47
Total compounds	100.00	100.00

*Not detected

Table (5): Fatty acid composition of *Moringa peregrina, Moringa oleifera* kernel oils compared with Extra virgin olive oil.

Fatty acid	*Moringa peregrina* kernel oil	*Moringa oleifera* kernel oil	Extra virigin olive oil
$C_{14:0}$	N.D*	0.05	N.D
$C_{16:0}$	9.58	6.34	15.23
$C_{16:1}$	2.41	1.27	0.98
$C_{18:0}$	4.62	0.32	0.62
$C_{18:1}$	77.48	81.77	72.36
$C_{18:2}$	0.43	0.60	10.01
$C_{18:3}$	N.D	N.D	0.79
$C_{20:0}$	1.83	3.25	N.D
$C_{20:1}$	1.07	1.39	N.D
$C_{22:0}$	2.10	4.80	N.D
$C_{24:0}$	0.48	0.21	N.D
Total unsaturated fatty acid	81.39	85.03	84.15
Total saturated fatty acid	18.61	14.97	15.85
Total component	100.00	100.00	100.00

*** Not detected**

Table (6): Fatty acid composition of sunflower and corn oils.

Fatty acid	Sunflower oil	Corn oil
$C_{16:0}$	6.41	8.71
$C_{18:0}$	4.48	3.07
$C_{18:1}$	20.39	26.28
$C_{18:2}$	68.69	61.55
$C_{18:3}$	*N.D	0.26
$C_{20:0}$	N.D	0.08
$C_{20:1}$	0.03	N.D
$C_{22:0}$	N.D	0.05
Total unsaturated fatty acid	89.11	88.09
Total saturated fatty acid	10.89	11.91
Total component	100.00	100.00

*** Not detected**

Table (7): The shelf life of crude *Moringa peregerina* and *Moringa oleifera*, extra virgin olive oil and refined corn and sunflower oils at ambient temperature.

Samples	Oxidative stability					
	Rancimat at 100 °C		Caculated * at ambient temp.			
	Mean (Hours)	S.D. ± (Hours)	Induction (Months)	Expired (Months)	Mean (Months)	± S.D. (Months)
Moringa peregrina kernel oils	128.96	2.49	71.48	191.31	131.40	59.92
Moringa oleifera kernel oils	190.26	2.49	105.46	282.25	193.86	88.40
Extra virgin olive oil	18.45	0.55	10.23	27.37	18.80	8.57
Corn oil	15.75	0.55	8.73	23.37	16.05	7.32
Sunflower oil	8.82	0.40	4.89	13.08	8.99	4.10

* The oxidation stability conducted with Rancimat at 100 °C were calculated at 25 °C using the temperature coefficient of 2.2 for induction period (Hadorn and Zurcher, 1974) and 2.5 for expired period (Pardun and Krol, 1972).

Table (8): Effect of addition crude *Moringa peregrina* kernel oil on the oxidative stability of corn oil.

Samples	Oxidation stability					
	Rancimat at 100 ºC		Caculated * at ambient temp.			
	Mean (Hours)	S.D. ± (Hours)	Induction (Months)	Expired (Months)	Mean (Months)	± S.D. (Months)
Moringa peregrina kernel oils	128.96	2.49	71.48	191.31	131.40	59.92
Corn oil	15.75	0.55	8.73	23.37	16.05	7.32
Corn oil+10% *Moringa peregrina* kernel oil	16.10	0.40	8.92	23.88	16.40	7.48
Corn oil+20% *Moringa peregrina* kernel oil	17.85	0.35	9.89	26.48	18.19	8.30
Corn oil+20% *Moringa peregrina* kernel oil	19.75	0.35	10.95	29.30	20.13	9.18

* The oxidation stability conducted with Rancimat at 100 ºC were calculated at 25 ºC using the temperature coefficient of 2.2 for induction period (Hadorn and Zurcher, 1974) and 2.5 for expired period (Pardun and Krol, 1972).

Table (9): Effect of addition crude *Moringa peregrina* kernel oil on the oxidative stability of sunflower oil.

Samples	Oxidation stability					
	Rancimat at 100° C		Caculated * at ambient temp.			
	Mean (Hours)	S.D. ± (Hours)	Induction (Months)	Expired (Months)	Mean (Months)	± S.D. (Months)
Moringa peregrina kernel oil	128.96	2.49	71.48	191.31	131.40	59.92
Sunflower oil	8.82	0.40	4.89	13.08	8.99	4.10
Sunflower oil+10% *Moringa peregrina* kernel oil	11.15	0.45	6.18	16.54	11.36	5.18
Sunflower oil+20% *Moringa peregrina* kernel oil	11.65	0.35	6.46	17.28	11.87	5.41
Sunflower oil+30% *Moringa peregrina* kernel oil	12.80	0.30	7.10	18.99	13.05	5.95

* The oxidation stability conducted with Rancimat at 100 °C were calculated at 25 °C using the temperature coefsficient of 2.2 for induction period (Hadorn and Zurcher, 1974) and 2.5 for expired period (Pardun and Krol, 1972).

Table (10): Effect of addition crude *Moringa oleifera* kernel oil on the oxidative stability of refined corn oil.

Samples	Oxidation stability					
	Rancimat at 100 °C		Caculated * at ambient temp.			
	Mean (Hours)	S.D. ± (Hours)	Induction (Months)	Expired (Months)	Mean (Months)	± S.D. (Months)
Moringa oleifera kernel oil	190.26	2.49	105.46	282.25	193.86	88.40
Corn oil	15.75	0.55	8.73	23.37	16.05	7.32
Corn oil+10% *Moringa oleifera* kernel oil	19.60	0.40	10.86	29.08	19.97	9.11
Corn oil+20% *Moringa oleifera* kernel oil	19.65	0.35	10.89	29.15	20.02	9.13
Corn oil+30% *Moringa oleifera* kernel oil	20.40	0.30	11.31	30.26	20.79	9.48

* The oxidation stability conducted with Rancimat at 100 °C were calculated at 25 °C using the temperature coefficient of 2.2 for induction period (Hadorn and Zurcher, 1974) and 2.5 for expired period (Pardun and Krol, 1972).

Table (11) : Effect of addition crude *Moringa oleifera* kernel oil on the oxidative stability of sunflower oil.

Samples	Oxidation stability					
	Rancimat at 100° C		Caculated * at ambient temp.			
	Mean (Hours)	S.D. ± (Hours)	Induction (Months)	Expired (Months)	Mean (Months)	± S.D. (Months)
Moringa oleifera kernel oil	190.26	2.49	105.46	282.25	193.86	88.40
Sunflower oil	8.82	0.40	4.89	13.08	8.99	4.10
Sunflower oil+10% *Moringa oleifera* kernel oil	9.82	0.39	5.44	14.57	10.01	4.57
Sunflower oil+20% *Moringa oleifera* kernel oil	10.37	0.44	5.75	15.38	10.57	4.82
Sunflower oil+30% *Moringa oleifera* kernel oil	12.50	0.40	6.93	18.54	12.74	5.81

* The oxidation stability conducted with Rancimat at 100 °C were calculated at 25 °C using the temperature coefficient of 2.2 for induction period (Hadorn and Zurcher, 1974) and 2.5 for expired period (Pardun and Krol, 1972).

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دراسات طبيعية وكيميائية على زيت لب بذور المورينجا

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تم دراسة الخصائص الطبيعية والكيميائية لزيت لب بذور صنفين من المورينجا وهما *Moringa peregrina* ,أو *Moringa oleifera* الخام مقارنة بزيت الزيتون البكر الممتاز وكذلك تم دراسة تركيب الأحماض الدهنية والمواد الغير متصبنة كما تم تقييم الثبات عن طريق جهاز الرانسيمات. وأوضحت النتائج أن زيت لب بذور *Moringa oleifera* و *Moringa peregrina* الخام يحتوي على نسبة عالية من حامض الأوليك (أحادي عدم التشبع) مثل زيت الزيتون حيث احتوت العينات على ٧٧,٤٨% ، ٨١,٧٧% ، ٧٢,٣٦% من حامض الأوليك على الترتيب. كما أشارت النتائج أن نسب المواد الغير متصبنة تتراوح ما بين ١,٤٠% ، ١,٤٤ % ، ١,١٧% على التوالي وتشكل الهيدروكربونات حوالي ٥٩,٤٠% ، ٤٩,٥٥% ، ٤٨,٤٠% من مكونات المواد الغير متصبنة حيث يشكل C_{23} المكون الأساسي للهيدروكربونات حيث كانت نسبته ٤٧,١٢% ، ٣١,٢١% ، ٢,٧٥% بينما تمثل الأستيرولات من المواد الغير قابلة للتصبن ٤٠,٦٠% ، ٥٠,٤٥% ، ٥١,٦٠% ويعتبر البيتاسيتوستيرول هو المركب الرئيسي للاستيرولات حيث كانت نسبته ٢٢,٨% ، ٣٠,٣٠% ، ٤٨,٢٣% لكلا من *Moringa peregrina* أو *Moringa oleifera* على التوالي ،كما أظهرت النتائج أن تركيب زيت لب بذور المورينجا الخام لكلا من الصنفين يكون مقاوم للأكسدة بالهواء الجوي حيث أن الثبات الأكسيدي كان ١٣١,٤٠ ، ١٩٣,٨٦ ، ١٨,٨٠ شهر على ٢٥°م لزيت لب بذور *Moringa oleifera* , *Moringa peregrina* الخام وزيت الزيتون البكرالممتاز على التوالي. كما أوضحت النتائج أن اضافة زيت لب بذور *Moringa oleifera* أو *Moringa peregrina*الخام إلى زيت عباد الشمس يعمل على تحسين ثباته حيث زاد الثبات من ٨,٩٩ إلى ١١,٣٦، ١١,٨٧ ثم إلى ١٣,٠٥ شهر على ٢٥°م بينما زادت من ٨,٩٩ إلى ١٠,٠١ ، ١٠,٥٧ ، ١٢,٧٤ شهر على ٢٥°م وذلك عند إضافة ١٠%، ٢٠%، ٣٠% من زيت لب بذور *Moringa oleifera* أو *Moringa peregrina* الخام إلى زيت عباد الشمس. أيضا عند إضافة أي من الاصنفين السابقين إلى زيت الذرة يعمل على تحسين ثباته حيث زاد الثبات من ١٦,٠٥ إلى ١٦,٤٠ ، ١٨,١٩ ، ٢٠,١٣ شهر على ٢٥°م بينما زاد من ١٦,٠٥ إلى ١٩,٧٧ ، ٢٠,٠٢ ، ٢٠,٧٩ شهر على ٢٥°م عند إضافة ١٠%، ٢٠%، ٣٠% من أحد الصنفين السابقين إلى زيت الذرة على التوالي.

مما سبق يتضح أن هذه الدراسة أثبتت صلاحية بذور المورينجا كمصدر إضافي للزيوت النباتية الغذائية نظرا لإرتفاع نسبة حامض الأوليك (الأحادي عدم التشبع).