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Determination of Fat – Soluble Vitamins and Natural Antioxidants in Seventeen Vegetable Oils

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ABSTRACT

The fat – soluble vitamins (A, D, E and K) and the most natural antioxidants (T.polyphenols, tocopherols, chlorophylls, carotenoids, δ – oryzanol, phenolic and flavonoid compounds) of seventeen vegetable oils (olive, corn crystal, corn lecuir, sunflower, palm olein, soybean, linseed, cottonseed, sesame, rice bran, peanut, blending, wheat germ, safflower, rapeseed, castor and coconut oils) were estimated. Results showed that, parameters established (acidity, peroxide value, K232 and 270nm.) to measure level of quality and fatty acid composition of olive oil were the best compared to other studied oils and also were in side the range reported by the Egyptain standareds for olive oil and International Olive Oil Cuoncel (IOOC).All vegetable oils contain a great amounts from vitamin E, especially corn lecuir, sesame, safflower, soybean and coconut oils was 36661, 30811,22540, 20334 and 16384 ppm., respectively, contrary with vitamin K recorded a lower values in all studied vegetable oil, it was ranging from 0.3 ppm in soybean oil to 6.1 ppm in rapeseed oil. On the other side safflower oil contained a higher amount from vitamin A (336.9 ppm), while linseed oil contained a considerable amount from vitamin D (46.5 ppm) followed that, rapeseed oil 23.3 ppm then corn crystal oil 22.9 ppm and wheat germ oil 21 ppm. Olive oil had a higher amount from T.polyphenols 324.91 ppm. Also results showed that, corn lecuir oil contained the highest value from T. tocopherols (212.53 ppm) compared to other vegetable oils. Carotenoids was the highest value in wheat germ oil 10.03 ppm, followed that in linseed oil 4.76 ppm , in rapeseed oil 4.5 ppm and in olive and castor oils were 2.28 and 2.05 ppm respectively. All studied vegetable oils had nearly amounts from chlorophylls, it was ranging from 0.538 ppm in corn crystal to 2.517 ppm in olive oil. δ – oryzanol contents found to be higher values in rice bran and wheat germ oils, (0.365 and 0.203 %, respectively,) but it was the lowest value in linseed oil (0.002 %) compared with other oils. This results indicated that, all vegetable oils enriched with the most identified phenolic compounds. Also it is clear from results narerigin compound was the highest value in some vegetable oils under study compared to other flavonoid compounds, whearas recorded the highest value in sesame oil (39.5 ppm.), followed by corn crystal oil (5.9 ppm.) then in corn lecuir oil (4.5 ppm.).

Keyword: Vegetable oils, natural antioxidant (T.polyphenols, tocopherols, chlorophylls, carotenoids, δ – oryzanol, phenolic and flavanoid compounds), fat – soluble vitamins (A.D.E.K.).

INTRODUCTION

Oilseeds such as sunflower, safflower, soyabean, rapeseed and groundnut are annual plants. They are the largest source of vegetable oils even though most oil bearing tree fruits provide the highest oil yields like olive, coconut and palm trees. Oilseeds are grown in a range of countries. Increases in a small number of crops, including sunflower, soyabean and rapeseed, account for the increase in world production oil. However, according to Food and Agriculture Organization (FAO), more traditional oil crops like groundnut and sesame seeds continue to be important in the food supply and food security of many countries.

Plant based vegetable oils is reported to be a good source of omega 6 (linoleic acid) and omega 3- (alpha linolenic acid) fatty acids, along with the presence of essential macro - and micro - nutrients (vitamin E, phyto sterols) (Combea and Rossignol-Castor a,2010).

Rice bran oil (RBO) is one of the most nutritious and healthful edible oils due to the presence of abundance natural bioactive phytochemicals such as δ - oryzanol, tocopherols, tocotrienols (tocols) and play important roles in preventing some diseases (Fan *et al.,*2013). Rice bran oil has a composition similar to that of peanut oil, with 38% monounsaturated, 37% polyunsaturated, and 25% saturated fatty acids (Wikipedia 2014).

One of the phytochemical that found at high concentration in rice bran is gamma – oryzanol which is a group of ferulic acid esters of phytosterols and triterpeno alcohols (Chenvonky, 2003).

The fatty acid composition of rapeseed oil is most favorable in trems of the health benefits. Indeed, rapeseed oil is high (61%) in monounsaturated fatty acid (Alireza *et al.,*2010). Chlorophyll and carotenoids are important avality parameters because they correlate with color, which is abasic attribute for evaluating oil quality (Borchani *et al.,* 2010).

Sesame oil shows a remarkable stability despite being highly unsaturated. Furthermore, it has natural antioxidants (Kang *et al.,*1999).

Olive oil is a premium vegetable oil that is an important component of the Mediterranean diet. This oil, contrary to the majority of the other edible oils, can be consumed in crude form, conserving all beneficial properties, like vitamins, phenols, sterols and other important natural compounds (Ricardo *et al.,* 2009).

Virgin coconut oil contains a large amount of medium – chain fatty acids such as capric, caproic and caprylic acids which were also investigated to have antimicrobial and antiviral effects. It has been claimed that virgin coconut has several beneficial health effects (Rohman *et al.,* 2011).

Fat - soluble vitamins play an important role in keeping the body healthy and functioning from immune system and muscle and heart function, easy flow and clotting of blood as well as eye health. Fat – soluble vitamins of vitamin A, D, E and K are soluble mainly in lipids or oils and thus called fat- soluble vitamins (Panchumarthy *et al.,* 2015).

Vitamin A,D,E and K are fat soluble dissolved in oil or in melted fat, certain phyto nutrients argued that carotenoids such as β – carotene also come under this category (fat soluble). Vegetable oils such as soy bean, olive, and cotton seed oil are rich sources of vitamin K (Maas *et al.,* 2007).

Vitamin A maintains the right balance of these vitamins are transported with fat and stored in the liver and fat tissue. Deficiency in vitamin D can cause fragile, thin, or deformed bones and rickets in children and osteomalacia in adults. Vitamin E is a fat soluble

vitamin which is naturally present in small amounts in vegetable oils and biological fluids. Vitamin E comprises two vitamer types, tocopherols and tocotrienols. Tocopherols are capable of scavenging free radicals and, thus, together with the action of other natural antioxidants like ascorbic acid and β – carotene, prevent or delay the onset of the lipid peroxidation process. Vitamin E functions as an antioxidant to protect fat in membranes around cells (such as nerves, heart, muscles, and red blood cells) from damage by oxygen Josep (2000). Vitamin K is essential for building strong bones, preventing heart disease, and it plays a crucial part in other bodily processes as well, the biological role of vitamin K help to move calcium into the proper areas in the body, such as bones and teeth and also helps to remove calcium from arteries and soft tissues (Panchumarthy et al., 2015).

The aim of this study was to determine physicochemical properties, fatty acids composition, the fat – soluble vitamins (A, D, E and K) and the most natural antioxidant (T.polyphenols, tocopherols, chlorophylls, carotenoids, δ – oryzanol, phenolic and flavonoid compounds) of seventeen vegetable oils.

MATERIALS AND METHODS

Materials:

The vegetable oils selected for analysis namely, olive, corn crystal, corn lecuir, sunflower, Palm olein, Soybean, linseed, cottonseed, Sesame, rice bran, blending oil (sunflower : soybean 50:50), wheat germ, safflower, rapeseed, castor and coconut oils were purchased from a local market, Egypt.

Fatty acid methyl esters (FAME) standards were purchased from Sigma Chemical Co. (St Louis, Mo,USA), and the stock standard solutions were prepared by dissolving the standard phenolic compounds and flavonoids in the appropriate volume of 50% aqueous methanol to produce a final concentration of 1 mg/ml. Stock from standards solutions were stored in the dark at -18º C.

Methods:

1. Physical and Chemical properties of samples of vegetable oils:-

- **Refractive index (RI):** RI of oils was determined at 25 ^{0}C according to A.O.A.C , (2000) by using refractometer (NXRL-3Poland).
- **Color of vegetable oils :** A lovibond tintometer was applied to measure the color using 5.25 inch cell according to the method of A.O.C.S. (1985).
- Acidity and peroxide values were determined according to the methods of the A.O.A.C. (1995).
- **Absorbency in ultravioletat 232 and 270 nm. :** ultravioletat and visible spectra were conducted using a pye unicum double beam recording spectrophotometer Model SP 1600, as described by Kates (1972). The oil samples were dissolved in freshly distilled cyclohexane and the absorption were measured at 232 and 270nm.
- Iodine and saponification values of vegetable oils were calculated from fatty acids percentage by equation according to Nelson Susana (1995).
- Oxidative stability of oils was evaluated by the Rancimat method (Mendez, 1997). Stability was expressed as the oxidation induction time (hours), measured with the Rancimat 679 apparatus (Metrohm Co., Switzerland), using an oil sample of 5g heated to 100ºC with air flow of 20 L/h.
- Fatty acid composition of oils: The fatty acids methyl esters of oils were prepared using trans-estrification with cold methanolic solution of potassium hydroxide. The fatty acids methyl esters were identified by GC- capillary column according to the method of IOOC (2001).

2.Determination of some natural antioxidants of vegetable oils:-

- The total polyphenols was determined in oils according to the method of Gutfinger (1981).
- The total tocopherols of oils was determined according to the method described by Wong et al, (1988).
- The chlorophylls and carotenoids of oil samples were determined according to the method of Mosquera et al,(1991).
- δ-oryzanol of oil samples was determined according to the methods of Gopala et al. (2006).

3. Determination of vitamins (A, D, E and K): Vitamins A, D, E and K were determined according to the methods of Perez-Ruiz *et al.*,(2007), Nöll (1996), Gimeno *et al.,* (2000) and Wittiy *et al.,* (2013), respectively.

4. Determination of phenolic and flavonoid compounds: Phenolic and flavonoid compounds of oils were identified by HPLC according to the methods of Goupy *et al.,* (1999).

RESULTTS AND DISCUSSION

Physical and chemical properties of vegetable oils :

The results of the physical and chemical properties of vegetable oils (olive, corn crystal, corn lecuir, sunflower, palm olein, soybean, linseed, cottonseed, sesame, rice bran, peanut, blending, wheat germ, safflower, rapeseed, castor and coconut oils) are shown in Table (1). Data shows that the refractive index (RI), colour, acidity, peroxide value (PV), K232nm, K270 nm., iodine value (IV), saponification value (SV) and stability are ranged in 1.4554 – 1.4791, 0.1 – 10 red color at 35 yellow, 0.029 – 7.144 %, 0.2 – 14.73 meqO_2/kg oil, 0.16 – 7.80 nm., 0.08 – 5.25 nm., 10.22 – 194.38 I_2/100g oil, 161.83 – 259.42 mg koH / g oil and 6.32 – 35.8 hr., respectively. With regarding the data linseed, castor , safflower and wheat germ oils gave the higher values from RI comparing with other vegetable oils . concerning to color of oils, wheat germ oil was the highest value of red color 10 at 35, this related to it content of higher amount from carotenoids pigment (10.03 ppm) followed by linseed oil 7 red color then cottonseed and olive oils have nearly the same values (6.2 and 6 red color at 35 yellow respectively,) also sesame and rapeseed oils gave nearly the same values of red color 5.2 and 5 at 35 yellow respectively. On the other hand soybean oil gave the lowest value of red color 0.1 at 35 yellow . Regarding to color of studied oils, olive oil only gave the blue color 4.5 at 35 yellow . This due to it content of higher amount from

chlorophylls pigment (2.517 ppm) compared to other oils. Acidity of wheat germ oil was the highest value compared to other oils, also PV was found to be higher in safflower oil, which is an indication that it contains more hydroperoxids as a results it has high percentage from polyunsaturated fatty acids (75.9%) than other oils. On the other side PV of olive oil is the lowest value in oils, also the values of K232 and K270nm. of olive oil are the lowest values compared with all vegetable oils under investigation, which is an indication that it contains more natural antioxidants and it has high oleic acid (72.1%).

Also, Table (1) shows the IV and SV of vegetable oils, the IV was found to be maximum value (194.38 I_2/100g oil) in linseed oil, which is an indication that it contains a higher amount from polyunsaturated fatty acids (C18:3), while it was minimum value (10.22 I_2/100g oil) in coconut oil , that related to it contains more percentage from the saturated fatty acids especialy lauric acid C12:0 (50.6%) . The SV of the most studied oils was found to be about 200 mg KOH / g oil except for coconut and castor oils, were (259.42 and 161.83 mg KOH / g oil, respectively.). The results in the same table show that, the sesame, olive, palm olein and coconut oils had high stability compared other vegetable oils. The stability of sesame oil was the highest (35.8 hr). This may be it content of higher amount from sesamol, sesamin and sesamolein compounds which decreased the antioxidation of oil at a relatively low temperature (Borchani *et al.,* 2010). Also the highest stability of olive oil (35.42 hr),that may be due to high amount from natural antioxidants especially total polyphenols (324.91 ppm.) and high percentage from oleic acid (72.1% from total fatty acids). The stability increament of palm olein oil may be it had a more amount from total saturated fatty acid (44.9%) and enriched with natural antioxidant.

Also the oxidative stability of coconut oil was reported to be high,it was 32.89%. This may be due to it contains the highest total polyphenols (Marina *et al.,* 2009). Contrary with wheat germ and safflower oils have the lowest stability compared with other vegetable oils, which is an indication that its contain more percentage from the polyunsaturated fatty acid, which related to quick oxidation process of these oils, that caused decreament the stability of these oils . This difference in physicochemical properties of previous oils may be related to their lipids and glyceride composition (Rahman *et al.,* 2007).

Table 1. Physical and chemical properties of vegetable oils :

Vegetable oils	RI at 25° C	Color red	Color blue	Acidity %	PV (meqO_2 /kg oil)	K_{232} nm.	K_{270} nm.	I.V I_2/100g oil	S.V (mg koH /g oil)	Stability (hr.)
Olive	1.4710	6.0	4.5	0.244	0.2	0.16	0.08	85.60	201.41	35.42
Corn crystal	1.4731	2.5	-	0.134	0.66	0.76	0.19	130.36	200.88	21.71
Corn lecuir	1.4733	3.0	-	0.046	0.89	0.57	0.13	130.17	201.35	17.5
Sunflower	1.4727	0.4	-	0.067	2.06	2.04	1.47	123.08	200.09	12.95
Palm olein	1.4655	2.3	-	0.124	2.80	1.23	0.66	58.85	203.3	33.66
Soybean	1.4742	0.1	-	0.029	1.44	4.36	2.18	123.07	202.54	13.22
Linseed	1.4791	7.0	-	4.007	7.01	0.66	0.12	194.38	201.02	7.65
Cottonseed	1.4740	6.2	-	0.130	7.73	2.82	1.56	100.02	201.98	23.8
Sesame	1.4711	5.2	-	0.907	6.50	2.44	1.22	117.26	200.76	35.8
Rice bran	1.4712	2.8	-	0.126	5.14	6.10	5.25	100.58	202	20.2
Peanut	1.4713	0.2	-	0.124	4.04	2.63	0.58	104.01	196.35	16.42
Blending	1.4740	2.4	-	0.278	9.33	4.54	1.60	138.75	200.91	10.04
Wheat germ	1.4757	10.0	-	7.144	12.17	5.10	2.80	138.86	202.14	6.32
Safflower	1.4762	3.0	-	0.199	14.73	7.80	2.30	147.58	196.75	7.35
rapeseed	1.4711	5.0	-	0.261	2.04	1.63	0.56	99.58	197.10	17.44
Castor	1.4782	2.1	-	0.487	5.32	2.51	1.11	94.60	161.83	28.2
Coconut	1.4554	1.1	-	0.103	2 .27	0.28	0.14	10.22	259.42	32.89

Where as : blending oil (50% soy oil + 50% sunflower oil)

Fatty acid composition of vegetable oils:

The importance of any vegetable oil is related to its high levels of monounsaturated fatty acids (mainly oleic acid) and bioactive components. From the obtained results given in Table (2), it could be noticed that the major saturated fatty acids composition in coconut oil was C12:0 (50.6 %) and in palm olein oil was palmitic acid which recorded 39.1%. While, the main unsaturated fatty acid for olive oil was C18:1 omega (9) which gave the highest value (72.1 %) follwed by peanut, sunflower, palm olein, sesame, cottonseed and rice bran oils, which gave the values 44.9, 44.2, 43.3, 42.3, 41.7 and 41.7 % respectively, but castor and coconut oils have the lowest values for oleic acid, were 5.8 and 7.6%, respectively. On the other hand, safflower oil enriched with omega (6) (C18:2) was 75.9%, and also blending, wheat germ, corn crystal, corn lecuir, soybean, sunflower, sesame, peanut and rice bran oils contain a considerable amount from it, Which ranged from 33.4 % in rice bran oil to 59.7% in blending oil, but it recorded the lowest value in coconut oil, which contains 1.9 % comparing with other vegetable oils in this study.

Meanwhile, the finding of omega (3) (C18:3) was the major unsaturated fatty acid in linseed oil (54.9 %) , followed that rapeseed oil (7.6%), then wheat germ oil (7.2 %) and blending oil (3.7 %), but it was in the most other vegetable oils, less than 1%. From the results, it could be noticed that the (C20:1) was the highest value in rapeseed oil, it was (14.2 %), while was less than 1% for the most vegetable oils. C22:1 (erucic acid) describes rapeseed oil, however rapeseed oil had the highest value (17.2 %) from it. Also from the tabulated data, in the same table castor oil only enriched with C24:1 was (81.4 %) .

The total saturated fatty acids for coconut oil recorded a higher value (90.4 %) followed by palm olein oil (44.9%), but castor oil contains a lowest value (3.9 %) from it. On the other hand, castor oil gave the highest value from total unsaturated fatty acid (96.1%) followed by rapeseed oil (94.4 %), then linseed oil (90.6 %) and sunflower oil (90.5%), while coconut oil gave the lowest value (9.6 %) from it . The variation in fatty acid composition of vegetable oils may be due to the environmental condition, especially temperature , which effect on the fatty acid composition of oil crops during growth and harvest season for both oil crops.

Table 2 . Fatty acids composition of vegetable oils :

	Fatty acids (%)													
Vegetable oils	**C 10:0**	**C 12:0**	**C 14:0**	**C 16:0**	**C 18:0**	**C 18:1**	**C 18:2**	**C 18:3**	**C 20:0**	**C 20:1**	**C 22:0**	**C 22:1**	**C 24:1**	**T.SFA**	**T.USFA**
Olive	-	-	-	13.0	2.1	72.1	10.5	0.7	0.5	1.1	-	-	-	15.6	84.4
Corn crystal	-	0.1	0.1	9.5	2.5	29.4	56.7	0.7	0.3	0.4	0.3			12.8	87.2
Corn lecuir	-	-	0.1	10.5	1.8	29.6	56.3	0.8	0.4	0.4	0.1	-	-	12.9	87.1
Sunflower	-	-	-	5.7	2.9	44.2	45.5	0.5	0.3	0.3	0.6	-	-	9.5	90.5
Palm olein	-	0.2	1.0	39.1	4.1	43.3	11.1	0.2	0.4	0.5	0.1	-	-	44.9	55.1
Soybean	-	-	0.1	16.2	2.9	23.3	55.4	0.9	0.4	0.5	0.3	-	-	19.9	80.1
Linseed	-	-	0.2	5.0	3.9	19.5	15.9	54.9	0.3	0.3	-	-	-	9.4	90.6
Cottonseed	-	-	0.4	19.9	1.9	41.7	33.1	1.2	0.9	0.7	0.3	-	-	23.4	76.6
Sesame	-	-	-	8.4	5.0	42.3	42.9	0.7	0.5	0.2	-	-	-	13.9	86.1
Rice bran	-	-	0.4	19.8	1.9	41.7	33.4	1.1	0.8	0.7	0.2	-	-	23.1	76.9
Peanut	-	-	0.6	10.4	2.7	44.9	35.3	0.2	1.5	1.8	2.6	-	-	17.8	82.2
Blending	-	-	0.1	8.3	3.9	23.4	59.7	3.7	0.3	0.2	0.4	-	-	13.0	87.0
Wheat germ	-	-	-	16.3	0.7	15.5	58.3	7.2	0.4	1.6	0.1	-	-	17.2	82.8
Safflower	-	-	-	6.9	2.8	12.4	75.9	0.1	0.9	0.2	0.8	-	-	11.4	88.6
Rapeseed	-	-	-	3.5	1.5	39.9	15.5	7.6	0.6	14.2	-	17.2	-	5.6	94.4
Castor	-	-	-	1.8	2.0	5.8	7.4	0.8	0.1	0.7	-	-	81.4	3.9	96.1
Coconut	6.4	50.6	19.9	10.3	3.1	7.6	1.9	-	0.1	0.1	-	-	-	90.4	9.6

Some natural antioxidants of vegetable oils:

Data in Table (3), concerning the natural antioxidants (T. polyphenols, T.tocopherols, carotenoids, chlorophylls and δ - oryzanol) in previous studied vegetable oils . In general the highest levels of total polyphenols were presented in olive oil (324.91 ppm.), followed by safflower oil (214.75 ppm.) then in castor oil (184.94 ppm.) and in coconut oil (176.57 ppm.), but it was the lowest value in the rice branoil (18.53 ppm.) under investigation. On the other hand, corn oils (lecuir and crystal) enriched with total tocopherols (212.53 and 185.78 ppm.), followed by cottonseed (179.99 ppm.), then blending (159.99 ppm.) and soybean oils (156.38 ppm.). According to data in the same Table (3), wheat germ oil was surperior to that other vegetable oils with containing a higher amount from carotenoids contents (10.03 ppm.), follow that linseed, rapeseed, olive and castor oils were 4.76 ppm., 4.5 ppm., 2.28 ppm. and 2.05 ppm., respectively. Also, from the results, it is clear that, rice bran oil was enriched with δ-oryzanol (0.365%) followed by wheat germ oil (0.203 %), then olive oil (0.056 %) and peanut oil (0.055 %). The results show that olive oil contains the highest level from chlorophyll content (2.517 ppm.), followed by peanut oil (1.941 ppm.), then sesame oil (1.892 ppm.) and wheat germ oil (1.794 ppm.). This difference in natural antioxidants may be due to difference extraction methods , processing treatments, commoditry treading and storage period for both oil.

Fat - soluble vitamins of vegetable oils:

Fat - soluble vitamins primarily include retinol (VA), tocopherol (VE), radiostol (VD) and antihemorrhagic vitamin (VK). These vitamins play different specific and vital functions in metabolism, and can cause health problem when they are either lacking or in excess (Dionex, 2009). Table (4) shows the fat-soluble vitamins contents of vegetable oils under study. From the results presented in Table (4), it could be noticed that, the highest content of vitamin A was found in safflower oil (336.9 ppm.). follow that coconut oil (48.2 ppm.), corn lecuir (36.1 ppm.), sesame (32.2 ppm.), cottonseed (30 ppm.) and wheat germ (16.4 ppm.) oils , but the lowest content was found in blending oil (0.2 ppm.) while the highest values from vitamin D presented in linseed oil (46.5 ppm.), followed by in rapeseed (23.3 ppm.), then in corn crystal oil (22.9 ppm.), and in wheat germ oil (21 ppm.). Also results indicated that, there is a greater amount from vitamin E in all vegetable oils, ranging from 193 ppm. in castor oil to 36661 ppm. in corn lecuir oil. On the contrary, vitamin K recorded the lowest values compared with other vitamins in studied oils, it was found to be maximum (6.1 and 5.7 ppm. in rape and linseed oil, respectively.), while it was minimum 0.3 ppm. in soybean oil.

Table 3 . Some natural antioxidants of vegetable oils

Vegetable oils	natural antioxidants				
	polyphenols (ppm)	Tocopherols (ppm)	Carotenoids (ppm)	Chlorophyll (ppm)	δ –oryzanol (%)
Olive	324.91	123.37	2.28	2.517	0.056
Corn crystal	34.41	185.78	0.40	0.538	0.048
Corn lecuir	58.77	212.53	0.37	0.783	0.045
Sunflower	31.75	133.73	0.4	1.223	0.047
Palm olein	91.38	110.60	0.52	0.946	0.054
Soybean	21.76	156.38	0.37	0.946	0.023
Linseed	75.63	107.71	4.76	1.387	0.002
Cottonseed	42.03	179.99	0.55	0.734	0.036
Sesame	34.98	99.99	0.905	1.892	0.022
Rice bran	18.53	148.91	0.54	0.750	0.365
Peanut	79.04	84.82	0.88	1.941	0.055
Blending	32.34	159.99	0.39	0.653	0.032
Wheat germ	37.33	110.36	10.03	1.794	0.203
Safflower	214.75	116.14	1.21	1.060	0.047
Rapeseed	37.04	138.31	4.50	1.566	0.043
Castor	184.94	100.96	2.05	1.517	0.045
Coconut	176.57	38.79	0.32	0.718	0.034

Table 4 . Fat – soluble vitamins of vegetable oils

Vegetable oils	Vitamins (ppm)			
	A	D	E	K
Olive	0.9	4.5	773	1.8
Corn crystal	0.6	22.9	2248	3.2
Corn lecuir	36.1	4.1	36661	0.6
Sunflower	0.6	11.8	616	1.9
Palm oline	1.2	11.7	612	0.5
Soybean	7.5	1.1	20334	0.3
Linseed	3.0	46.5	2972	5.7
Cottonseed	30.0	0.2	14527	3.5
Sesame	32.2	0.0	30811	1.0
Rice bran	7.2	12.3	252	3.6
Peanut	6.1	9.1	13963	1.3
Blending	0.2	8.7	671	2.8
Wheat germ	16.4	21.0	1003	3.6
Safflower	336.9	9.9	22540	1.2
rapeseed	0.9	23.3	649	6.1
Castor	0.3	6.5	193	0.5
Coconut	48.2	3.1	16384	0.8

Phenolic compounds of vegetable oils:

Phenolic compounds play an important role in human health because of their anti- inflammatory, anti-allergic, anti- microbial, anti- carcinogentc, and anti-viral activities Medina et al. (2007).

Phenolic compounds were separated and analyzed by HPLC and peaks were identified by comparing their relative retention times with those of standards. Eighteen phenolic compounds with different retention times were detected in vegetable oil and the obtained data are listed in Table (5). The obtained results showed that, identified eighteen phenolic compounds were: ferulic, caffeine, pyrogallol, caffeic, coumarin, categhein, chlorogenic, benzoic, gallic, protocatchoic, Epi-catechin, vanillic, cinnamic, salicylic, catechol, ellagic, 4 amino- benzoic and p-hydroxybenzoic. Results in Table (5) revealed that pyrogallol compound was the predominant phenolic compound identified in most vegetable oils; olive, corn crystal, corn lecuir, sunflawor, soybean, linseed, rice bran, blending, wheat germ and castor oils which were (7.79, 4.97, 0.76, 16.77, 15.78, 9.66, 0.71, 14.75,4.07 and 8.57 ppm.), respectively, but coumarin compound was the major phenolic acid in olive oil (7.05ppm.) follow that in castor oil (3.02ppm.). Coconut oil had the highest values from catechein and caffeic phenolic compounds were (9.04 and 3.05 ppm., respectively.). The highest value of chlorogenic compound found in coconut and olive oils were (2.42 and 2.25 ppm., respectively, followed by in sunflower oil, was 1.07 ppm., while benzoic acid was the predominant phenolic compound in sesame oil (7.22 ppm.), follow that sunflower, castor , corn crystal and cottonseed oils were 5.77, 2.51, 2.48 and 2.17 ppm. respectively.

Also data show that castor oil enriched with 4 amino-benzoic and salicylic acids, (8.35 and 6.07 ppm., respectively,) compared with other studied oils. Also from the results it could be notice that catechol compound recorded a higher increament in olive, palm olein,sesame

and castor oils (2.25, 2.25, 2.31 and 1.22 ppm., respectively,) while cottonseed oil contains a higher amount from ellagic and vanillic phenolic compounds (8.56 and 4.53 ppm.) respectively.

This difference in phenolic compounds may be due to extraction procedure of oil, environmental and ecological characteristies for both oil (Borchani et al., 2010)

Table 5 . Phenolic compounds of vegetable oils:

Vegetable oils	Phenolic compounds (ppm.)																	
	Ferulic	Caffeine	Pyrogallol	Caffeic	Coumarin	Catechein	Chlorogenic	Benzoic	Gallic	Pro-tocatchoic	Epi-catechin	Vanillic	Cinnamic	Salicylic	Catechol	Ellagic	4Amino-benzoic	P-hydrox benzoic
Olive	0.24	0.23	7.79	0.11	7.05	0.68	2.25	0.83	1.19	0.89	1.01	1.91	0.32	3.77	2.25	3.35	0.25	0.58
Corn crystal	0.28	-	4.97	0.11	0.40	0.10	0.51	2.48	0.06	0.50	0.24	0.33	0.03	0.48	0.53	-	0.09	-
Corn lecuir	0.06	0.05	0.76	-	0.03	-	0.05	0.15	0.17	0.08	0.02	0.28	-	0.15	-	0.30	-	0.05
Sunflower	0.17	0.18	16.77	0.09	0.35	0.24	1.07	5.77	-	1.39	0.40	0.50	0.07	1.02	-	0.93	0.12	0.86
Palm olein	0.03	0.21	0.42	0.03	0.23	0.68	0.05	0.66	0.01	0.17	0.40	0.27	0.12	1.23	2.25	0.61	0.02	0.30
Soybean	0.04	0.07	15.78	-	0.04	-	0.03	0.37	0.08	0.08	0.16	0.11	0.01	0.14	-	0.28	0.01	0.14
Linseed	0.42	0.06	9.66	0.25	1.19	0.10	0.60	-	0.26	1.71	0.13	0.46	0.09	2.18	1.00	1.64	0.09	0.50
Cottonseed	0.09	0.37	5.97	0.26	0.79	0.14	0.26	2.17	-	1.13	1.28	4.53	0.10	0.56	-	8.56	0.05	0.10
Sesame	0.63	-	-	0.21	0.18	-	-	7.22	-	1.99	-	1.48	0.03	2.51	2.31	3.30	-	-
Rice bran	0.04	0.07	0.71	0.09	0.15	0.03	0.14	0.03	-	0.29	0.44	0.26	-	0.32	-	0.44	-	0.17
Peanut	0.09	0.08	0.31	0.05	0.10	0.25	0.08	1.40	0.20	1.32	0.21	0.23	0.02	0.30	0.60	1.14	0.09	0.29
Blending	0.07	0.16	14.75	0.18	0.23	0.50	0.55	0.43	-	1.57	0.78	0.53	0.03	0.91	-	0.74	0.24	0.68
Wheat germ	0.08	0.19	4.07	0.02	0.01	0.16	0.22	0.15	0.16	1.63	0.74	1.01	0.16	0.04	0.13	0.57	0.09	0.06
Safflower	0.01	0.04	0.01	0.03	0.05	0.09	0.03	0.45	0.03	0.57	0.28	0.05	0.21	0.20	0.11	0.61	0.09	0.26
rapeseed	1.46	0.01	-	0.02	0.07	0.10	0.08	0.67	-	1.03	0.13	0.47	0.01	0.05	-	0.06	0.05	0.21
Castor	0.06	0.32	8.57	0.28	3.02	0.04	0.36	2.51	0.28	0.15	0.73	0.79	0.11	6.07	1.22	-	8.35	0.76
Coconut	0.31	-	-	3.05	-	9.04	2.42	-		-	-	0.01	0.00	-	-	-	-	

Table 6 . Flavonoid in some vegetable oils:

Vegetable oils	Flavonid (ppm.)										
	Narenginin	Quercitrin	Querctin	Rutin	Hispertins	7- OH flavone	Rosmarinic	Hisperidin	Luteolin	Kaempferol	Narerigin
Olive	0.01	0.09	0.03	0.23	0.63	-	0.06	1.09	0.5	0.25	0.5
Corn crystal	-	1.55	6.65	0.75	0.20	0.85	0.12	3.4	0.09	0.45	5.9
Corn lecuir	-	1.4	5.2	0.40	-	-	0.10	-	-	0.90	4.5
Sunflower	-	-	0.07	-	-	-	0.01	-	-	0.95	-
Palm olein	-	-	-	-	-	-	-	0.70	-	-	-
Soybean	-	0.07	-	-	0.26	-	-	2.15	-	-	-
Linseed	0.045	0.46	0.75	0.06	-	0.44	0.09	1.13	0.27	-	0.87
Cottonseed	-	0.20	0.11	0.03	-	-	-	-	-	0.12	-
Sesame	-	1.1	-	-	-	0.20	-	-	0.30	-	39.5
Rice bran	-	0.07	-	0.05	0.02	-	-	-	-	-	-
Peanut	-	1.04	0.08	0.09	0.27	-	-	-	-	-	-
Blending	0.07	-	0.20	0.10	0.10	0.02	-	-	-	-	-
Wheat germ	0.22	0.22	0.13	0.50	2.57	0.01	-	0.30	-	-	0.32
Safflower	0.02	-	0.07	-	0.15	-	-	-	-	-	1.34
Rapeseed	-	0.7	0.10	-	0.20	-	-	-	-	0.20	-
Castor	0.27	-	-	-	0.13	0.14	-	0.36	-	0.1	-
Coconut	0.01	0.05	0.02	0.02	0.02	0.01	0.0	0.08	0.03	0.05	0.04

Flavonoid compounds in vegetable oils:

Flavonoid compounds were determined for both vegetable oils under studed and the obtained results are illustrated in Table (6). The illustrated data in this table revealed that narerigin compound was the highest value (39.5 ppm.) in sesame oil compared to other flavonoid compounds, follow that in corn crystal and lecuir oils (5.9 and 4.5 ppm., respectively and in safflower oil

(1.34 ppm.), also querctin and quercitrin compounds recorded a higher values in corn crystal and lecuir oils were (6.65 and 5.2 ppm.) and (1.55 and 1.4 ppm.) respectively compared to other vegetable oils. With regarding data corn crystal, soybean, linseed and olive oils had the highest values from hisperidin compound, was (3.4, 2.15, 1.13 and 1.09 ppm., respectively.), while wheat germ oil contains a higher amount from hispertins compound (2.57 ppm.).

CONCLUSION

The quality and fatty acid composition of olive oil was the best compared to the other vegetable oils . Olive, sesame, palm and coconut oils were more stable comparing with other oils.Wheat germ oil was superior to that other vegetable oils in carotenoids , but rice bran oil in δ – oryzanol and corn (crystal and lecuir) oils in tocopherols. The results indicated that linseed oil enriched with vitamins E and D, while safflower oil gave the highest value from vitamin A compared with other studied oils.

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تقدير الفيتامينات الذائبة فى الدهون ومضادات الاكسدة الطبيعية فى ١٧ زيت نباتي

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قسم بحوث الزيوت والدهون- معهد تكنولوجيا الاغذية- مركز البحوث الزراعية- الجيزة- مصر.

تم تقيم الفيتامينات الذائبة فى الدهون (K, E, D, A) ومعظم مضادات الاكسدة الطبيعية (الفينولات والتوكوفيرولات الكلية – الكلوروفيل – الكاروتينات – الجاما ايزونول – المركبات الفينولية والفلافونويد) فى ١٧ زيت نباتى (زيتون – ذرة كريستال ولسيور – عباد الشمس – أولين النخيل – صويا – كتان – بذرة القطن – سمسم – جنين الارز – سودانى – خليط – جنين القمح – القرطم – الشلجم – الخروع – جوز الهند) وأوضحت النتائج الاتى :- كانت القياسات الشائعة (حموضة – بيروكسيد – القياس فى المنطقة الفوق البنفسجية على طول موجى ٢٣٢ – ٢٧٠ نانوميتر) لقياس مستوى الجودة وتركيب الاحماض الدهنية لزيت الزيتون كانت الافضل مقارنة بباقى الزيوت التى تمت دراستها وكانت أيضا داخل المدى المحدد تبعا للقياسات المصرية والمجلس الدولى لزيت الزيتون.كما أوضحت النتائج أن كل الزيوت النباتية تحتوى على كمية كبيرة من فيتامين E خصوصا زيوت الذرة لسيور – السمسم – القرطم - الصويا – جوز الهند حيث كانت٣٦٦٦١ , ٣٠٨١١ , ٢٢٥٤٠, ٢٠٣٣٤ و ١٦٣٨٤ جزء فى المليون على التوالى وبالعكس سجل فيتامين K قيم صغيرة جدا فى كل الزيوت النباتية موضع الدراسة حيث يتراوح من ٣و٠ جزء فى المليون فى زيت الصويا الى ١و٦ جزء فى المليون فى زيت الشلجم. كما أوضحت النتائج الى أحتواء زيت القرطم على كمية كبيرة من فيتامين A ٩و٣٣٦ جزء فى المليون فى حين أحتوى زيت الكتان على كمية معقولة من فيتامين D (٥و٤٦ جزء فى المليون) و زيت الشلجم (٣و٢٣ جزء فى المليون) و زيت الذرة كريستال (٩و٢٢ جزء فى المليون) وجنين القمح (٢١ جزء فى المليون).كما أتضح من النتائج احتواء زيت الزيتون على كمية كبيرة من الفينولات الكلية ٩١و٣٢٤ جزء فى المليون . كما أتضح من النتائج أيضا أحتواء زيت الذرة لسيور على رقم عالى فى التوكوفيرولات الكلية ٥٣و٢١٢ جزء فى المليون مقارنة بالزيوت الاخرى. كما أشارت النتائج الى أن الرقم الاعلى للكاروتينات كان فى زيت جنين القمح ٠٣و١٠ جزء فى المليون يلى ذلك فى زيت الكتان (٧٦و٤ جزء فى المليون) ثم فى زيت الشلجم (٥٠و٤ جزء فى المليون) وفى زيت الزيتون والخروع (٢٨و٢ و ٠٥و٢ جزء فى المليون) على التوالى.كما أوضحت النتائج أيضا احتواء كل الزيوت النباتية على كميات متقاربة من الكلوروفيل يتراوح بين ٣٨٥و جزء فى المليون فى زيت الذرة كريستال الى ١٧٥و٢ جزء فى المليون فى زيت الزيتون . كما وجدت مكونات الجاما ايرزانول بقيم عالية فى wheat germ and rice bran oils ٣٦٥و٠, ٢٠٣و٠ % على التوالى ولكن كانت أقل قيمة فى زيت الكتان ٠٠٢و٠ % مقارنة بالزيوت الاخرى. كما تشير النتائج الى أن كل الزيوت النباتية غنية بمعظم الاحماض الفينولية التى تم التعرف عليها.كما تشير النتائج أيضا أن مركب الناريجين كان الاعلى قيمة فى بعض الزيوت النباتية مقارنة بالمركبات الفلافونويد الاخرى. حيث سجل أعلى قيمة فى زيت السمسم ٣٩.٥ جزء فى لمليون وفى زيت الذرة ٥.٩ جزء فى المليون وفى زيت لسيور ٤.٥ جزء فى المليون .