J. Agric. Sci. Mansoura Univ., 27(1): 425 - 437, 2002.

PROPERTIES OF ROSELLE SEEDS (*Hibiscus sabdauriffa* L.) AS A NEW SOURCE OF OIL

Salem, M.A.*; H.E Moustafa; M. E. Abdel-Aziz** and M. Roushdi***

*** Food Sci. and Technol. Dept., Fac. of Agric., Kafr El-Sheikh, Tanta Univ.**

**** Food Sci and Technol. Dept., Fac. of Agric., Tanta, Tanta Univ.**

ABSTRACT

Physico-chemical properties of roselle seed and its oil as affected by extraction method were investigated. The obtained results revealed that moisture, ether extract, crude protein, crude fiber, ash and carbohydrate contents of roselle seed were 8.38%, 22.24%, 26.25%, 16.22%, 5.61% and 21.30%, respectively. The most predominant minerals in whole roselle seed were K, Na, Mg and Ca. The results indicated that the major essential amino acids present in roselle seed were leucine, lysine and phenylalanine. The lowest limiting amino acid in roselle seed was tryptophan (0.34 g/16 gN). Also, the results of lipid classes indicated roselle seed oil contained a moderate amounts of sterols (3.17% and 3.40% in oil extracted by petroleum ether and cold pressing) and sterol esters (2.84% and 2.23%, respectively). GLC analysis of both fatty acids and unsaponifiable matters composition of roselle seed oil indicated that oil has a high ratio of unsaturated fatty acids per saturated fatty acids and contained a high amount of β-sitosterol and a moderate amounts of campesterol and stigmasterol. Linoleic, oleic and palmitic acids were the major fatty acid constituents in crude oil. Petroleum ether extraction was the better method to extract the oil from the seed comparing to cold pressing due to high yield and quality of the extracted oil. Therefore, roselle seed oil could be used as an edible oil based on its physical and chemical properties.

Keywords : Roselle seeds, chemical composition, lipid classes, fatty acids composition, unsaponifiable matters analysis.

INTRODUCTION

There is no doubt that the demand of conventional edible oils will be increased as a result of population growth. Therefore, current work is necessary to evaluate unconventional new sources of edible oils.

Roselle (*Hibiscus sabdariffa* L.) is an annual plant belonging to Malvaceae family. This plant is cultivated for its jute like fiber in India and tropical regions. The calyces are red, non-fleshy, spiny and not used for food (Purseglove, 1976). The plant commonly cultivated in Egypt for its dried calyces which used as hot or cold beverages "called karkadae" (Al-Wandawi *et al.,* 1984). The cultivated area of roselle in Egypt were not more than 4, 313 feddans. The average yield of calyce production about 580 kg and 900 kg of seeds per feddan (Anon, 2000). Roselle seed has a high content of protein and oil. Whereas, protein and oil content were about 25.20% and 21.10%, respectively (Al-Wandawi *et al.,* 1984). Fatty acids composition of roselle seed oil was extensively studied by several investigators (Ahmad *et al.,* 1979; Ahmed and Hudson, 1982 and El-Sayed *et al.,* 1998). They concluded that main fatty acids in roselle seed oil were palmitic, oleic and linoleic acids. It was reported that acid value, iodine value, saponsification value and saponifiable matters (%) of roselle seed oil were 4.01, 108.61,

165.09 and 0.98, respectively (El-Sayed *et al.,* 1998). The present study was designed to investigate the physical properties and chemical composition of roselle seed. Also, the physico-chemical characteristics of crude roselle seed oil as affected by extraction method were studied.

MATERIALS AND METHODS

1. Materials :

Reselle (*Hibiscus sabdariffa* L.) seed Sobhia 17 variety was obtained from Medicinal and Aromatic Research Department, Horticulture Research Station, Agriculture Research Center, Alexandria, Egypt in December 1999. All chemicals used were AR grade.

2. Methods :

2.1. Crude oil extraction :

Roselle seeds were handily cleaned and divided into two portions. The first one was subjected to hydraulic pressure (Carver Inc., USA) at 11kg/cm^2 for 30 min. to obtain the pressed crude oil and the deffated roselle seed cake. The second portion was crushed using an electrical grinder (National Model MX-915C, Japan) at speed 6 for 2 min. to pass through 35 mm (42 mesh) sieve. The crushed seeds were used for oil extraction by using petroleum ether (40 - 60°C) in a soxhlet apparatus according to A.O.A.C. (1990). The remained flour was called defatted roselle seed meal.

2.2. Physical properties of roselle seeds :

Weight and volume of 1000 seeds and bulk density were measured according to Kramer and Twigg (1962). Seed dimensions (mm) were estimated using the average of length, width and thickness of 25 seeds as described by Adair *et al.* (1973).

2.3. Gross chemical composition of roselle seeds :

Moisture, crude protein, ether extract, crude fiber and ash contents were performed according to A.O.A.C. (1990). Non-protein nitrogen (NPN) was estimated as described by De-Lumen and Reyes (1982), while protein nitrogen (PN) was calculated by subtracting NPN from total nitrogen (TN) present in the same extract (Foda *et al.*, 1986). Total carbohydrate was estimated by difference. Amino acids content of roselle seed was carried out using amino acid analyzer (Beckman amino acid analyzer, Model 194 CL) as described by Moore and Stein (1963). Tryptophan was performed colorimetrically in the alkaline hydrolyzate following the method of Miller (1967).Minerals content were determined by using atomic absorption spectrophotometer (Perkin-Elmer Instrument Model 2380).

2.4. Physical properties of crude oil :

Refractive index, specific gravity, melting point and colour of crude roselle seed oil were carried out according to A.O.A.C. (1990). While relative viscosity was estimated as described by Joslyn (1950).

2.5. Chemical properties of roselle seed oil :

Acid, iodine, saponification, peroxide values and unsaponifiable matters (%) were performed as described in the A.O.A.C. (1990).

2.6. Determination of lipid classes :

Lipid classes of crude roselle seed oil were fractionated onto silica gel glass plate using TLC technique as described by Mangold (1969). Sample application was 700-800 μg. The chromatogram was dried and sprayed with Charring reagent of Rouser *et al.* (1970). Lipid classes were identified by comparison of their R_F values with standards. Thin layer chromatogram was scanned at 700 nm and percentage of each class was calculated.

2.7. Unsaponifiable matters analysis :

The esterified unsaponifiable matters (1 μl) were injected in the chromatographic port of Hewlett Packard gas chromatograph model 5890 equipped with FID. The chromatographic conditions were: injection port and detector temperature were 250°C and 300°C, respectively. Flow rate of N_2 gas was 1 ml/min., oven programmed from 100 to 280°C at 5°C/min. followed by 20 min. at 280°C. The hydrocarbon and sterol compounds were identified by comparing their retention times with the authentic standards.

2.8. Determination of fatty acids composition :

Fatty acids in roselle seed oil were converted to their methyl esters according the method of Stahl (1965).The esters were analyzed by Hewlett Packard Gas Liquid Chromatograph (model 5890) equipped with a FID and attached the Hewlett Packard 2392 integrator. Stainless steel column packed with 10% DEGS (Di-ethyl glycol succsinate) was used. One μl of fatty acid methyl ester was injected into the column. The gas chromatographic condition was :

a) Temperature :	**b) Flow rates :**
Detector : 300°C	Hydrogen : 30 ml/min.
Injector : 250°C	Nitrogen : 30 ml/min.
Oven : 170°C	Air : 330 ml/min.

2.9. Statistical analysis :

Data were analyzed statistically using the analysis of variance. Means were further tested using the least significant difference test (LSD) as outlined by Steel and Torrie (1980).

RESULTS AND DISCUSSION

1. Physical properties of roselle seeds :

Physical properties of roselle (*Hibiscus sabdariffa* L.) seeds were determined to evaluate their characteristics. Data presented in Table (1) indicated that seed index (weight of 1000 seeds in gram) and volume of whole roselle seed were 34.50 g. and 31.40 cm^3, respectively. Thus, Bulk density was 1.10 g/cm^3. Also, roselle seed dimensions including length, width and thickness were 5.35, 4.19 and 2.60 mm, respectively.

Table (1):Some physical properties of roselle seeds.

Properties	Roselle seed (M±SD)
Seed index (g)*	34.50±0.07
Volume of 1000 seed (cm^3)	31.40±0.06
Bulk density (g/cm^3)	1.10±0.02
Seed dimensions :	
Length (mm)	5.35±0.04
Width (mm)	4.19±0.05
Thickness (mm)	2.60±0.02

*** Seed index = Weight of 1000 seeds.**

- M ± SD = Mean of three determinations ± standard deviation.

2. Gross chemical composition of whole and defatted roselle seeds:

2.1. Moisture content :

As shown in Table (2) moisture content of whole seed was (8.38%) not significantly different ($P \leq 0.05$) than that of roselle seed cake (8.26%), the lowest moisture content was found in the roselle seed meal. These results are in agreement with those reported by Al-Wandawi *et al.* (1984), who stated that moisture content of roselle seed was ranged from 5.75% to 11.66%.

2.2. Ether extract :

Crude oil of whole roselle seed was 22.24%, while defatted roselle seed meal and cake was 0.45 and 5.74%, respectively (Table, 2). These results are in full agreement with those reported by Abd El-Fadeel and El-Shamei (1986) and Ismail and Mohamed (1997). However, it was higher than that estimated by Ahmed *et al.* (1979).

2.3. Nitrogenous constituents :

Nitrogenous constituents of whole roselle seed were 26.25%, 24.25%, 3.88% and 0.32% for CP,TP, PN and NPN, respectively. The corresponding values in roselle seed cake were 30.58%, 28.31%, 4.53% and 0.36%, respectively. The highest values of the nitrogenous constituents were detected in roselle seed meal (33.59%, 31.13%, 4.98% and 0.39%, respectively). These values were significantly ($P \leq 0.05$) different in whole roselle seeds comparing with roselle seed meal. Where no high significant differences were found between roselle seed meal and cake (Table, 2). These results are in agreement with Al-Wandawi *et al.* (1984) and Abd El-Fadeel and El-Shamei (1986), they mentioned that crude protein of whole roselle seed ranged from 25.20% to 31.02%. But they were conflict with that obtained by Backeit *et al.* (1994), who mentioned that crude protein of roselle seed cake content was 49.11%.

2.4. Crude fiber:

Crude fiber content of whole seed was 16.22% (Table, 2). Similar results were obtained by Al-Wandawi *et al.* (1984); Abd El-Fadeel and El-Shamei (1986). This value was significantly lower comparing with both defatted roselle seed meal and cake. These results are in full agreement with that of Backeit *et al.* (1994).

Table (2): Gross chemical composition of whole and defatted roselle seeds (dry weight basis).

Constituents	Whole roselle seed (M±SD)	Defatted roselle seed	
		Meal (M±SD)	Cake (M±SD)
Moisture (%)	8.38 ± 0.36a	7.10 ± 0.32b	8.26 ± 0.37a
Ether extract (%)	22.24 ± 1.03a	0.45 ± 0.02c	5.74 ± 0.26b
Nitrogenous constituents (%):			
Total nitrogen (TN)	4.20 ± 0.16b	5.37 ± 0.21a	4.89 ± 0.20ab
Non protein nitrogen (NPN)	0.32 ± 0.01b	0.39 ± 0.02a	0.36 ± 0.02ab
Protein nitrogen (PN)	3.88 ± 0.14b	4.98 ± 0.18a	4.53 ± 0.17ab
Crude protein (CP)	26.25 ± 1.05b	33.59 ± 1.35a	30.58 ± 1.28ab
True protein (TP)	24.25 ± 0.97b	31.13 ± 1.24a	28.31 ± 1.18ab
Crude fiber (%)	16.22 ± 0.62b	19.66 ± 0.75a	18.90 ± 0.67a
Ash (%)	5.61 ± 0.23c	7.90 ± 0.33a	6.74 ± 0.28b
Minerals (mg/100g):			
Calcium	285.00 ± 7.13b	365.00 ± 9.13a	345.00 ± 8.97a
Sodium	507.00 ± 15.21c	652.00 ± 17.60a	614.00 ± 19.64b
Potassium	1085.00 ± 28.21c	1397.00 ± 36.33a	1314.00 ± 36.79b
Magnesium	373.00 ± 11.93c	480.00 ± 15.36a	452.00 ± 15.82b
Manganese	3.06 ± 0.06c	3.90 ± 0.10a	3.69 ± 0.09b
Iron	6.90 ± 0.23c	8.81 ± 0.29a	8.30 ± 0.29b
Zinc	4.64 ± 0.17c	5.89 ± 0.21a	5.60 ± 0.20b
Carbohydrate (%)*	21.30 ± 0.94b	31.30 ± 1.38a	29.78 ± 1.34a

*** Carbohydrate was calculated by difference.**

- In a row, means followed by a similar letters are not significantly different (P≤0.05).

- M±SD = Mean of three determinations ± standard deviation.

2.5. Ash content :

Ash content of whole roselle seed was (5.61%) which significantly (P≤0.05) increased in both types of defatted roselle seeds (Table, 2). It is clear that ash content of cake was (6.74%), and markedly lower than that of meal (7.90%). The values of ash content in both types of defatted roselle seeds were lower comparing with those reported by Backeit *et al.* (1994). This may be due to the variation in phenotype of the seeds.

It is clear that potassium (K), sodium (Na), magnesium (Mg) and calcium (Ca) were the major minerals in both whole and defatted roselle seed followed by iron, zinc and manganese. The amounts of these minerals were significantly increased in both roselle seed cake and meal. In conclusion, roselle either whole seeds or defatted one could be considered as a good source for essential minerals such as K, Na, Ca and Mg. The roselle seed contained a moderate amounts of Fe, Mn and Zn. The minerals content, generally, of whole seed was significantly (P≤0.05) lower than that of defatted seed. These results are in agreement with those reported by Al-Wandawi *et al.* (1984) and Backeit *et al.* (1994).

2.6. Total carbohydrate :

As shown in Table (2) percentage of total carbohydrate in whole roselle seed or defatted seed was calculated by differences. The results indicated that defatted roselle seed comprised significantly ($P \leq 0.05$) higher amounts of total carbohydrate (31.30% and 29.78% for meal and cake, respectively) than that found in whole seed (21.30%). These results are in accordance with those reported by Al-Wandawi *et al.* (1984) and Abd El-Fadeel and El-Shamei (1986).

2.7. Amino acids composition of whole roselle seeds :

Roselle seed contained 10 essential amino acid beside of 8 non essential amino acids (Table, 3). The major essential amino acids present in roselle seed were leucine lysine and phenylalanine. The whole roselle seed comprised tyrosine and cystine, which they were not present in casein as standard protein. Essential amino acids content of whole roselle seed are in a good amounts as recommended by FAO and WHO (1973). The lowest limiting amino acid in roselle seed was tryptophan (0.34 g/16 gN).

Table (3): Amino acids composition of whole roselle seeds and casein as a reference protein (g/16g nitrogen).

Amino acid	Whole roselle seeds	Casein	FAO/WHO pattern (g/16g nitrogen)
Essential amino acids :			
Lysine	5.46	7.50	5.5
Methionine	1.15	2.96	3.5
Cystine	2.78	-	
Threonine	4.66	3.43	4.0
Isoleucine	3.24	5.01	4.0
Leucine	7.29	9.20	7.0
Valine	3.32	8.42	5.0
Phenylalanine	5.25	9.81	6.0
Tyrosine	3.39	-	
Tryptophan	0.34	1.21	1.0
Non essential amino acids:			
Alanine	5.10	2.65	
Arginine	10.49	4.22	
Aspartic acid	10.50	5.97	
Glutamic acid	21.38	17.53	
Glycine	4.27	1.72	
Histidine	2.59	2.63	
Proline	4.14	5.92	
Serine	4.65	5.59	

As for non essential amino acids that existent as a major amounts in whole roselle seed were glutamic, aspartic and arginine. Beside of moderate amounts of alanine, serine, glycine and proline, the lowest one was histidine. It was clear that whole roselle seed contained higher amounts of some amino acids comparing with casein such as alanine, arginine, aspartic, glutamic and glycine. These results are in agreement with those reported by Al-Wandawi *et al.* (1984).

3. Physical and chemical properties of fresh roselle seed oil as affected by extraction method :

The effect of extraction method on physical and chemical properties of roselle seed oil was investigated. The data of oil analysis was represented in Table (4). The refractive index of fresh oil that extracted by petroleum ether was 1.4616 at 25°C. Meanwhile, it was 1.4626 when the oil was extracted by cold pressing.

Table (4): Some physical and chemical properties of fresh roselle seed oil as affected by extraction method.

Properties	Extraction method	
	Petroleum ether (M±SD)	Cold pressing (M±SD)
Refractive index at 25°C	1.4616 ± 0.00031b	1.4626 ± 0.00031a
Specific gravity at 25°C	0.9527 ± 0.0005b	0.9576 ± 0.0006a
Relative viscosity at 25°C	20.10 ± 0.65b	20.67 ± 0.68a
Colour	Y=35& R=7.10a	Y=35& R=7.40a
Melting point (°C)	1.00 ± 0.03°C a	1.25 ± 0.04°C a
Acid value	2.58 ± 0.08a	1.62 ± 0.05b
Iodine value	104.27 ± 3.34a	102.97 ± 3.60b
Saponification value	184.24 ± 7.37b	192.82 ± 7.71a
Peroxide value	1.68 ± 0.06b	2.35 ± 0.08a
Unsaponifiable matters (%)	1.02 ± 0.03a	0.99 ± 0.02b

- **In a row, means followed by a similar letters are not significantly different (P≤0.05).**
- **M ± SD = Mean of three determinations ± standard deviation.**

Specific gravity of roselle seed oil at 25°C was 0.9527 and 0.9576 for oil extracted by petroleum ether and cold pressing methods, respectively. These results are in agreement with those reported by El-Sayed *et al.* (1998) who indicated that specific gravity of roselle seed oil extracted by petroleum ether was 0.9563.

Relative viscosity is an adequate indicator of the resistance of the oil towards flow, and generally, it proportional correlated with the polymeric material of the oil. The relative viscosity of the investigated oil samples were 20.10 for roselle seed oil extracted by petroleum ether and 20.67 for roselle seed oil extracted by cold pressing. These results are in agreement with that mentioned by Sarojini *et al.* (1985) and El-Kady (1995).

The colour of roselle seed oil extracted by petroleum ether was 35.0 yellow and 7.1 red units, while it was 35.0 yellow and 7.4 red units for the oil extracted from the seeds by cold pressing. Ismail and Mohamed (1997), reported that the total Lovibond colour (Y±10R) of roselle seed oil was 78.

Melting points of roselle seed oil extracted by petroleum ether and cold pressing were 1.00°C and 1.25°C, respectively. These results are in agreement with El-Sayed *et al.* (1998), who found that melting point of roselle seed oil was 1.07°C. Jane (1992), indicated that the melting point is progressively lowered with increasing unsaturation.Acid value of roselle seed

oil extracted by petroleum ether was 2.58 and 1.62 for roselle seed oil extracted by cold pressing. These results are lower than that reported by Ismail and Mohamed (1997) and El-Sayed *et al.* (1998), who mentioned that acid value of roselle seed oil was ranged between 4.00 and 10.15.

The iodine value of roselle seed oil extracted by petroleum ether and cold pressing were 104.27 and 102.97, respectively. These results are in accordance with those reported by Ismail and Mohamed (1997), and El-Sayed *et al.* (1998).

Saponification value gives an idea about the chain length of the fatty acids in the triglycerides of the oil. Table (4), showed that saponification value of oil extracted by petroleum ether from roselle seed was 184.25 and 192.82 for the oil extracted by cold pressing. These results are in harmony with those obtained by Ahmad *et al.* (1979); Panford and de Man (1990); Ismail and Mohamed (1997) and El-Sayed *et al.* (1998).

Concerning the peroxide value of the oil samples under investigation, it was clear that all samples had low peroxide values. Peroxide value of roselle seed oil extracted by petroleum ether was (1.68 meq/kg oil). While roselle seed oil extracted by cold pressing had significantly ($P \leq 0.05$) higher peroxide value (2.35 meq/kg oil) than that of extracted oil by solvent. The peroxide value was lower than that of the stipulated maximum level of CAC (1982), which indicated that maximum value should not be more than 10 meq/kg oil for the edible oils.

The percentage of unsaponifiable matters of vegetable oils are relatively considered to be natural antioxidants which are able to minimize oil oxidation during storage. The unsaponifiable matters percent of roselle seed oil extracted by petroleum ether and cold pressing were 1.02% and 0.99%, respectively. These results are nearly agreed with those mentioned by Ahmad *et al.* (1979); Ismail and Mohamed (1997) and El-Sayed *et al.* (1998). The unsaponifiable matters present in roselle seed oil were lower than most of edible oils. Most oils and fats of normal purity contain less than 2% of unsaponifible matters (CAC, 1982).

4. Lipid classes percentage of fresh roselle seed oil as affected by extraction method :

Table (5) summarized the results of lipid classes in crude roselle seed oil extracted by two different methods (petroleum ether and cold pressing). As shown in Table (5) roselle seed oil included 7 lipid fractions beside of one unknown fraction which comprised 5.25% in the oil extracted by petroleum ether and 5.31% in the oil resulted by clod pressing. It was apparent also that roselle seed developed by cold pressing had significantly ($P \leq 0.05$) lower (4.88%) amounts of free fatty acids rather than roselle seed oil resulted from petroleum ether (5.94%). Meanwhile, roselle seeds oil extracted by cold pressing contained significantly ($P \leq 0.05$) higher amounts of monoglycerides (3.33%) and diglycerides (7.74%) than those found in roselle seed oil extracted by petroleum ether (2.57% and 6.65%), respectively.

The data of Table (5) established that roselle seed oil extracted by different methods held considerable amounts of sterols (3.17% and 3.40%)

and sterol esters (2.84% and 2.23%) for oil extracted by petroleum ether and cold pressing, respectively.

Table (5): Lipid classes percentage of roselle seed oil as affected by extraction method.

Lipid classes *	Extraction method	
	Petroleum ether (M±SD)	Cold pressing (M±SD)
Phospholipids	1.43 ± 0.05a	1.52 ± 0.06a
Unknown	5.25 ± 0.21a	5.31 ± 0.20a
Monoglycerides	2.57 ± 0.09b	3.33 ± 0.12a
Sterols	3.17 ± 0.12a	3.40 ± 0.14a
Diglycerides	6.65 ± 0.26b	7.74 ± 0.30a
Free fatty acids	5.94 ± 0.21a	4.88 ± 0.18b
Triglycerides	72.15 ± 2.89a	71.59 ± 3.22a
Sterol esters+ hydrocarbons+ pigments	2.84 ± 0.105a	2.23 ± 0.083a

*** Lipid classes were separated on silica gel thin layer chromatography plate.**

- **In a row, means followed by a similar letters are not significantly different (P≤0.05).**
- **M ± SD = Mean of three determinations ± standard deviation.**

These results confirmed the data in Table (4), since roselle seed oil extracted by petroleum ether involved significantly (P≤0.05) higher free fatty acids and similar percentage of unsaponifiable matters comparing with those of roselle seed oil developed by cold pressing. These results are in agreement with those mentioned by El-Sayed *et al.* (1998).

5. Unsaponifiable matters composition of fresh roselle seed oil as affected by extraction method :

Hydrocarbons and sterols in the unsaponifiable matters of fresh roselle seed oil extracted by petroleum ether and cold pressing were analyzed using Gas Liquid Chromatography (GLC). The obtained results are tabulated in Table (6). The data revealed that total hydrocarbons (TH%) in roselle seed oil extracted by petroleum ether was 11.07% and 10.49% in roselle seed oil developed by cold pressing. Contrary, oil extracted by petroleum ether had lower percentage (86.63% of total sterols) than that found in oil developed by cold pressing (88.14%). The major hydrocarbons of roselle seed oil were squalene and C_{30} followed by C_{26}, C_{24} and C_{18}. While the minor hydrocarbons were C_{20}, C_{28}, C_{16}, C_{14}, C_{12} and C_{22}. As shown in Table (6), sterols fractions constituted the major part of the unsaponifiable matters of oil sample. It is quite obvious that β-sitosterol was the predominant fraction of sterols in roselle seed oil besides of moderate amounts of campesterol (6.17% and 6.21%) followed by stigmasterol at the range of 1.81% to 1.89% for oil extracted by petroleum ether and cold pressing.

Table (6): Unsaponifiable matters composition of fresh roselle seed oil as affected by extraction method.

Component (%)		Extraction method	
		Petroleum ether	Cold pressing
Hydrocarbon	C_{12}	0.09	0.04
"	C_{14}	0.11	0.16
"	C_{16}	0.31	0.24
"	C_{18}	1.05	0.97
"	C_{20}	0.84	0.78
"	C_{22}	0.07	0.09
"	C_{24}	1.32	1.21
"	C_{26}	1.84	1.68
"	C_{28}	0.75	0.61
"	C_{30}	2.23	2.19
Squalene		2.46	2.52
Total hydrocarbon		11.07	10.49
Campesterol		6.17	6.21
Stigmasterol		1.81	1.89
β-sitosterol		78.65	80.04
Total sterols		86.63	88.14
Unknown		2.30	1.37
β-sitrosterol/campesterol ratio		12.75 : 1	12.89 : 1

β-sitosterol/campesterol ratio could be used as index to identify the purity of any oil besides the necessary confirmatory tests (El-Hinnawy *et al.,* 1983).In the present investigation, β-sitosterol/campesterol ratio of roselle seed oil was ranged from 12.75 : 1 to 12.89 : 1. In this respect, Abdel-Naby *et al.* (1991) showed that the sterol contents of 14 crude cottonseed oil samples extracted from different cultivars varied between 42.45% and 64.25% which was mainly β-sitosterol (76% - 87%), campesterol (5.4% - 14.5%) and the ratio between β-sitosterol and campesterol varied from 10.2 : 1 to 15.4 : 1. Such results were also mentioned by Mohamed *et al.* (1995), who indicated that the major sterols in kenaf seed oil (*Hibiscus cannabinus* L.) were β-sitosterol (72.30% of the total sterols), campesterol (9.9%) and stigmasterol (6.07%). These results are in agreement with those found by Ismail and Mohamed (1997), who also reported that the sterol content of some Malvaceae seeds (roselle; okra; mallow and cotton seeds) ranged from 74.67% to 91.95%, while β-sitosterol (65.23% to 84.02), campesterol (5.08% to 6.77%) and the ratio between β-sitosterol and campesterol varied from 10.22 : 1 to 16.47 : 1.

6. Fatty acids composition of fresh roselle seed oil as affected by extraction method :

Table (7) showed GLC data of fatty acids methyl esters derived from roselle seed oils extracted by different methods. The data displayed that linoleic ($C_{18:2}$), oleic ($C_{18:1}$) and palmitic ($C_{16:0}$) were the dominant fatty acids in roselle seed oil. These results are similar with those found by Sarojini *et al.* (1985), who reported that the major fatty acids in roselle seed oil were linoleic, oleic and palmitic. Stearic ($C_{18:0}$) and linolenic ($C_{18:3}$) were the minor

fatty acids, while luric ($C_{12:0}$), myristic ($C_{14:0}$) and arachidic ($C_{20:0}$) were present in roselle seed oil as a traces (less that 0.5%). The total saturated fatty acid exhibited about 22%, while total unsaturated fatty acids represented about 77.50%. Thus, ratio of unsaturated/saturated fatty acids was about 3.5:1.

Table (7): Fatty acids composition of fresh roselle seed oil as affected by extraction method.

Fatty acid (%)		Extraction method	
		Petroleum ether	Cold pressing
Luric	$C_{12:0}$	0.19	0.23
Myristic	$C_{14:0}$	0.21	0.14
Palmitic	$C_{16:0}$	19.09	19.23
Palmitoleic	$C_{16:1}$	0.41	0.84
Stearic	$C_{18:0}$	2.61	2.68
Oleic	$C_{18:1}$	27.35	28.44
Linoleic	$C_{18:2}$	48.67	46.33
Linolenic	$C_{18:3}$	1.21	1.93
Arachidic	$C_{20:0}$	0.14	0.07
Unknown		0.12	0.11
Total saturated fatty acids		22.24	22.35
Total unsaturated fatty acids		77.64	77.54
Unsaturated/saturated ratio		3.49 : 1	3.47 : 1

It is obvious that the method of oil extraction (petroleum ether or cold pressing) had no markedly effect on the fatty acids composition of the oil. Since, the differences between the two types of oil was not noticeable with exception of linoleic and arachidic of oil extracted by petroleum ether which they were slightly higher in comparison with those found in roselle seed oil developed by cold pressing. In contrast, palmitoleic and oleic detected in roselle seed oil extracted by petroleum ether were lower than those recorded in roselle seed oil developed by cold pressing. These results are established the data of Table (4), where iodine value and melting point of both oils were not significantly different. Consequently, stability and high nutritional quality could be a characteristics of roselle seed oil. The high level of the unsaturated fatty acids (oleic, linoleic and linolenic) reflects a good nutritional quality of such oils (Smolin and Grosvenor, 2000).

Finally, roselle seed oil could be used as an edible oil based on its physical and chemical properties.

REFERENCES

Abd El-Fadeel, M.G. and Z.A. El-Shamei (1986). Fatty acid composition of roselle seeds and chufa tubers oils. J. Agric. Sci., Mansoura Univ., Egypt, 10 (8): 6311-6325.

Abdel-Nabey, A.A.; A.D.Y. Shehata; M.H. Ragab and J.B. Rossel (1991). Total unsaponifiables, sterols and tocopherols of cottonseed oil from Egyptian and other varieties. Rivista-Italiana-dell-Sostanze-Grasse, 68 (11): 583-587.

Adair, C.R.; C.N. Bollich; D.H. Bowman' N.E. Jodan; T.H. Johnston; B.D. Webb and J.G. Athins (1973). Rice breeding and testing methods in

the United States. In: Rice in the United States. Varieties and production, 19 - 64. USDA Handbook 289.U.S. Dept. Agric.; Washington, DC. USA.

Ahmad, M.U.; S.K. Husain; H.I. Ahmad and S.M. Osman (1979). *Hibiscus sabdariffa* seed oil : A Re-investigation. J. Sci. Food Agric., 30: 424-428.

Ahmed, A.K. and B.J.F. Hudson (1982). The fatty acid composition of *Hibiscus sabdariffa* seed oil. J. Sci. Food Agric., 33: 1305-1309.

Al-Wandawi, H.; K. Al-Shaikhly and M. Abdul-Rahman (1984). Roselle seeds: A new protein source. J. Agric. Food Chem., 32 (3): 510-512.

Anon (2000). Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Agricultural Statistics, Cairo, Egypt.

A.O.A.C. (1990). Official Methods of Analysis of Association of Official Analytical Chemists. 15th Edition, Published by Association of Official Analytical Chemists, Arlington, Virginia, USA.

Backeit, M.H.; A.E. Elzubeir and S.K. Jubarah (1994). The nutritional value of roselle seed meal in laying hen diets. J. Sci. Food Agric., 65 (1): 199-200.

C.A.C. (1982). Codex Alimentanus Commission, recommended internal standards for edible fats and oil. CAC No 1. X1, ed. 1, Joint FAO/WHO Food Standards Program, Rome.

De-Lumen, B.O. and P.S. Reyes (1982). Chemical composition studies on winged dean tubers. J. Food, Sci., 47 (3): 821-827.

El-Hinnawy, S.E.; M.A. Torki; Z.A. El-Hadidy and A.R. Khalil (1983). Studies on the unsaponifiable matters in some vegetable oils. Annals Agric. Sci., Fac. of Agric., Ain Shams Univ., 28 (1): 395-415.

El-Kady, E.A. (1995). Chemical and Technological studies on some seed oils. M.Sc. Thesis, Fac. Agric., Kafr El-Sheikh, Tanta Univ., Egypt.

El-Sayed, H.; S.T. Kheir and M.B. Atta (1998). Some physico-chemical characteristics and fatty acid composition of roselle (*Hibiscus sabdariffa* L.) seed oil. Assiut J. Agric. Sci., 29(5): 103:113.

FAO/WHO (1973). Food and Agriculture Organization and World Health Organization. Energy and protein requirements. WHO Techn. Rept. Series No. 522, Geneva.

Foda, Y.H.; F.M. Abu-Salem; S. El-Dashleuty; N.M. Rasmy and A. Soror (1986). Chemical constituents of Bolti fish. Annuals Agric. Sci., Fac. Agric., Ain Shams Univ., Cairo, Egypt, 3 : 499-518.

Ismail, A.I. and H.M.A. Mohamed (1997). Characteristics and fatty acid content of oils of some seeds of Malvaceae. Egypt J. Agric. Res., 75 (3): 769-787.

Jane, B. (1992). Food Theory and Applications. Macmillan Publishing Company, New York.

Joslyn, M.A. (1950). Methods in Food Analysis. Academic press. Inc., Publishers, New York.

Kramer, A. and B.A. Twigg (1962). Fundamentals of Quality Control for the Food Industry. AVI Publishing Co. West Port, pp. 512.

Mangold, H.K. (1969). In "Thin-layer Chromatography" Stahl, E. (ed.), Springer, New York, pp. 155-200; 363-421.

Miller, E.L. (1967). Determination of the tryptophan content of feeding stuffs with particular references to cereals. J. Sci. Food Agric., 18: 381-387.

Mohamed, A.; H. Bhardway; A. Hamama and C. Webber (1995). Chemical composition of kenaf (*Hibiscus cannabinus* L.) seed oil. Industrial crops and products, 4 (3): 157-165.

Moore, S. and W.H. Stein (1963). Chromatographic determination of amino acids by the use of automatic recording equipment. In "Methods in Enzymology" Ed. Colowick, S.P. and Kaplan, N.O., 6: 819. Academic Press, N.Y., USA.

Panford, J.A. and J.M. de Man (1990). Determination of cottonseed oil. Influence of fatty acid composition on wavelength selection. JAOCS, 67 (8): 473-482.

Purseglove, J. W. (1976).Tropical Crops. Dicotyledons 1. Third ed. Longman, G.L. Longman, London, pp. 333-374.

Rouser, G.; S. Fieskher and I. Yamamota (1970). Two dimensional thin layers chromatographic separation of polar lipids and determination of phospholipids by phosphorus of spots. Lipids, 5: 444-446.

Sarojini, G.; R.K. Chittemma; P.G. Tulpule and G. Lakshminarayana (1985). Effects of processing on physico-chemical properties and fatty acid composition of *Hibiscus sabdariffa* seed oil. JAOCS., 62 (4): 728-730.

Smolin, L. and M.B. Grosvenor (2000). Nutrition Science and Applications, 3rd Ed, Pub. by Saunders Coule, USA.

Stahl, E. (1965). Thin-layer chromatography. Academic Press Inc. Publishers, New York, London.

Steel, R.G. and J.H. Torrie (1980). Principles and Procedures of Statistics, 2nd Ed., Mc Graw-Hill, New York, USA, pp. 120.

خواص بذور الكركدية كمصدر جديد للزيت

موسى عبده سالم*، حبيب السيد مصطفى، محمود إمام عبدالعزيز**، منتصر رشدى***

*** قسم علوم وتكنولوجيا الأغذية - كلية الزراعة بكفرالشيخ - جامعة طنطا**

**** قسم علوم وتكنولوجيا الأغذية - كلية الزراعة بطنطا - جامعة طنطا**

تم دراسة الخواص الطبيعية والكيماوية لبذرة الكركدية وللزيت المستخلص منها بطريقتى المذيب والعصر. وقد أظهرت النتائج المتحصل عليها أن بذره الكركدية تعتبر مصدر جيد لكل من الزيت والدهن حيث تحتوى على حوالى ٢٢,٢٤% زيت ، ٢٦,٢٥% بروتين، الى جانب ارتفاع محتواها من العناصر المعدنية التالية: البوتاسيوم - الصوديوم - الماغنسيوم - الكالسيوم. كما أوضحت النتائج أن الأحماض الأمينية الأساسية فى بذرة الكركدية هى الليوسين والليسين والفينيل الانين. كما أظهرت نتائج التحليل الكروماتوجرافى ذو الطبقة الرقيقة TLC للزيت أن الجليسريدات الثلاثية هى المكون الأساسى والرئيسى فى الزيت كما أنه يحتوى على كميات متوسطة من الإستيرولات (٣,١٧% و ٣,٤٠% فى الزيت المستخلص بالأثير البترولى وبالعصر على التوالى) واسترات الأستيرولات (٢,٨٤% و ٢,٢٣% على التوالى).

وقد أوضحت نتائج التحليل الكروماتوجرافى الغازى GLC للزيت أن حامض اللينوليك والأوليك والبالميتك هى الأحماض الدهنية السائدة فى الزيت وأن نسبة الأحماض الدهنية الغير مشبعة الى نسبة الأحماض الدهنية المشبعة كانت عالية، كما أنه يحتوى على كميات مرتفعة من البيتاسيتوسترول وعلى كميات متوسطة من الكمبسترول و ستجماستيرول. كما وجد أن طريقة الإستخلاص بالأثير البترولى كانت أفضل لإستخلاص الزيت من بذرة الكركدية مقارنة بطريقة العصر حيث تعطى محصول أعلى من الزيت بالإضافة الى ارتفاع جودة الزيت الناتج.

مما سبق يتضح أن بذرة الكركدية تعتبر مصدر جديد للزيت القابل للإستهلاك الآدمى حيث يتمتع الزيت الناتج منها بصفات طبيعية وكيماوية متشابهة مع بعض الزيوت النباتية الأخرى