Comparative Study of Morphological Characteristics and Chemical Constituents for Seeds of Some Grape Table Varieties

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Abstract: This study was conducted to evaluate morphological characteristics and chemical constituents of six seeded grape varieties of the *Vitis vinifera* L. grapes namely: Rich Baba; Red Globe; Roumi Ahmer; Black Rose; Matrouh Eswed and Ribier. Results indicated that Ribier and Matrouh Eswed recorded the lowest number of seeds per berry, followed in an ascending order by Black Rose, Roumi Ahmer, Rich Baba and Red Globe. Red Globe, Black Rose and Rich Baba recorded the highest average weight of seeds per berry, while Roumi Ahmer, Ribier and Matrouh Eswed recorded the lowest average weight of seeds per berry. Black Rose, Red Globe and Roumi Ahmer seeds recorded the highest total carbohydrates content, while Rich Baba, Matrouh Eswed and Ribier seeds recorded the lowest total carbohydrates content. Black Rose, Red Globe, Roumi Ahmer and Rich Baba seeds recorded the highest crude protein content, followed by Matrouh Eswed and Ribier seeds. Black Rose and Red Globe seeds recorded the highest tannins content, followed in a descending order by Roumi Ahmer, Rich Baba, Ribier and Matrouh Eswed seeds. Black Rose, Red Globe, Roumi Ahmer and Rich Baba seeds recorded the highest oil yield, while Matrouh Eswed and Ribier seeds recorded the lowest oil yield. From these findings, it can be concluded that Black Rose, Red Globe, Roumi Ahmer and Rich Baba seeds could be used in animal feed production, based on the high carbohydrates and proteins. Although Matrouh Eswed and Ribier seeds are low in carbohydrates and proteins content, they are still suitable for animal feed production due to the low tannins content. Black Rose, Red Globe, Roumi Ahmer and Rich Baba seeds are suitable also for production of oil, due to the high oil yield with high level of unsaturated fatly acids, which gives it excellent dietetic properties for human consumption and makes it useful in the field of various food industries.

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1. Introduction

Grapes are one of the fruit crops grown widely in many areas of the world (Anonymous, 1999). Grapes belong to the family Vitaceae, cultivated originally in Asia, in addition to minor grows in south Europe, North Africa and Middle East (Chopra *et al*., 1970).

The non-processed residues of grapes such as the seed still constitute more of a disposal problem than valuable byproducts. Grape seeds comprise 20 to 26% of the pomace (Kamel *et al*., 1985). Grape seeds contain about 26.43% of total carbohydrates (Owon 1999) and about 6.26% of protein content (Mironeasa *et al*., 2010). Also, grape seeds contain antioxidants (polyphenols, including proanthocyanidins) (Joshi *et al*., 2001). Oil of grape seeds constitutes from 10 to 20% of the weight of seeds (Schuster, 1992). Also, grape seed oil contains nutritionally useful essential fatty acids and tocopherols (vitamin E) (El-Mallah, and Murui, 1993). Moreover, it is a highly concentrated source (76%) of linoleic acid (Anderson, 1998). Oil of grape seeds having a smoke point of 320°F (160°C) can safely be used in cooking as low fat diet and also used in salad dressing, margarine, deep frying, baking and massage oil. It helps in skin retain (the normal structure of the epithelium and nerve cells) and is also used in sunburn lotions, hair products, body hygiene cream, lip balm and hand cream (Joshi *et al*., 2001).

The purpose of the present study was to evaluate morphological characteristics and chemical constituents for six seeded grape varieties of the *V. vinifera* grapes namely: Rich Baba; Red Globe; Roumi Ahmer; Black Rose; Matrouh Eswed and Ribier.

2. Material and Methods

This study was conducted for 2010 season in a private vineyard located at El-Khatatba, Menoufiya governorate; to evaluate morphological characteristics and chemical constituents for six seeded grape varieties of the *V. vinifera* grapes namely: Rich Baba; Red Globe; Roumi Ahmer; Black Rose; Matrouh Eswed and Ribier. Vines were nine years old grown in a sandy loam soil spaced 2 x 3 m apart and irrigated by the drip irrigation system. Vines were cane pruned and trellised

by the Spanish Parron system. Five hundred seeds were taken for each variety. Each one hundred acted as a replicate and each five replicates were chosen for each cultivar under study.

The following parameters were adopted to evaluate for seeds of the tested varieties:-

Morphological characteristics:

Average number of seeds/berry

Average weight of seeds/berry (mg)

Average seed weight (mg)

Average seed length (mm)

Average seed width (mm)

Chemical Constituents:

Determination of moisture content (%)

The seeds taken of each replicate were weighed, oven dried at 70°C until constant weight and the average seed fresh weight (g) was determined as recommended by A.O.A.C. (2000). The percentage of fresh weight was calculated on a total seed weight basis.

Determination of ash (%)

Average seed dried sample (0.2 g) was weighed in a porcelain crucible and placed in a temperature-controlled muffle furnace at 550°C for several hours until a constant weight was determined as recommended by A.O.A.C. (2000). The percentage of ash was calculated on a dry weight basis.

Determination of total carbohydrates (%)

A known weight (0.2 g) of dried sample was placed in a test tube, then 1N HCl acid (10 ml) was added. The tube was sealed and placed for 6 hours in an oven at 100°C. The solution was then filtered and the filtrate was clarified by the leading and deleading method using lead acetate solution (137 g/L) and the excess of lead salt was precipitated using N/3 potassium oxalate solution. The extract was measured into a measuring flask (50 ml). The combined filtrate was completed to the mark with distilled water. Total carbohydrates were determined according to the method of Dubois *et al*., (1956) as follows: an aliquot of 1 ml of the sugars solution was quantitatively transferred into a test tube and treated with 1 ml 5% aqueous phenol solution followed by 5 ml of concentrated sulfuric acid added by a fast delivery pipette. The blank experiment was carried out using 1 ml of distilled water instead of the sugar solution. The absorbance of yellow-orange color was measured in spectrophotometer at wavelength of 490 nm.

A standard curve was prepared using known concentrations of glucose. The established curve was used to convert the colorimeter O.D. into milligrams of glucose. The data was expressed as g/100 g D.W.

Determination of crude protein (%)

The seeds were oven dried at 70°C until a constant weight, then ground to a powdery mixture and 0.2 g was taken to determine the nitrogen content in the digested solutions (with concentrated sulfuric acid) by modified micro kjeldahl methods as described by Pregl (1945). Nitrogen content was multiplied by 6.25 to obtain the crude protein content.

Determination of polymeric procyanidins (Tannins) (%)

Tannins in the samples were detected by Adams procedure (Harbertson *et al*., 2002) as follows: seed extracts were diluted, 10 µL of the aqueous extract with 990 µL of 12% ethanol (v/v) containing 5 g/L potassium bitartrate, and adjusted to pH 3.3 with HCl, then the absorbance was recorded at 280 nm.

The reversed-phase HPLC analysis of seed extracts was carried out using authentic standards for identification of catechin, epicatechin, and epicatechin gallate in the elution profile (Lamuela-Raventos, and Waterhouse, 1994).

A standard curve was prepared using (+)-catechin in the range of 50 to 300 µg by combining aliquots of a 1 mg/mL solution of catechin in 10% ethanol with the TEA/SDS buffer to give a final volume of 875 µL. Then 125 µL of the $FeCl_3$ reagent was added and the mixture was vortexed and incubated at room temperature for 10 min before reading the absorbance at 510 nm. A zero catechin sample was prepared by adding 125 µL of the $FeCl_3$ reagent to 875 µL of the TEA/SDS buffer, and the absorbance (510 nm) of this solution was subtracted from each of the points on the standard curve. Tannin values for seed extracts and wines were obtained from the standard curve, thus values for tannin are reported in catechin equivalents. The data were recorded on basis of dry extract.

Determination of phenolic compounds (%)

Grape seeds (*V. vinifera* L.) were handily separated from grape berries, then washed with tap water and then left to dry in open air away from direct sunlight. They were crushed in a coffee grinder for 2 min, but during this time the grinding was halted for 15 sec at periodic intervals to prevent heating of the sample. The samples were wrapped and stored at -18°C until the extractions were performed.

Extraction of phenolic compounds was conducted according to the method described by Daniel and George (1972) as follows: 1g of dry crushed grape seeds were macerated in 5-10 ml 80% ethanol for at least 24 hours at 0°C. The alcohol was clarified; the remained residue was re-extracted with 5-10 ml 80% ethanol 3 times. At the end, the clarified extract was completed to 50 ml using 80% ethanol.

The colorimetric method of Folin-Denis as described by Daniel and George (1972) was employed for the chemical determination of phenolic compounds as follows: Folin-Denis reagent was prepared by mixing sodium tungstate (100 g) with sodium molybdate (25 g), water (700 ml), phosphoric acid (50

ml, 85%) and concentrated hydrochloric acid (100 ml) in 1.5 L. conical flask. The flask was attached to a reflux condenser and gently boiled for 10 hours. After cooling to room temperature, lithium sulfate (150 g), water (50 ml) and a few drops of liquid bromine were added. The mixture was then boiled without condenser for about 15 min to remove excess bromine, then cooled, diluted to 1 liter and filtered (A.O.A.C., 1967).

Saturated solution of sodium carbonate was prepared by dissolving anhydrous sodium carbonate (35 g) in water (100 ml) at 70-80°C. The solution was cooled, kept over night and filtered.

An aliquot of 0.5 ml of the previous extract and 0.5 ml of Folin-Denis reagent were well mixed in a dry test tube, the tube was thoroughly shaken for 3 min., 1.0 ml of saturated Na_2CO_3 solution was added, mixed well and 3 ml of distilled water were added. After one hour quantities were determined by reading the developed blue color at 725 nm. 0.5 ml 80% ethanol and reagents only were used as a blank.

Determination of percentage of oil (%)

Dried seeds were crushed in a grinder for two min, but at 15 s intervals the process was stopped for 15 s to avoid heating the sample. Oil content was determined according to the AOCS method (A.O.A.C., 1990). The powdered grape seeds (5 g) were extracted in a Soxhlet extractor (Büchi Universal Extraction System B-811, Germany) for 6 h with 150 mL of hexane at 60°C.

Identification and determination of fatty acids

The extracted oil was saponified with alcoholic potassium hydroxide (20 ml, 60% w/v), left over night for complete saponification and then heated at 60°C for 15 min on a water-bath. The fatty acids were obtained by treating the aqueous layer with sulphuric acid (20% v/v) and the liberated fatty acids were extracted three times with diethyl ether. The combined ether extract was washed several times with distilled water and dried over anhydrous sodium sulphate. The separation of fatty acids was performed according to the method described by Farag *et al*., (1990) as follows: the fatty acids were methylated with ethereal solution of diazomethane, the solvent was evaporated at room temperature and the residue was dissolved in a small quantity of chloroform. An aliquot of this solution was injected into GC.

Fatty acids of seeds oil extracted were identified and determined using an Hewlet-packard-GC 5890 plus series gas chromatograph equipped with a flame ionization detector and a HP-5 capillary column (25 m X 0.32 mm (i.d.)) was used. The sample was injected into the column using Hamilton microsyringe. The gas chromatographic conditions used a temperature program as follows: Initial column temperature was 110°C, raised to 180°C by a rate of 25°C/min then raised to 210°C by a rate of 3°C/min, then stopped. Detector temperature was 250°C, and injector temperature was 150°C. The flow rate of gases was nitrogen 1.5 ml/min, hydrogen 30 ml/min, and air 330 ml/min. The fatty acids were identified and calculated according to authentic sample of fatty acids chromatographed under the same conditions.

Statistical analysis

The completely randomized design was adopted for this investigation. The obtained data were statistically analyzed according to Snedecor and Cochran (1990). The new LSD values at 5% level were taken as a measure for comparing among means of treatments.

3. Results and Discussion

Morphological characteristics of seeds

Data in Table 1 and Figure 1 revealed the morphological characteristics of seeds, i.e. average number of seeds/berry, average weight of seeds and average seed dimensions.

Average number of seeds/berry

Results showed that amongst different varieties, it is obvious that Red Globe and Rich Baba recorded the highest number of seeds per berry followed in a descending order by Roumi Ahmer and Black Rose. On the other hand, Matrouh Eswed and Ribier grape recorded the lowest number of seeds per berry.

These results are in accordance with Cortell *et al.,* (2005) who noticed that the higher number of seeds per berry in the low-vigor zones on Grape (*V. vinifera* L. Cv. Pinot Noir). In addition, Khan *et al*., (2008) showed that amongst different varieties, Haita grape variety contains 1-2 large seeds, Sahibi grape variety contains 1-3 medium seeds, while Tor grape variety contains 1-4 fairly seeds.

Average weight of seeds

As regards weight of seeds/berry, it is noticed that Red Globe, Black Rose and Rich Baba grape seeds varieties were significantly recorded the highest average weight of seeds per berry, while Roumi Ahmer, Ribier and Matrouh Eswed recorded the lowest average weight of seeds per berry.

With respect to average seed weight, it is obvious that Red Globe and Black Rose recorded the highest average of seed weight. On the other hand, Rich Baba, Ribier, Roumi Ahmer and Matrouh Eswed recorded the lowest average of seed weight.

The obtained results are in agreement with those reported by Obreque-Slier *et al.,* (2010), who found that the seed weight of Carmenere and Cabernet Sauvignon grapes experienced a significant decrease from veraison stage to harvest stage.

Average seed length and width

Concerning average seed length, it is noticed that Red Globe seeds recorded the highest average of seed length, followed in a descending order by Black Rose, Roumi Ahmer, Rich Baba and Ribier seeds. On

the other hand, Matrouh Eswed seeds recorded the lowest average of seed length.

Table 1: Morphological characteristics for seeds of some grape table varieties

Variety	Average number of seeds/berry	Average weight of seeds/berry (mg)	Average seed weight (mg)	Average seed length (mm)	Average seed width (mm)
Rich Baba	4	184	46	7.0	4.4
Red Globe	5	315	63	9.3	5.1
Roumi Ahmer	3	129	43	7.3	4.2
Black Rose	3	186	62	7.6	5.8
Matrouh Eswed	2	82	41	6.1	3.9
Ribier	2	88	44	6.9	4.2
new L.S.D. (0.05)	2	135	17	1.4	1.9

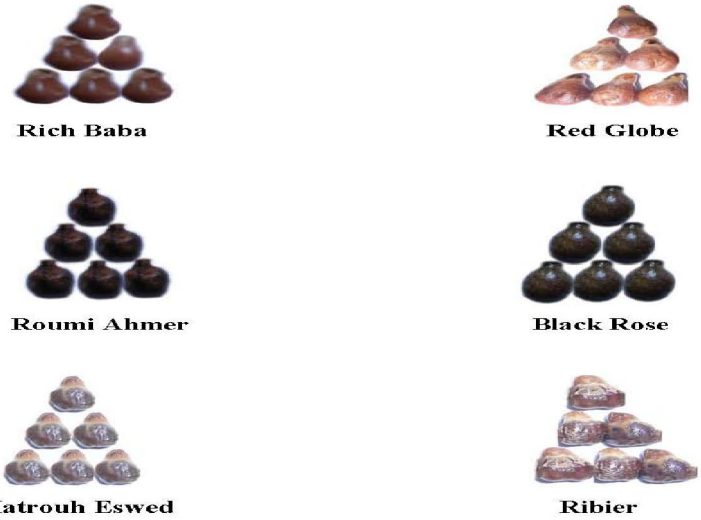

Figure 1: Morphological characteristics for seeds of some grape table varieties

With respect to average seed width, it is obvious that Black Rose seeds recorded the highest average of seed width, followed in a descending order by Red Globe, Rich Baba, Roumi Ahmer, and Ribier seeds. On the other hand, Matrouh Eswed seeds recorded the lowest average of seed width.

These results are in line with Çalisir *et al.,* (2005), who found, on studying Turkey okra seeds, which the length of about 81% of the seeds ranged from 6.8–8.2 mm and the width of about 78% of the seeds ranged from 3.95–4.65 mm at 5.21% moisture content. On the other hand, the length of about 86% of the seeds ranged from 7.4–9 mm and the width of about 87% of the seeds ranged from 4.15–5.1 mm at 16.55% moisture content. Also, Mironeasa *et al.,* (2010) noticed that the results obtained from the determination of the grape seeds dimensions, i.e. length and width depend on the variety, obtaining method and cultivation area. In addition, Ahmadi and Siahsar (2011) showed that the dimensions of Bojnordi and Fakhri grape cultivars seeds were significantly affected by the moisture content in the both cultivars. The length and width of both cultivars seeds increased linearly with increasing moisture content.

Chemical Constituents

Data in Tables 2 and 3 revealed the chemical constituents of seeds, i.e. moisture content, ash content, total carbohydrates, crude protein, polymeric procyanidins (tannins), phenolic compounds, percentage of oil and identification and determination of fatty acids.

Percentage of moisture

As shown in Table 2, it is noticed that Black Rose, Roumi Ahmer and Red Globe seeds recorded the highest moisture content, while Matrouh Eswed, Ribier and Rich Baba seeds recorded the lowest moisture content.

These results are in accordance with Razavi and Fathi (2009). They showed that moisture content of grape (*V. vinifera* L.) seeds were determined as a function of seed varying from 5.21–16.55% (on dry basis). Also, Selcuk *et al.,* (2011) found that moisture

content of byproduct grape seeds from grape pekmez production was significantly higher than winery byproduct. Major constituent of grapes is water, which is essential in numerous chemical reactions during grape growth and processing into a variety of products. In addition, Ahmadi and Siahsar (2011)

showed that all physical properties of the grape cultivars seeds were significantly affected by the moisture content in the studied range of 11.5 to 23.9% on dry basis. The relationships between physical properties and moisture content were linear for Bojnordi and Fakhri grape cultivars.

Table 2: Chemical constituents for seeds of some grape table varieties

Variety	Average moisture (%)	Average ash (%)	Total carbohydrates (%)	Crude protein (%)	Polymeric Procyanidins (%)	Total phenol (%)	Oil yield (%)
Rich Baba	10.83	2.53	18.51	7.42	79.93	4.83	14.9
Red Globe	13.26	2.59	19.21	7.65	83.71	5.03	15.4
Roumi Ahmer	13.12	2.57	18.63	7.53	81.03	4.96	15.1
Black Rose	14.76	2.68	26.11	7.71	85.12	5.19	16.3
Matrouh Eswed	11.79	2.56	15.59	6.51	76.90	4,71	14.8
Ribier	11.54	2.52	14.13	6.58	74.83	4.68	14.5
new L.S.D. (0.05)	2.17	0.13	7.49	1.07	3.02	0.24	2.7

Percentage of ash

Results in Table 2 showed that Black Rose, Red Globe, Roumi Ahmer and Matrouh Eswed seeds recorded the highest ash content. On the other hand, Rich Baba and Ribier seeds recorded the lowest ash content.

The obtained results are in agreement with those reported by Owon (1999) who found that grape (*V. vinifera*) seeds contain about 2.86% of ash. Also, Mouhammad and Ali (2008) studied the grape (*V. vinifera*) seeds of two Syrian cultivars for chemical composition. They noticed that Syrian grape seeds contain about 1.45–1.65% of ash content. In addition, Mironeasa *et al.,* (2010) noticed that the results obtained from the determination of the grape seeds ash content were ranged from 2.14 to 8.28% according to cultivar.

Percentage of total carbohydrates

As shown in Table 2, it is noticed that Black Rose, Red Globe and Roumi Ahmer seeds recorded the highest total carbohydrates content, while Rich Baba, Matrouh Eswed and Ribier seeds recorded the lowest total carbohydrates content.

These results are in accordance with Owon (1999), who found that grape (*V. vinifera*) seeds contain about 26.43% of total carbohydrates. In addition, Mouhammad and Ali (2008) studied the grape (*V. vinifera*) seeds of two Syrian cultivars for chemical composition. They noticed that Syrian grape seeds contain about 15.55–15.65% of total carbohydrates.

Percentage of crude protein

Results in Table 2 showed that Black Rose, Red Globe, Roumi Ahmer and Rich Baba seeds recorded the highest crude protein content. On the other hand, Ribier and Matrouh Eswed seeds recorded the lowest crude protein content.

The obtained results are in agreement with those reported by Ohnishi *et al.,* (1990), who reported that the seeds of the different grape cultivars have high protein content. In addition, Mironeasa *et al.,* (2010) noticed that the results obtained from the determination of the grape seeds protein content were ranged from 6.26-9.01% according to cultivar.

Percentage of polymeric procyanidins (tannins)

As shown in Table 2, it is obvious that Black Rose and Red Globe seeds recorded the highest procyanidins content, followed in a descending order by Roumi Ahmer and Rich Baba seeds, while Matrouh Eswed and Ribier seeds recorded the lowest procyanidins content.

These results are in accordance with Porter (1994), who found that procyanidins or condensed tannins are the oligomeric and polymeric polyhydroxyflavan-3-ol units, that are ubiquitous in plants and constitute the 2nd most abundant group of natural phenolics after lignin. Also, Agli *et al.,* (2004) found that the grape seed extract was composed of 89.3% proanthocyanidins. Similarly, Atanassova (2009) noticed that grape (*V. vinifera*) seeds contain about 93.44% of the tannins. In addition, Slier *et al.,* (2010) noticed that total tannins of seeds from Carmenere and Cabernet Sauvignon grapes were decreased with advance of ripening stage. Total tannins were higher in Cabernet Sauvignon seeds than in Carmenere seeds.

Percentage of phenolic compounds

Results in Table 2 showed that Black Rose, Red Globe and Roumi Ahmer seeds recorded the highest total phenolics content. On the other hand, Rich Baba, Matrouh Eswed and Ribier seeds recorded the lowest total phenolics content.

The obtained results are in agreement with those reported by Pastrana-Bonilla *et al.,* (2003), who found that the two most abundant phenolic compounds for the grape seeds are catechin and epicatechin. Ellagic acid, resveratrol, myricetin, quercetin, and kaempferol were found in the skins and

gallic acid was found as one of the phenolic compounds present in grape seeds. In addition, they noticed that the total phenolics in grape parts were, on average, five times more concentrated in the seeds than in the skin and 80 times more than in the pulp. Also, Monagas *et al.,* (2006) noticed that Graciano grape seeds possess total phenol similar to Cabernet Sauvignon grape seeds for blending with Tempranillo grape seeds. In addition, Canals *et al.,* (2008) noticed that grape seeds are richer in phenols than skins or pulp, in both red and white grapes and these concentrations increase with an increase in grape seed concentration or the length of maceration. Moreover, Rababah *et al.,* (2008) studied the total phenol of different grape seed cultivars. The total phenolics of grape seed extract ranged from 4.66 to 5.12 g/100 g extracts. In addition, Gođevac *et al.,* (2010) noticed that the amounts and distribution of various phenolic compounds in grape seeds depend directly on the cultivar. Also, Slier *et al.,* (2010) noticed that total phenol of seeds from Carmenere and Cabernet Sauvignon grapes were decreased with advance of ripening stage. Total phenols were higher in Cabernet Sauvignon seeds than in Carmenere seeds.

Percentage of oil

As shown in Table 2, it is obvious that Black Rose, Red Globe, Roumi Ahmer and Rich Baba seeds recorded the highest oil yield, while Matrouh Eswed and Ribier seeds recorded the lowest oil yield.

These results are in line with Owon (1999), who found that grape (*V. vinifera*) seeds contain about 12.69% of oil. Also, Baydar and Akkurt (2001) showed that the oil concentration of 18 grape cultivar seeds ranged from 11.6 to 19.6%. In addition, Akhter *et al.,* (2006) reported that oil yield obtained are 13.0%, 6.6%, 8.8%, 4.3%, 9.6% and 11.7% for the Perlette, Anib-e-Shah, Madess Field, Black Hobbage, South Columbia and Autumn grape seeds cultivars, respectively. In this respect, Rababah *et al.,* (2008) studied the oil contents of different grape seed cultivars. Baladi black and Asbani black grape seed cultivars had the highest amount of oil content; 14.52 and 14.22 g /100 g seed, respectively, followed by Baladi green grape seed cultivar (13.28 g /100 g seed), Ajloni green grape seed cultivar (12.24 g/100 g seed), and Khudari green grape seed cultivar (10.92 g/100 g seed), respectively. Also, Tangolar *et al.,* (2009) studied the oil contents of nine grape seed cultivars (Alphonse Lavallée, Muscat of Hamburg, Alicante Bouschet, Razakı, Narince, Öküzgözü, and Horoz karası, Salt creek and Cosmo 2). The oil contents were found to be different for each cultivar, which ranged from 10.45% to 16.73% for Razaki and Salt creek grape seeds cultivars, respectively. In addition, Ahmadi and Siahsar (2011) showed that the oil content of the grape cultivars seeds were significantly affected by the type of cultivar, the oil content obtained are 16 and 14.7% for the Bojnordi and Fakhri grape cultivars seeds, respectively. Also, Sabir *et al.,* (2012) reported that the grape seed oil concentration of some different cultivars ranged from 7.3 to 22.4%

Identification and determination of fatty acids

Data in Table 3 showed that the total fatty acids in the seeds of six grape cultivars contain about 86.26 to 88.62% of the total unsaturated fatty acid, while the total saturated fatty acid were 11.34 to 13.68%. Lenoleic acid (C18:2) is the major component of the main unsaturated fatty acid, while the main saturated fatty acid is palmetic acid (C16:0).

The ranges of fatty acids in the seeds of six grape cultivars were 62.82 to 72.54% for lenoleic acid (C18:2), followed in a descending order from 15.19 to 22.17 for oleic acid (C18:1), 7.22 to 7.96 for palmitic acid (C16:0), 3.84 to 5.71 for stearic acid (C18:0) and less than 1% for linolenic acid (C18:3), palmitoleic acid (C16:1), arachidic acid (C20:0), arachidonic acid (C20:1), margaric acid (C17:0) and margaoleic acid (C17:1).

The obtained results are in agreement with those reported by Baydar and Akkurt (2001), who reported that the ranges of fatty acids in the seeds of 18 grape cultivars were 6.5 to 9.7% for palmitic acid, 3.5 to 7.3% for stearic acid, 17.8 to 26.5% for oleic acid, 60.1 to 70.1% for linoleic acid and less than 1% for linolenic acid. Similarly, Akhter *et al.,* (2006) reported that the ranges of fatty acids in the seeds of six grape cultivars (Perlette, Anib-e-Shah, Madess Field, Black Hobbage, South Columbia and Autumn) were 7.3 to 11.1% for palmitic acid, 3.2 to 15.0% for stearic acid, 16.7 to 19.8% for oleic acid, 71.7 to 76.6% for linoleic acid and less than 2% for linolenic acid. In this respect, Stefaine *et al.,* (2007) found that grape seed oil includes high amount of essential fatty acids such as, linoleic acid (69-78%), palmitic acid (5-11%), oleic acid (15-20%) and stearic acid (3-6%). Also, Matthäus (2008) showed that grape seed oil has a high content (70%) of linoleic acid, whereas the total part of unsaturated fatty acids amounts to about 90%. In addition, Mouhammad and Ali (2008) studied the grape (*V. vinifera*) seeds of two Syrian cultivars for chemical composition. They noticed that Syrian grape seeds contain oils having 7–11 fatty acids; palmetic acid (11.91–11.69%) is the main saturated fatty acid, while the main unsaturated is lenoleic acid (66.64–68.31%). The grape oil obtained shows a high level of unsaturated fatly acid (83.49–84.26%), which gives it excellent dietetic properties. In this trend, Ahmadi and Siahsar (2011) studied the fatty acids composition of the Bojnordi and Fakhri cultivars of grape seeds. Fatty acid composition for both cultivars of grape seeds consisted of palmitic, stearic, oleic, linoleic and linolenic acid. The values for palmitic, stearic, oleic,

linoleic and linolenic acid for the Bojnordi cultivar were 9.56, 4.37, 22.87, 62.85 and 0.33% and for the Fakhri cultivar were 9.22, 4.33, 19.75, 66.40 and 0.28%, respectively. In addition, Sabir *et al.,* (2012) reported that linoleic acid is the major component comprising 53.6–69.6% of the total fatty acids, followed by oleic (16.2–31.2%), palmitic (6.9–12.9%) and stearic (1.44–4.69%).

Table 3: Chemical constituents of fatty acids for seeds of some grape table varieties

Variety	Rich Baba	Red Globe	Roumi Ahmer	Black Rose	Matrouh Eswed	Ribier
Palmitic acid, C16:0	7.63	7.26	7.22	7.28	7.25	7.96
Palmitoleic acid, C16:1	0.38	0.18	0.24	0.14	0.16	0.34
Margaric acid, C17:0	0.05	0.05	0.06	0.06	0.12	0.06
Margaoleic acid, C17:1	0.02	0.02	0.03	0.06	0.03	0.02
Stearic acid, C18:0	5.71	3.84	4.73	4.32	4.37	4.78
Oleic acid, C18:1	22.17	15.19	20.94	17.53	17.66	19.85
Linoleic acid, C18:2	62.82	72.54	65.44	69.62	69.11	65.65
Linolenic acid, C18:3	0.59	0.41	0.61	0.43	0.54	0.64
Arachidic acid, C20:0	0.29	0.19	0.31	0.23	0.30	0.30
Arachidonic acid, C20:1	0.28	0.28	0.37	0.27	0.41	0.34
Trace components	0.06	0.04	0.05	0.06	0.05	0.06
Total saturated fatty acid	13.68	11.34	12.32	11.89	12.04	13.10
Total unsaturated fatty acid	86.26	88.62	87.63	88.05	87.91	86.84

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