Effect of Cultivar on Yield, Acceptability, Physicochemical Properties, Bioactive Components and Antioxidant Activity of Pomegranate (*Punica granatum* L.) Juice

Faten, F. Abdel-Salam, Esmat, S. El-Zalaki & Moharram, Y.G.

Food Science and Technology Dept., Fac. of Agric.,
El-Shatby, 21545, Alexandria Univ., Alexandria, Egypt

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ABSTRACT

Four pomegranate cultivars; namely, *Edkawy*, *Manfaloty*, *Sahrawy* and Wonderful were investigated in the present study. Yield, acceptability, colour measurement, physicochemical properties, bioactive components and antioxidant activity of the juice extracted from both of the whole fruits and fruit arils were evaluated. Statistical significant differences were demonstrated in the measured parameters between cultivars and the source of the extracted juice. The yield of the juice was generally higher when extracted from the arils than from the whole fruits. Wonderful cultivar showed the highest yield of the four cultivars. The highest values of the total soluble solids, total sugars, reducing sugars, and total acidity were found in the extracted juice of Wonderful cultivar followed by those from *Edkawy*, *Manfaloty* and *Sahrawy,* respectively. The maturity index, indicated that the four cultivars belong to the sweet class of pomegranate. The L*, a*,b * Hunter colour values revealed that both of the whole fruit and aril juices from the four cultivars had a dark dull colour with purplish hue. The darkness and dullness were more pronounced in *Edkawy* juice than that of the other cultivars, especially Wonderful. The aril juices generally showed more darkness and dullness than the whole fruit juices. The most acceptable juice was that of wonderful, particularly upon extraction from the whole fruits. Except for the total anthocyanins ,the total phenolic compounds ,total flavonoids, total tannins and antioxidant activity were higher in whole fruit juices compared with arils juices, particularly from *Edkawy* and Wonderful cultivars. In contrast, the total anthocyanin content was higher in aril juice than whole fruit juice, especially that of *Edkawy* cultivar.

Key Words*: *pomegranate, yield, physico-chemical, antioxidant activity, DPPH, FRAP, phenolic compounds, Acceptability.

INTRODUCTION

Pomegranate (*Punica granatum* L.) is one of the oldest edible fruits. It is widely grown in parts of Asia, North Africa, around the Mediterranean areas and the Middle east (Sarkhosh *et al*., 2006). It is popularly consumed as fresh fruits, fresh juice, beverages and other processed products. Also, its extract is used as a botanical ingredient in herbal medicines and dietary supplements (Zhou *et al*., 2011).

Pomegranate fruit is rich in several bioactive components. The major group is polyphenols (Elfalleh *et al*., 2011). Pomegranate polyphenols include flavonoids*;* namely, flavonol, flavanols and anthocyanins, condensed tannins (proanthocyanidins) and hydrolysable tannins*;* namely, ellagitannins and gallotannins (Legua *et al*., 2012).

Anthocyanins are the water soluble pigments responsible for the appealing bright red colour of the juice and other products of pomegranate fruits, as reported by Einbond *et al.* (2004). The stability of anthocyanins is influenced by various factors such as temperature, pH, light and oxygen, in addition to the degradation oxidizing enzymes as polyphenol oxidase, as demonstrated by the fast tests of Dionex Corporation (2010).

Hydrolysable tannins are the predominant polyphenols in pomegranate juice which are responsible of its antioxidant activity. Therefore, pomegranate juice can provide protection against cardiovascular diseases and stroke by acting as a potent antioxidant against LDL oxidation and inhibition of atherosclerosis development. Also, consumption of pomegranate juice has been associated with the inhibition of prostate cancer in men, reduction in serum oxidative stress in plasma of type two diabetes mellitus, and improving metabolic health. Such activities may be related to diverse phenolic compounds in pomegranate juice including punicalagin isomers, ellagic acid derivatives and anthocyanins (Gundogdu & Yilmaz, 2012).

The taste of pomegranate fruit and its products depends mainly on its acid-sugar balance and polyphenol content. Generally, acids decrease from sweetness and increase sourness. The proportion of total acid content to sugar level is used as a criterion of fruit maturity. Phenolic substances may gain the pomegranate juice an astringency taste (Fadavi *et al*.,2005).

The total cultivated area of pomegranate in Egypt increased from 10171 feddans in year 2010 to 26851 feddans in year 2012, with an increase in the annual yield of feddan from 8.50 tons to be 17.95 tons, respectively, according to Agriculture Directorates of Governorates (2013). This was mainly due to the introduction of the new pomegranate cultivars especially Wonderful, which replaced some of the locally cultivated varieties such as *Edkawy*, *Sahrawy* and *Manfaloty*, particularly in the reclaimed dessert lands. The increment awareness about pomegranate bioactive compounds and its juice nutritional effects led to increase the cultivated area together with the development of pomegranate processing in Egypt.

Accordingly, the present study was carried out to demonstrate the influence of cultivar on yield, physicochemical and sensory properties, bioactive components and antioxidant activity of the pomegranate juice. The predominant four pomegranate cultivars cultivated in Egypt; namely, *Edkawy*, *Manfaloty*, *Sahrawy* and Wonderful were investigated. This was carried out with the aim of further study to select the most promising pomegranate cultivar for commercial cultivation and processing.

MATERIALS AND METHODS

Materials

Approximately 30 Kg of pomegranate (*Punica granatum* L.) fruits, at harvesting maturity from four cultivars; namely ,*Edkawy*, *Sahrawy, Manfaloty* and Wonderful, were purchased from commercial fruits and vegetables market in Alexandria city, Egypt in August 2014 and 2015. The fruits were transported and stored at 10^{o}C in the postharvest technology center, Faculty of Agriculture, Alexandria University, Egypt. All the chemicals and reagents used in this study were of an analytical grade.

Methods

Juice extraction and yield

Pomegranate juice was extracted from either the whole fruits or the arils by using a hand press after cutting into halves. Arils were manually separated after cutting the washed fruit into four pieces and removing the fruit peel and skin covering the arils. The separated arils were mixed in an electric mixer for 30 sec. The extracted juice from each of the whole fruits and the arils was filtered through muslin cloth to remove any suspended matters before storage at -18^{o}C until analysis. The yield of juice was calculated from the extracted juices taken from 5 random chosen fruits and 100 g of arils separated from 5 random chosen fruits of each cultivar. Yield was expressed as volume of juice per 100g of fruits or arils (Hmid *et al*., 2013).

Colour measurement

Hunter Lab colourimeter (Ultra scan vis, USA) was used to measure the colour index of both of the whole and arils juices of pomegranate fruits. Five readings of the colour index of the Hunter scale (L*, a*, b*) were recorded. The instrument was standardized during each sample measurement with a black and a white tail (L*= 99.1, a*= -1.12, b*= 1.26) ,where colour is represented by whiteness or brightness / darkness (L*), redness / greenness (a*) and yellowness / blueness (b*) (Piggott, 1988).

Analytical methods

Analytical tests were carried out in triplicates. Total soluble solids (TSS) was measured by hand Atago referactometer. Titratable acidity (TA) as citric acid (%) was determined by titration of the diluted homogenized juice with 0.1 M NaOH to an end point of pH 8.2 using a pH meter. The pH value of juice was assayed by a digital pH meter after homogenization of 2 ml of the juice with 25 ml distilled water. Vitamin C (mg/100 ml) was determined by a volumetric method using 2,6 dichlorophenol indophenol. Reducing sugars (%) were determined by Lane-Eynon method. Total sugars were determined after hydrolyzing non reducing sugars with 2.5 N HCL for 3 hr at 70°C according to the AOA C (2000). The difference between reducing sugars content after and before hydrolysis of total sugars was recorded as non reducing sugars.

Folin –Ciocalteu reagent was used to assay total phenolics of the juice using tannic acid as a standard. The reaction mixture was kept in dark at ambient temperature (22±2°C) for 2 hr before measuring the absorbance at a wave length of 765 nm using UV-Vis. Spectrophotometer (Laxco-Alpha-1102, Suite). pH differential method using two buffer systems, potassium chloride buffer, pH 1 (0.025 M) and sodium acetate buffer, pH 4.5 (0.1M) was used to estimate the total anthocyanins content as mg as cyanidin-3-glucoside/ L of juice (Ozgen *et al.*, 2008). Total flavonoids content of the juice was spectrophotometrically determined at a wave length of 430 nm using UV-Vis Spectrophotometer (Laxco-Alpha-1102, Suite) as mentioned by Hmid *et al.* (2013). The method is based on the formation of complex flavonoid- aluminum. Rutin was used as a standard and the flavonoid level was expressed as mg of rutin equivalent per liter of juice. Total tannins in juice were estimated as tannic acid using the spectrophotometric procedure at a wave length of 760 nm as described in the AOAC (2000).

Antioxidant activity of pomegranate juice was estimated by two methods.

The first method was the ferric reducing antioxidant power (FRAP) of Jayanthi & Lalitha (2011). The method measures the total antioxidant capacity using potassium ferricyanide (Fe^{+++}) to form potassium ferrocyanide (Fe^{++}) which then reacts with ferric chloride to form ferric ferrous complex with an absorption maximum at a wave length of 700 nm. In this method, an aliquot of 40 µL of diluted juice was withdrawn. A mixture of methanol: water 6:4 v/v was used to dilute pomegranate juice in a ratio of 1:20 v/v mixed with 2.5 ml of 0.2M phosphate buffer (pH 6.6) and 2.5 ml potassium ferricyanide (1% w/v) then kept at 50 °C in a water bath for 20 min. After cooling, 2.5 ml of 10% trichloroacetic acid (TCA) solution was added and the mixture was centrifuged at 3000 xg for 10 min. The supernatant was separated and mixed with 5 ml distilled water and 1 ml freshly prepared 0.1% ferric chloride solution. The absorbance was measured at a wave length of 700 nm by UV-Vis spectrophotometer (Laxco-Alpha-1102, Suite). A blank was prepared without using the juice. A calibration curve was prepared using an aqueous solution of potassium ferrocyanide as a standard. Increased absorbance of reaction mixture indicates increase in reducing power.

% Increasing in the reducing power = (A test / A blank) –1 × 100

Where A test is absorbance of the tested solution, A blank is the absorbance of blank, at a wave length of 700 nm.

The second method is based on the evaluation of the free radical-scavenging effect on the 1,1 diphenyl-2-picryl hydrazine (DPPH) radical as described by Brand-Williams *et al*. (1995). The absorbance of the reaction mixture with and without DPPH was measured at a wave length of 517nm by UV-Vis Spectrophotometer (Laxco-Alpha-1102, Suite). The results were expressed as percentage of inhibition of the DPPH using the following equation :

Antioxidant activity (%) = 1– (Abs. sample at 517 nm / Abs. control at 517 nm) X 100.

Sensory evaluation

Colour, appearance, acceptability and flavour of pomegranate juice were evaluated by 20 panelists of the members of the Food Science and Technology Department, Faculty of Agriculture, Alexandria University, Egypt. They were randomly chosen. A five point scale was used, 5 means extremely like, 4 moderately like, 3 acceptable, 2 slightly dislike and 1 extremely dislike, as reported by Piggott (1988).

Statistical analysis

Statistical analysis system (SAS) software 917 SAS (USA) using 2 factor factorial analysis of variance (ANOVA) was followed. The differences among means were determined for significance at $P<0.05$ among cultivars and juice sources using Duncans's multiple range test.

RESULTS AND DISCUSSION

Yield and physicochemical properties of pomegranate juice

The results presented in Table (1) show the yield and some of the physicochemical properties of the juices extracted from the whole and arils of four Egyptian pomegranate cultivars. Significant differences ($P<0.05$) were recorded for the juice yield among the pomegranate cultivars as well as the sources of the extracted juice. The mean yield of juice differed from 57.55 % in *Edkawy* caltivar to 60.23 % in Wonderful cultivar. The yield was also higher when the juice was extracted from arils (60.43%) than from the whole fruits (57.21%). Generally, the juice yield of these four Egyptian cultivars was higher than that reported for the local and foreign pomegranate cultivars grown in Morocco (29.37 to 46.55%), as indicated by Hmid

Table 1: Yield and some physicochemical properties of each of the whole fruits and arils juices of four pomegranate cultivars.

Property	Juice source	Pomegranate cultivars				
		Edkawy	*Manfaloty*	*Sahrawy*	Wonderful	Means
Yield (%)	Whole fruits	56.18	58.72	55.83	58.14	57.21 b
	Arils	58.93	60.31	60.19	62.32	60.43 a
Means		57.55d	59.51b	58.01c	60.23 a	
pH	Whole fruits	3.51± 0.01	3.54±0.03	3.54±0.08	3.56±0.01	3.54 a
	Arils	3.51± 0.01	3.55±0.05	3.56±0.07	3.55±0.04	3.54 a
Means		3.51 a	3.54 a	3.55 a	3.55 a	
Titratable acidity as citric acid (%)	Whole fruits	0.29±0.01	0.29±0.005	0.25±0.01	0.48±0.07	0.32 a
	Arils	0.29±0.04	0.29±0.08	0.25±0.17	0.46±0.08	0.32 a
Means		0.29 b	0.29 b	0.25 c	0.47 a	
Total soluble solids (%)	Whole fruits	16.66±0.57	14.33±0.57	15.33±0.57	17.00±0.57	15.83 a
	Arils	17.0±0.57	14.33±0.57	15.33±0.57	16.33±0.57	15.91 a
Means		16.83 a	14.33 c	15.33 b	16.66 a	
Total sugars (%)	Whole fruits	16.01±0.20	13.70±0.71	14.50±0.50	16.26±0.24	15.11 a
	Arils	16.02±0.30	13.78±0.22	14.51±0.69	16.30±0.08	15.15 a
Means		16.01 a	13.74 c	14.50 b	16.28 a	
Reducing sugars (%)	Whole fruits	15.09±0.30	12.71±0.52	13.53±0.48	15.34±0.26	14.16 a
	Arils	15.08±0.29	12.85±0.25	13.49±0.68	15.37±0.07	14.19 a
Means		15.08 a	12.78 c	13.51 b	15.35 a	
Non reducing sugars (%)	Whole fruits	0.92±0.01	0.99±0.08	0.97±0.02	0.92±0.05	0.95 a
	Arils	0.94±0.09	0.93±0.09	1.02±0.02	0.93±0.01	0.95 a
Means		0.93 a	0.96 a	0.99 a	0.92 a	
Vitamin C (mg/100 ml)	Whole fruits	7.27±0.07	6.27±0.11	5.73±0.08	6.30±0.10	6.36 a
	Arils	7.35±0.15	6.27±0.13	5.73±0.05	6.20±0.86	6.38 a
Means		7.31 a	6.27 b	5.73 c	6.19 b	

Means with the same letter are not significantly different at P < 0.05 level.

et al. (2013). Meanwhile, Tehranifar *et al.* (2010) stated that the juice percentage varied from 26.95 to 46.55 % among pomegranate cultivars. Accordingly, the whole fruit and the arils of the four investigated Egyptian pomegranate cultivars are considered and recommended as suitable sources for juice production and pomegranate processing.

The results shown in Table (1) indicate that no significant differences (P< 0.05) were observed in the pH values, TA, TSS, total, reducing and non reducing sugars in addition to ascorbic acid content of the juice extracted from either the whole fruit or the arils of the pomegranate fruits.

In contrast and with the exception of pH and non reducing sugars, significant differences were recorded in the other physicochemical parameters among the juices extracted from the four cultivars. Generally, the highest mean values of TSS (16.83%), total sugars (16.28%) and reducing sugars (15.35%) were found in the juices from both of *Edkawy* and Wonderful. Juice of Wonderful cultivar had higher TA (0.47%) compared with the juices of the other caltivars (0.25-0.29%). The pH of the juices ranged from 3.51 to 3.55 among the four cultivars. The previous results are in agreement with those stated by Poyrazoglu *et al.* (2002), Hmid *et al.* (2013) for the juices extracted from various pomegranate cultivars .Poyrazoglu *et al*, (2002) and Fadavi *et al*, (2005) found that TSS of pomegranate juice varied from 10 to 19^{o} Brix according to the genotype and the degree of maturity of pomegranate fruits. Legua *et al*. (2012) showed that the TA of the juice of 10 pomegranate varieties grown in different regions of Morocco differed from 0.24 to 3.7%.

Hmid *et al.* (2013) reported that the cultivar type plays an important role in terms of TSS, pH and TA of the pomegranate juice. Melgarejo (1993) classified Spanish pomegranate cultivars according to their maturity index (MI = TSS / TA) into sweet cultivars with 31-98 MI, sour sweet cultivars with 17-24 MI and sour cultivars with 5-7 MI. According to this classification, the MI of the juice of *Edkawy*, *Manfaloty*, *Sahrawy* and Wonderful cultivars grown in Egypt was 58,49.1,61.3 and 35.44, respectively .This means that the juices of the four cultivars belong to the sweet class.

Table (2) summarizes the colour measurements (L*= lightness, a*and b*= chromaticity coordinates) of pomegranate juices extracted from either the whole or arils of the pomegranate fruits of four cultivars. Generally, L*, a*, b* values reveal the visual colour perceived by Hunter colourimeter as important parameters to determine and compare the colour quality of pomegranate juices. The results in Table (2) show that the pomegranate juices extracted from either whole or arils of the four cultivars had a dark dull colour with red purplish hue. The colour of *Edkawy* juice was the highest in dullness and darkness followed by those of *Manfaloty*, *Sahrawy* and Wonderful cultivars, respectively. On the other side, generally the colour of the pomegranate arils juice was less in the dullness and more in darkness than that obtained from the whole fruits. Such results may be attributed to the variation in anthocyanin content among juices of pomegranate cultivars. According to Einbond *et al.* (2004), the water soluble anthocyanin pigments are responsible of the red purplish colour of pomegranate juice.

Table 2: Hunter colour measurements of the juice of pomegranate cultivars

Colour parameters	Juice source	Pomegranate cultivars			
		Edkawy	*Manfaloty*	*Sahrawy*	Wonterful
L*	Whole fruits	20.39	19.49	20.38	20.46
	Arils	20.03	20.06	20.06	24.36
a*	Whole fruits	2.64	3.62	3.35	4.85
	Arils	3.28	1.77	3.28	12.80
b*	Whole fruits	-0.04	0.59	0.12	0.47
	Arils	0.21	0.20	0.23	0.00

Sensory properties

The results presented in Table (3) indicate that the panelists significantly preferred the juices extracted from the whole fruits than those from the arils. The best sensory properties were those for the juice of Wonderful followed by that of *Edkawy*, *Manfaloty*, and Sahrawy, respectively. The juices of whole fruit especially from Wonderful cultivar had a slight bright red colour, sweet sour taste, nearly odourless ,showed homogenous consistency and acceptable appearance as described by the panelists. According to Dionex Corporation (2010), the level and stability of anthocyanins affect the colour and appearance of the pomegranate juice.

Table 3: Sensory properties of the whole and aril juices of four pomegranate cultivars

Sensory properties	Juice source	Pomegranate cultivars				
		Edkawy	*Manfaloty*	*Sahrawy*	Wonderful	Means
Appearance	Whole fruits	4.07 ± 0.07	3.32 ± 0.10	2.76 ± 0.12	4.45 ± 0.05	3.65^a
	Arils	3.55 ± 0.08	2.95 ± 0.11	2.97 ± 0.08	3.93 ± 0.07	3.35^b
Means		3.81^b	3.13^c	2.86^d	4.19^a	
Colour	Whole fruits	4.07 ± 0.07	3.05±0.10	2.66 ± 0.11	4.50 ± 0.03	3.57^a
	Arils	3.55 ± 0.08	2.92 ± 0.13	3.00 ± 0.09	3.90 ± 0.08	3.34^b
Means		3.81^b	2.98^c	2.83^c	4.20^a	
Odour	Whole fruits	4.07±0.07	3.17 ± 0.10	2.69± 0.10	4.07 ± 0.07	3.50^a
	Arils	3.00 ± 0.16	3.00 ± 0.25	3.00 ±0.16	4.00 ± 0.15	3.25^b
Means		3.53^b	3.08^c	2.84^d	4.03^a	
Taste	Whole fruits	4.07 ± 0.07	3.27 ± 0.09	2.71 ± 0.10	4.77 ± 0.24	3.70^a
	Arils	3.57 ± 0.07	2.88 ± 0.12	3.02 ± 0.09	3.95 ± 0.07	3.35^b
Means		3.82^b	3.07^c	2.86^d	4.36^a	

Means in a row with the same letter are not significantly different at $P < 0.05$ level.

Total phenolics (TP)

As seen from Fig. (1), marked variations were demonstrated in TP content of the whole and arils pomegranate juices. Generally, TP content was higher in the whole fruit juices than from those of the arils. This was attributed to the leaching out of polyphenols, especially flavonoids and hydrolysable tannins, from peels and rinds of the whole fruits during juice extraction by pressing. Also, the cultivar had a significant effect on the TP content of pomegranate juice. The highest amount of TP (8044.2 mg/L) was detected in *Edkawy* juice followed by Wonderful (6810.9 mg/L) then *Manfaloty* (4843mg/L) and lastly *Sahrawy* (4329.8 mg/L). Gil *et al.* (2000) reported that the commercial pomegranate juice in California contained 2566 ±131mg /L TP. The TP of pomegranate arils of California Wonderful cultivar was 2117 ± 95 mg/L. Cam *et al.* (2009) found that TP of juices of arils of 8 pomegranate cultivars ranged between 2083 to 3436 mg/L. Hmid *et al.* (2013) showed that TP level varied from 1385 to 9476 mg/L among the pomegranate juices of 18 cultivars. Comparing with other fruit juices, TP content of pomegranate juice was more than that of red grape juices (1782 mg/L) and red wine (772 mg/L) (Gatti *et al.*, 2011).

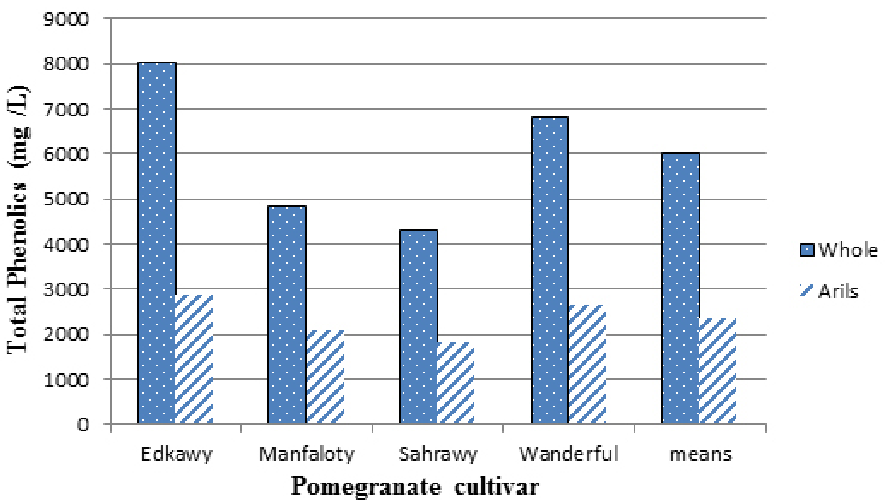

Fig. 1 : Total phenolics of pomegranate juices of four cultivars

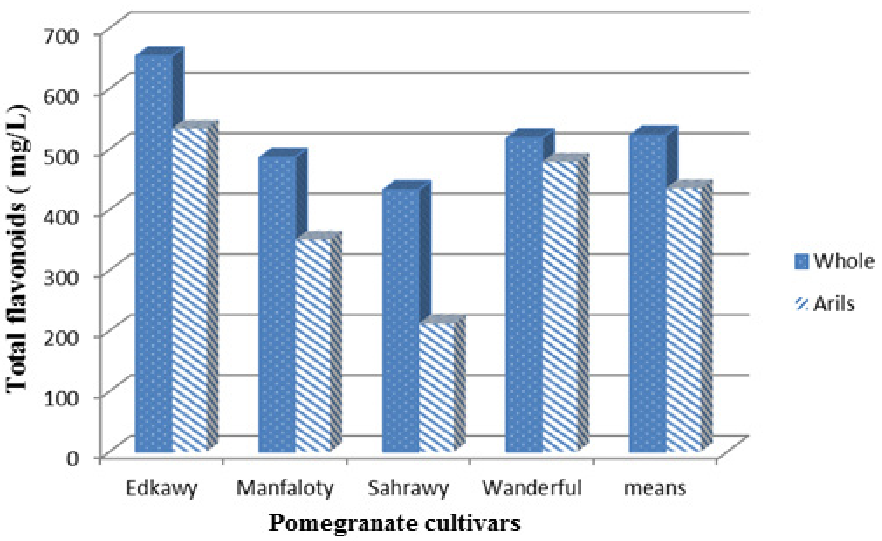

Fig. 2:Total flavonoids of pomegranate juices of four cultivars

Total flavonoids (TF)

As illustrated in Fig. (2), obvious differences in TF are observed in pomegranate juices due to the cultivar and the source of the fruit juice. The highest level of TF was detected in whole fruit and arils juice of *Edkawy* followed by Wonderful, *Manfaloty* and *Sahrawy*, respectively. Hmid *et al.* (2013) stated that the range of TF in pomegranate juice was 150 to 580 mg rutin / L. The data of TF in the present study among cultivars (211.7- 533.3 mg rutin /L) and between whole fruit and aril juices (435-522.6 mg rutin / L) are within that range. According to Guo *et al.* (2008), TF in commercial pomegranate juice (177 mg/ ml) was higher than that of apple (42 mg / L). They concluded that daily consumption of pomegranate juice improved the antioxidant function in the elderly than did apple juice.

Total anthocyanins (Ta)

As illustrated in Fig. (3) both the cultivar and the source of the extracted juice had a marked effect on the Ta content of the pomegranate juices. Because anthocyanins are mainly located in the arils of pomegranate fruits, the arils juice contained higher content of Ta (225.1 mg/ L) than the whole fruit juice. Among the cultivars, juice of

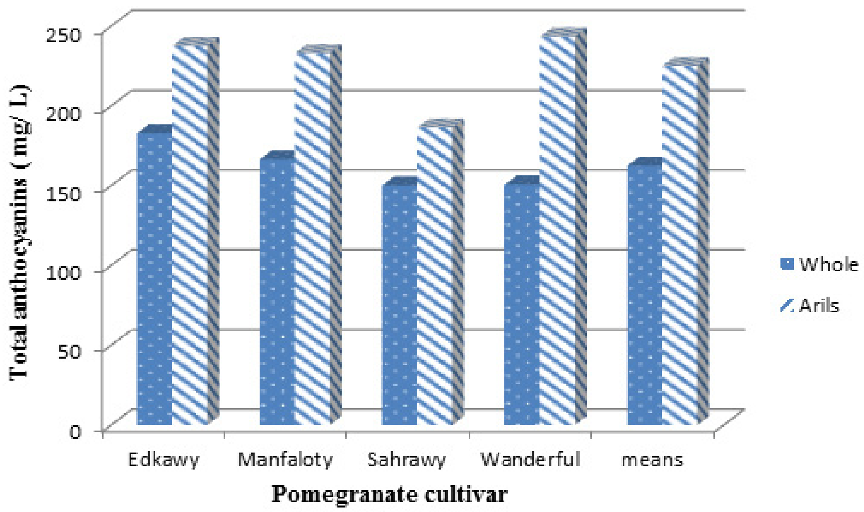

Fig. 3:Total anthocyanin of pomegranate juices of four cultivars

Edkawy cultivar had the highest level of Ta, followed in a descending order by Wonderful (167 mg / L), *Manfaloty* (124.8 mg / L) and *Sahrawy* (83.4 mg / L), respectively. Cam *et al.* (2009) found that Ta content of the arils juice of 8 pomegranate cultivars grown in Turkey varied from 81to 369 mg/ L. Hmid *et al.* (2013) stated that the range of Ta content in 18 pomegranate cultivars grown in Morocco was 50 to 190 mg /L. Such results indicated that the Ta content of pomegranate juice differs according to genotype, cultivation location and practices, and the source of the juice extracted from fruits. Generally, according to the results of the present work, the anthocyanin rich cultivars, namely, *Edkawy* and Wonderful are recommended for juice extraction on a commercial scale.

Total tannins (TT)

Fig. (4) shows that the juices extracted from whole pomegranate fruits had higher amounts of TT than those from the arils. Also, the highest TT concentration was that of the juice extracted from *Edkawy* cultivar followed by Wonderful, *Manfaloty* and *Sahrawy*, respectively. Generally, there are two types of tannins in pomegranate fruits; namely, condensed and hydrolysable tannins. Proanthocyanidins are the important component of condensed tannins. Meanwhile, punicalagin, gellotannins and ellagitannins are the main compounds of pomegranate hydrolysable tannins, which are responsible of the antioxidant activity and antimicrobial effect of pomegranate fruit and its products, as reported by Hayrapetyan *et al.* (2012). Form the other side, tannins may affect the taste, cause blurring and sedimentation of the juice.

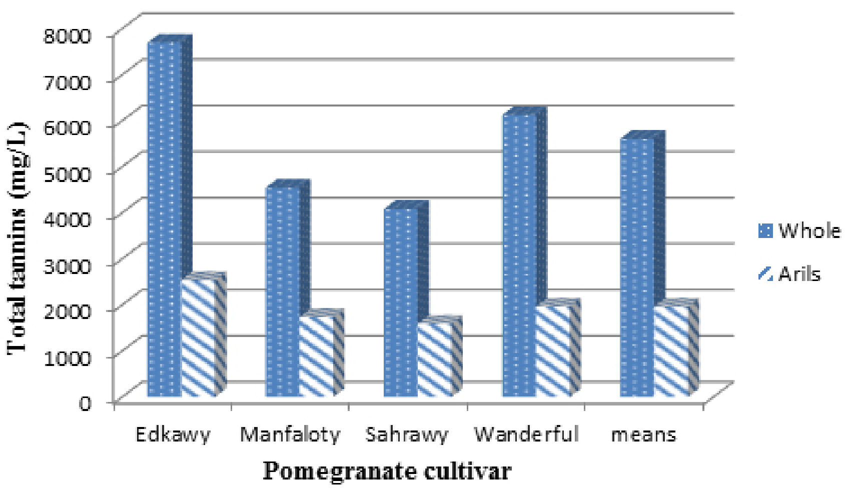

Fig.4:Total tannins of pomegranate juices of four cultivars.

Antioxidant activity (AC)

The results of antioxidant activity (AC) measured by two different methods, namely, FRAP and DPPH for the juices extracted from whole and arils of four Egyptian pomegranate cultivars are illustrated in Figs. (5) and (6). According to the results of FRAP assay (Fig. 5), the values of AC ranged from 3893.2 to 4085.2 Mm Fe^{++} /L for whole fruit juice and from 3869.2 to 4016 Mm Fe^{++} /L for aril juices. The highest antioxidant activity was found in the juice extracted from *Edkawy* and Wonderful cultivars followed by *Manfaloty* and *Sahrawy* cultivars, respectively. Tezcan *et al.* (2009) mentioned that the commercial pomegranate juice in Turkey is usally extracted from whole fruits. Therefore, it had higher antioxidant activity (18.34-121.80 mm Fe^{++}) than that obtained from the arils of the fruit. The same finding was previously stated by Gil *et al.* (2000) for juices extracted from whole fruit and

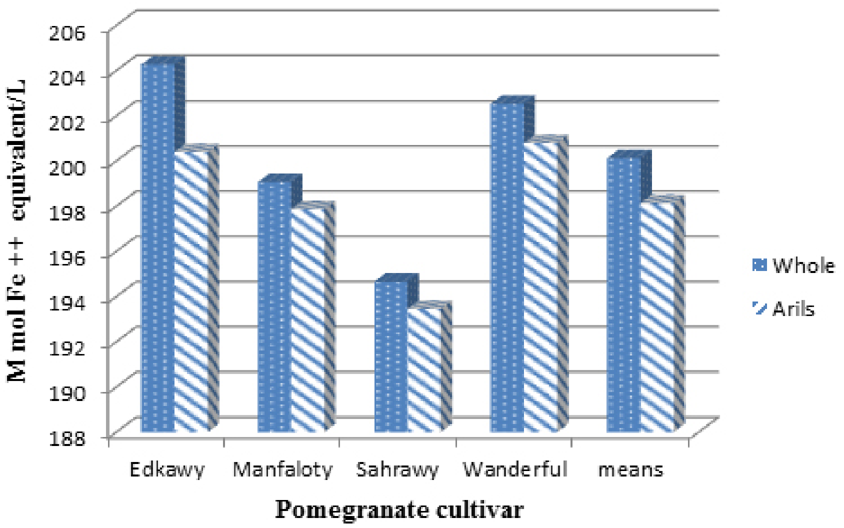

Fig. 5:Antioxidant activity of pomegranate juices measured by FRAP

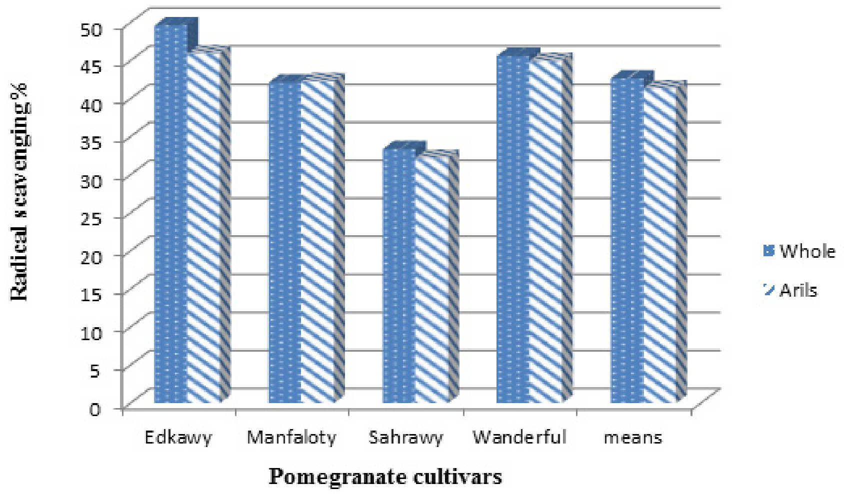

Fig. 6: Radical scavenging of pomegranate juices as DPPH

arils of Wonderful cultivar grown in California. This may be due to the punicalagin poly-phenol originating in the peel which is then removed into the juice during pressing the whole fruits.

The DPPH radical scavenging assay is commonly applied to evaluate the ability of antioxidant to scavenge free radical. According to the results shown in Fig. (6), there were slight differences in AC due to cultivar and the source of the extracted juice from pomegranate fruits. The AC assessed by DPPH procedure, was slightly higher in whole fruit juices than those from the arils. The highest value was that of the juices extracted from *Edkawy*, followed by Wonderful, *Manfaloty*, and Sahrawy, respectively in a descending order. Hmid *et al*. (2013) found a significant variation in the AC determined by DPPH method (31.16 to 76.3%) among the local and foreign pomegranate cultivars grown in Morocco. Similar results were reported by Tezcan *et al*. (2009) on 7 commercial pomegranate juices in Turkey. Tehranifar *et al*. (2010) found that the AC of Iranian pomegranate arils juice determined by DPPH varied from 15.59 to 40.72% among cultivars.

It is clear from the aforementioned results that the concentration, structure and interaction of polyphenols and their derivatives play an important role in increasing or decreasing the AC of pomegranate juice. Generally, strong antioxidant activity of pomegranate juice increases its use and consumption to achieve some health benefits.

The AC of pomegranate juice measured by FRAP (Fig. 5), is much more recommended for assessing AC of the juice than the DPPH method (Fig. 6). The FRAP showed marked differences between cultivars, as well as between the sources of the juice.

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تأثير الصنف على العائد، التقبل، الخواص الطبيعية الكيماوية، المكونات النشطة حيوياً و نشاط تضاد الأكسدة لعصير الرمان

فاتن فاروق عبد السلام ، عصمت صابر الزلاقى ، يحيى جمال الدين محرم
قسم علوم و تقنية الأغذية ، كلية الزراعة ، جامعة الأسكندرية ، الشاطبى ، ٢١٥٤٥،
الإسكندرية ، ج.م.ع.

تم فى هذه الدراسة استخدام أربعة أصناف من الرمان هم الإدكاوى ، المنفلوطى، الصحراوى و الوندرفول (صنف مستحدث). تم تقدير عائد العصير و مدى تقبل و قياسات اللون و الخواص الفيزوكيماوية و المواد النشطة حيوياً و النشاط المضاد للأكسدة للعصير المستخلص بالضغط على نصفى الثمرة الكاملة او الضغط على الحبوب.

أوضحت نتائج الدراسة وجود اختلافات معنوية فى المعايير المقاسة ترجع للصنف وأيضاً لطريقة استخلاص العصير. كان عائد العصير أعلى عند استخلاص العصير من الحبوب عن استخلاصه بالضغط على نصفى الثمرة الكاملة. أعطى صنف الوندرفول أعلى عائد عصير فى الأصناف الأربعة. وكانت أعلى قيم للمواد الصلبة الكلية ، السكريات الكلية و المختزلة و الحموضة الكلية فى العصير المستخلص من الصنف وندرفول متبوعاً بصنف الإدكاوى ثم المنفلوطى و اخيراً الصحراوى على الترتيب.

أوضحت دراسة لون العصير بجهاز هنتر أن العصير المستخلص من الثمرة الكاملة أو من الحبوب للأصناف الأربعة كان قرمزى داكن. و كان اللون الداكن اكثر وضوحاً فى عصائر الصنف الإدكاوى عن عصائر باقى الأصناف وكان العصير المستخلص من حبوب الصنف وندرفول أدكن من العصير المستخلص من ثماره الكاملة. وأكثر عينات العصير تقبلاً هو عصير الصنف وندرفول المستخلص من ثماره الكاملة.

أوضحت الدراسة أنه فيما عدا محتوى الأنثوسيانينات فإن المواد الفينولية الكلية، الفلافونويدات ، التانينات الكلية و نشاط تضاد الأكسدة كانت أعلى فى عصير الثمار الكاملة عن المستخلص من الحبوب خاصة لعصيري الأصناف الإدكاوى و الوندرفول. وبينما كان محتوى الأنثوسيانين أعلى فى العصير المستخلص من الحبوب عن عصير الثمار الكاملة خاصة لعصير صنف الإدكاوى.