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EFFECT OF SOLVENT TYPE ON THE ANTIOXIDANT POTENTIAL OF ULTRASONIC EXTRACTS OF IRANIAN GRAPE VARIETIES

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ABSTRACT

There is limited information on the antioxidant potential of Iranian grape varieties. Due to the very high consumption of grape varieties in Iran and their export, it is necessary to study their antioxidant properties. The aim of this study was to determine the content of phenolic compounds and the antioxidant potential of ultrasonic extracts of seed and skin of four grape varieties including Hosseini (H), Ghazandaei (G), Ghara Shira (GS) and Rish Baba (RB) cultivated in West Azerbaijan, Iran. Ultrasonic extraction was conducted using acetone, ethanol and methanol. Four methods including DPPH, ABTS, reducing power and total phenolic assays were used to examine the antioxidant potential of the samples. Acetone extracts showed the strongest antioxidant capacity and also had the highest total phenolic content. The antioxidant properties of the seed of grapes were higher than those of their skin. GS grape seed and RB grape skin showed the highest antioxidant activity ($P<0.05$). Moreover, RB extract had the highest total phenolic content. It was concluded that acetone was the best solvent for extracting antioxidants from grape seed and skin. GS seed and RB skin can be considered as good sources of natural antioxidants.

Keywords: Antioxidant, Grape, Phenolic Content, Seed, Skin, Ultrasound

INTRODUCTION

INTRODUCTION

Antioxidants are important both in terms of medicine and the food industry. It has been shown that natural antioxidants in fruits and aromatic plants may reduce the risk of chronic diseases; DNA damage, mutagenesis and carcinogenesis **(Zhu et al., 2002; Covacci et al., 2001; Jayaprakasha et al., 2002)**. Defense systems of human body use enzymatic and non-enzymatic antioxidants to prevent diseases and damage of cellular components by free radicals **(Niki, 2014; Baiano, 2020)**. Besides, a balanced diet containing nutrients and rich in antioxidant molecules can play an essential role in reducing free radicals **(Touriño et al., 2008)**. In food systems, antioxidants play a crucial role in preventing lipid oxidation. Lipid oxidation process can lead to the degradation of nutritional components, undesirable changes in taste, aroma and color, the generation of toxic compounds and decreasing the shelf life of food **(Benzie, 1996)**.
Due to the negative side-effects of chemical and synthetic preservatives, research focused on finding natural antioxidant and antimicrobial compounds and their applications in food systems **(García-Becerra et al., 2016)**. Agricultural wastes such as by-products from grape juice factories can be considered as a low-cost source of natural antioxidants **(Spigno et al., 2007)**. Among these, skin and seed of grapes as by-products of juice factories are rich in phenolic compounds **(Da Porto et al., 2013)**. Different classes of phenolic compounds are found in leaves, skins and seeds of grapes **(Casazza et al., 2010)**. Grape phenolics with antioxidant activity are classified as flavanols, flavanols, phenolic acids, stilbenes, and anthocyanins **(Bowyer et al., 2022)**. Phenolic compounds such as catechin, epi-catechin, and quercetin were determined in grape skins at higher concentrations **(Farhadi et al., 2016)**. Meanwhile, anthocyanins which are responsible for color are mainly found in red grape skins **(Xia et al., 2010)**.
The largest producer and processing countries of grapes are the Mediterranean countries, especially Italy, Spain and France. So far, around 10,000 different grape varieties have been identified in the world, and if grape hybrids are considered, this figure will be very high. West Azerbaijan province, and especially the provincial capital, Urmia, is one of the largest grape producers in Iran **(Bakkalbasi et al., 2005; Orak et al., 2007; Hassanpour and Khoshamad, 2017)**. It has been shown that each of the different parts of the grape including skins, seeds and leaves of the plant have own antioxidant properties **(Farhadi et al., 2016; Xia et al., 2006)**. The grape skin had a high power in eliminating free radicals and this antioxidant activity is affected by grape varieties and time of ripening (Bartolome et al., 2006). There are various methods for extracting and separating antioxidant compounds from natural sources such as maceration, hydro-distillation and Soxhlet methods. However, these methods are time-consuming and degradation of active components is possible during extraction. Meanwhile, environmental pollution may occur by organic solvent wastes **(Vinatoru, 2001)**. Therefore, to overcome these drawbacks, novel techniques such as ultra-sound-assisted extraction have been introduced to extract the bioactive compounds from natural sources **(Da Porto et al., 2013; Rodríguez-Rojo et al., 2012; Wang and Weller, 2006)**. The ultrasound can penetrate the cells and extract the com-pounds **(Luque-García and Luque de Castro, 2003)**. Some studies have shown that ultrasound can be used for the extraction of bioactive compounds, including polyphenols, in different plants **(Sousa et al., 2021; Chemat et al., 2011)**.
Antioxidant activity of grape varieties from different countries has been reported. However, there is limited information on the antioxidant potential of Iranian grape varieties. Therefore, the aim of the present study was to compare the antioxidant potential of ultrasonic extracts (ethanol, methanol and acetone) of skin and seed of four popular grape varieties **(Hosseini, Ghazandaei, Ghara Shira and Rish Baba)** cultivated in West Azerbai-jan, Iran.

MATERIALS AND METHODS

Sample preparation

Approximately 5 kg of each grape variety (Hosseini (H) and Ghazandaei (G) as white grapes; Ghara Shira (GS) and Rish Baba (RB) as red grapes) at commercial maturity stage was purchased from a local market in Urmia, West Azerbaijan, Iran (Latitude: 37° 32' 59.99" N; Longitude: 45° 05' 60.00" E). Their skins and seeds were manually separated and then air-dried in shade place at room temperature (25 °C) and relative humidity of 40% for a week. After that, the samples were dried using an oven (UT 5050 E, Heraeus, Hanau, Germany) with forced air circulation at 50 °C for 1-2 days. The final moisture contents of skin and seed were ≈ 7.3 and 2.1 %, respectively. The dried samples were stored at -20 °C until extraction **(Drosoua et al., 2015)**.

Isolation of seed oil

After grinding the seeds, the fatty materials were isolated by petroleum ether using a Soxhlet apparatus at 60 °C for 6 h. After removal of the oil and ether residue, the defatted grape seed powder was dried and kept at -20 °C until extraction **(Baydar et al., 2006; Shi et al.,2003)**.

Ultrasound-assisted extraction

First, 10 ml of the extraction solvent (70% ethanol, 70% methanol and 70% acetone) was mixed with 1 g of the sample (skin or defatted seed). Then the mixture was sonicated by the ultrasonic probe (Hielscher Ultrasound, UP200H, Germany) at 24 kHz frequency and 200 watts for 5 min at a temperature lower than 30 °C. The extract was filtered through the paper filter and distributed into micro-tubs and stored at -20 °C until analysis **(Da Porto et al., 2013)**.

DPPH radical scavenging activity

DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging activity was determined ac-cording to the previously described method (Blois, 1958). First, the skin and seed extracts were di-luted 1:5 and 1:50, respectively. Then, 25 µL of the diluted extract was mixed with 2 ml of DPPH solution (24µg/ml). The mixture was incubated in the dark for 30 min. The discoloration of purple DPPH solution by the added extracts was measured at 517 nm using a spectrophotometer (Novaspec II; Pharmacia LKB, Uppsala, Sweden). The results were ex-pressed as radical scavenging activity (RSA) percentages using the following equation:
RSA (%) = [(A blank – A sample)/A blank] × 100
Where, A blank was the absorbance of blank and A sample was the absorbance of the ex-tract. BHT (butylated hydroxytoluene) was used as positive control.

ABTS radical scavenging activity

ABTS (2,2-azinobis-3-ethylenzothiazoline-6-sulphonicacid) radical scavenging capacity of the extracts was examined according to the method of **Re et al (1999)**. To prepare ABTS stock solution, an equal volume of ABTS (7.00 mM) and potassium per sulfate (2.45 mM) was mixed and incubated for 16 at room temperature. Then, the solution was diluted using ethanol to reach an absorbance of 0.70 ± 0.03 at 734 nm. The skin and seed extracts were diluted 1:5 and 1:20, respectively. Then, 20 µL of diluted extracts was added to 2 mL of ABTS solution and mixed. After that, the reaction mixture was allowed to stand in the dark for 6 min. Finally, the absorbance was recorded at 734 nm a spectrophotometer. The ABTS radical scavenging activity (%RSA) was calculated using the formula mentioned in DPPH method. BHT (butylated hydroxytoluene) was used as positive control.

Reducing power determination

First, the skin and seed extracts were diluted 1:5 and 1:20, respectively. Then, 1 ml of the diluted extract was used to determine reducing power according to the method of **Oyaizu (1986)**. Briefly, 1 ml of the diluted extract was mixed with 2.5 ml phosphate buffer (pH 6.6) and 2.5 ml potassium ferricyanide (1%) and incubated at 50 °C for 20 min. After that, 2.5 ml trichloroacetic acid (10%) was added to the mixture and centrifuged at 4000 rpm for 10 min. Then, 2.5 ml of the supernatant was added to tube containing 2.5 ml distilled water and 0.5 ml ferric chloride (0.1%) and mixed. After 10 min, the absorbance was measured at 700 nm. BHT (butylated hydroxytoluene) was used as positive control.

Total phenolic content

The Folin-Ciocalteu reagent assay was used to estimate total phenolic content with gallic acid as a standard **(Singleton and Rossi, 1965)**. 500 µL of the diluted extracts or gallic acid solution was added to 2.25 mL of distilled water and 250 µL of Folin-Ciocalteu reagent and vortexed for 1 min. After 5 min, 2 mL of Na2CO3 (7.50%) was added to the mixture. The samples were incubated at 25 °C for 120 min. Finally, the absorbance of the samples was recorded at 760 nm. The total phenolic contents were expressed as mg of gallic acid equivalent per gram of the skin or seed.

Statistical analysis

All experiments were performed in triplicate. Statistical analysis of data was performed using SPSS software (version 18). Two-way analysis of variance (ANOVA) followed by Tukey HSD post-Hoc test was used to analyze of data. The significance level was set at P<0.05.

RESULTS

In the present study, the antioxidant potential of ultrasonic extracts of skin and seed of four popular grape varieties including Hosseini (H), Ghazandaei (G), Ghara Shira (GS) and Rish Baba (RB) was evaluated. The effect of different solvents on ABTS radical scavenging activity of skins and seeds extracts of four grape varieties are presented in Table 1 and 2. Ethanol extracts of RB and GS showed significantly (P<0.05) higher antioxidant activity than those of other grapes. In the case of methanol and acetone extracts, RB also had the most potent radical scavenging activity. Generally, the skin extracts of RB exhibited the highest radical scavenging effect. However, the skin extracts of H had the weakest activity. On the other hand, acetone and ethanol extracts of the skin of grapes showed the strongest and the weakest ABTS radical scavenging activity, respectively.

Table 1 ABTS radical scavenging activity (%) of different extracts of skins of four grape varieties (at dilution of 1:5)

Grape Skin	Solvent		
	Ethanol (70%)	Methanol (70%)	Acetone (70%)
Hosseini	14.04 ± 0.56^{dB}	16.83 ± 2.76^{cB}	33.38 ± 1.78^{Ac}
Ghazandaei	20.64 ± 1.58^{cB}	21.86 ± 1.77^{cB}	50.14 ± 0.89^{bA}
Ghara Shira	24.32 ± 0.44^{bC}	32.07 ± 1.97^{bB}	52.38 ± 2.47^{bA}
Rish Baba	26.25 ± 0.27^{bC}	52.28 ± 1.44^{aB}	81.91 ± 1.38^{aA}
BHT	84.80 ± 0.94^{a}	-	-

a-d; Different small letters in each column indicate significant (p<0.05) statistical differences among ABTS radical scavenging activity of the grapes.
A-D; Different capital letters in each row indicate significant (p<0.05) statistical differences among ABTS radical scavenging activity of different extracts of each grape. BHT = Butylated hydroxytoluene, (1 mg/ml).

As shown in Table 2, ethanol extract of GS seed had the highest (P<0.05) ABTS radical scavenging activity among ethanol extracts of grapes seeds. G seed extracts showed the lowest radical scavenging activity. Similarly, methanol extract of GS seed showed the strongest activity among methanol extracts of the grapes. However, there were no signifi-cant differences among ABTS radical scavenging effects of acetone extracts of grapes seeds. In general, ABTS radical scavenging activity of acetone extracts of the seeds of grapes was significantly (P<0.05) higher than that of other extracts but radical scavenging activity of different extracts of GS seed was not significantly different.

Table 2 ABTS radical scavenging activity (%) of different extract of seeds of four grape varieties (at dilution of 1:20)

Grape Seed	Solvent		
	Ethanol (70%)	Methanol (70%)	Acetone (70%)
Hosseini	82.33 ± 2.87^{bB}	86.00 ± 1.00^{bB}	99.14 ± 1.14^{aA}
Ghazandaei	75.94 ± 2.66^{cB}	82.04 ± 2.40^{bB}	94.24 ± 4.89^{aA}
Ghara Shira	98.79 ± 0.45^{aA}	98.38 ± 0.30^{aA}	99.52 ± 0.51^{aA}
Rish Baba	86.81 ± 2.31^{bB}	89.46 ± 3.30^{bB}	98.75 ± 0.17^{aA}
BHT	84.80 ± 0.94^{b}	-	-

a-d; Different small letters in each column indicate significant (p<0.05) statistical differences among ABTS radical scavenging activity of the grapes.
A-D; Different capital letters in each row indicate significant (p<0.05) statistical differences among ABTS radical scavenging activity of different extracts of each grape. BHT = Butylated hydroxytoluene, (1 mg/ml).

DPPH radical scavenging activity of different extract of skins and seeds of four grape vari-eties are shown in Table 3 and 4. DPPH radical scavenging activity of ethanol and meth-anol extracts of RB skin was significantly (p<0.05) higher than those of other grapes. In the case of acetone extract, RB and G skin extracts showed higher radical scavenging effects. Furthermore, radical scavenging activity of acetone extracts was significantly (P<0.05) higher than that of other extracts.

Table 3 DPPH radical scavenging activity (%) of different extract of skins of four grape varieties (at dilution of 1:5)

Grape Skin	Solvent		
	Ethanol (70%)	Methanol (70%)	Acetone (70%)
Hosseini	7.30 ± 2.25^{dC}	17.84 ± 1.28^{cB}	37.94 ± 2.03^{bA}
Ghazandaei	19.23 ± 0.98^{cB}	22.91 ± 2.04^{bB}	44.84 ± 2.74^{aA}
Ghara Shira	17.36 ± 3.06^{cB}	23.56 ± 0.51^{bA}	26.04 ± 0.55^{cA}
Rish Baba	29.26 ± 2.61^{bB}	30.64 ± 0.08^{aB}	47.70 ± 1.83^{aA}
BHT	60.75 ± 1.42^{a}	-	-

a-d; Different small letters in each column indicate significant (p<0.05) statistical differences among DPPH radical scavenging activity of the grapes.
A-D; Different capital letters in each row indicate significant (p<0.05) statistical differences among DPPH radical scavenging activity of different extracts of each grape. BHT = Butylated hydroxytoluene, (1 mg/ml).

As can be seen from Table 4, GS seed extracts showed the most potent DPPH radical scavenging effect. However, no significant differences were found among radical scav-enging activity of methanol extracts of the seed of grapes. Meanwhile, acetone extracts of the seeds had the highest radical scavenging effect.

Table 4 DPPH radical scavenging activity (%) of different extract of seeds of four grape varieties (at dilution of 1:50)

Grape Seed	Solvent		
	Ethanol (70%)	Methanol (70%)	Acetone (70%)
Hosseini	32.61±2.54^{cC}	40.77±3.13^{aB}	51.60±2.21^{bA}
Ghazandaei	32.18±1.94^{cB}	42.07±2.60^{aA}	44.97±0.38^{cA}
Ghara Shira	52.07±1.53^{bB}	45.73±0.38^{aC}	67.38±0.38^{aA}
Rish Baba	34.32±1.95^{cB}	38.79±0.88^{aB}	50.79±3.56^{b,cA}
BHT	60.75±1.42^{a}	-	-

a-d; Different small letters in each column indicate significant ($p<0.05$) statistical differences among DPPH radical scavenging activity of the grapes.
A-D; Different capital letters in each row indicate significant ($p<0.05$) statistical differences among DPPH radical scavenging activity of different extracts of each grape. BHT = Butylated hydroxytoluene, (1 mg/ml).

Reducing power of different extracts of skins and seeds of four grape varieties are given in Table 5 and 6. Ethanol extract of RB skin indicated the strongest reducing power among ethanol extracts. However, there were no significant differences among reducing power of methanol extracts of RB, GS and G. Furthermore, acetone extracts of RB and H showed significantly higher reducing power than those of other grapes.

Table 5 Reducing power (absorbance at 700 nm) of different extract of skins of four grape varieties (at dilution of 1:5)

Grape skin	Solvent		
	Ethanol (70%)	Methanol (70%)	Acetone (70%)
Hosseini	1.087±0.051^{c,dB}	1.241±0.101^{bB}	2.210±0.054^{aA}
Ghazandaei	1.252±0.055^{cB}	1.393±0.061^{a,bB}	1.862±0.059^{bA}
Ghara Shira	0.999±0.031^{dC}	1.429±0.030^{a,bB}	1.787±0.095^{bA}
Rish Baba	1.655±0.049^{bB}	1.618±0.124^{aB}	2.254±0.108^{aA}
BHT	2.101±0.114^{a}	-	-

a-d; Different small letters in each column indicate significant ($p<0.05$) statistical differences among reducing power of the grapes.
A-D; Different capital letters in each row indicate significant ($p<0.05$) statistical differences among reducing power of different extracts of each grape.
BHT = Butylated hydroxytoluene, (1 mg/ml).

According to the results of reducing power of the grapes seeds (Table 6), ethanol extracts of H and GS showed the strongest reducing power. Methanol extract of GS showed the highest reducing power but had no significant differences with RB and H. In the case of acetone extracts, no significant differences were found among reducing power of acetone extracts of all grapes. Meanwhile, reducing power of acetone extracts were not significantly different from that of methanol extracts.

Table 6 Reducing power (absorbance at 700 nm) of different extract of seeds of four grape varieties (at dilution of 1:20)

Grape Seed	Solvent		
	Ethanol (70%)	Methanol (70%)	Acetone (70%)
Hosseini	2.338±0.118^{aA}	2.262±0.202^{aA}	2.334±0.130^{aA}
Ghazandaei	1.893±0.015^{cA,B}	1.490±0.224^{bB}	2.312±0.081^{aA}
Ghara Shira	2.300±0.041^{a,bB}	2.450±0.004^{aA}	2.387±0.042^{aA}
Rish Baba	2.060±0.081^{b,cB}	2.400±0.089^{aA}	2.247±0.135^{aA,B}
BHT	2.101±0.114^{a,b,c}	-	-

a-d; Different small letters in each column indicate significant ($p<0.05$) statistical differences among reducing power of the grapes.
A-D; Different capital letters in each row indicate significant ($p<0.05$) statistical differences among reducing power of different extracts of each grape.
BHT = Butylated hydroxytoluene, (1 mg/ml).

Table 7 shows total phenolic contents of different skin extracts of four grape varieties. It was found that RB extracts (ethanol, methanol and acetone) had the highest amount of total phenolic compounds among four grapes. Meanwhile, acetone extracts of all grapes had the highest total phenolic content.

Table 7 Total phenolic contents (mg GAE/ g of the skin) of different extract of skins of four grape varieties

Grape Skin	Solvent		
	Ethanol (70%)	Methanol (70%)	Acetone (70%)
Hosseini	4.07±0.18^{cB}	4.39±0.03^{cB}	11.52±0.14^{bA}
Ghazandaei	5.65±0.25^{bB}	4.93±0.14^{bC}	11.73±0.06^{bA}
Ghara Shira	5.37±0.06^{bB}	5.19±0.25^{bB}	9.50±0.33^{cA}
Rish Baba	8.53±0.32^{aB}	7.09±0.18^{aC}	13.80±0.37^{aA}

a-d; Different small letters in each column indicate significant ($p<0.05$) statistical differences among total phenolic contents of the grapes.
A-D; Different capital letters in each row indicate significant ($p<0.05$) statistical differences among total phenolic contents of different extracts of each grape.

As shown in Table 8, GS seed extracts (ethanol and methanol) had the highest total phenolic content but there were no significant differences among total phenolic content of acetone extracts of GS, RB and H. It can be concluded that acetone (70%) was the most suitable solvent for extracting phenolic compounds from skin and seed of the grapes.

Table 8 Total phenolic contents (mg GAE/ g of the seed) of different extract of seeds of four grape varieties

Grape Seed	Solvent		
	Ethanol (70%)	Methanol (70%)	Acetone (70%)
Hosseini	50.59±0.24^{bB}	51.53±1.55^{bB}	65.29±0.85^{aA}
Ghazandaei	47.84±0.51^{cB}	48.23±1.52^{bB}	61.09±1.50^{bA}
Ghara Shira	62.95±0.34^{aA}	59.55±0.68^{aB}	64.73±1.36^{aA}
Rish Baba	53.31±1.82^{bB}	50.84±1.48^{bB}	65.70±1.43^{aA}

a-d; Different small letters in each column indicate significant ($p<0.05$) statistical differences among total phenolic contents of the grapes.
A-D; Different capital letters in each row indicate significant ($p<0.05$) statistical differences among total phenolic contents of different extracts of each grape.

DISCUSSION

Grapes are one of the most widely grown fruits in the world. In addition to fresh uses, most grapes are processed in order to produce raisins, wine, vinegar and fruit juices and traditional products. The skin and seed of grape as a by-product of grape juice factories contain many active compounds. In the present study, ultrasound-assisted extraction method using three different solvents was applied to extract antioxidant compounds from the skins and seeds of four grape varieties (Hosseini, Ghazandaei, Ghara Shira and Rish Baba) cultivated in the West Azerbaijan province, Iran.
Different extraction methods such as maceration, Soxhlet, microwave assisted extraction and ultrasound-assisted extraction methods have been used to extract antioxidant compounds from grape pomace **(Singleton and Rossi, 1965; Bartolome et al., 2004; Baydar et al., 2006; Da Porto et al., 2013)**. In a study, maceration (12 h) was compared with ultrasound-assisted extraction (15 min) method to extract polyphenols from grape seeds. The efficacy of these two methods for recovering of polyphenols was similar but ultrasound-assisted extraction method had lower solvent consumption and shorter extraction time **(Da Porto et al., 2013)**. In another study, three methods including microwave-assisted and ultrasound-assisted extraction and the conventional Soxhlet extraction were used to recover polyphenols from red grape pomace **(Shi et al.,2003)**. The highest yield in total phenolic content and the strongest radical scavenging activity were obtained by ultrasound-assisted extraction. The effectiveness of conventional extraction method for recovery of phenolic compounds from grape skin was compared with ultrasound and microwave-assisted extraction techniques. The results showed that ultrasound-assisted extraction had the best performance in recovering of phenolic compounds **(Caldas et al., 2018)**. Recently, it has been reported that the combination of enzyme, microwave and salting-out extraction treatment was an effective meth-od for extraction of total phenolic compounds from grape seed **(Jia et al., 2021)**. Other researchers have reported that the modern extraction techniques such as subcritical water extraction **(Todd and Baroutian, 2017)** and cold plasma (Bao et al., 2020) could enhance the extraction of phenolic compounds from grape pomace.
In previous studies, different solvents such as 70% methanol, methanol, ethyl acetate, and 70% acetone have been used in order to extract phenolic compounds from grape seed **(OszmiańskiJean and Sapis, 1989; Santos-Buelga et al., 1995; Guendez et al., 2005; Yilmaz and Toledo, 2006)**. The extraction solvent type can influence the phenolic compounds extraction and antioxidant property of red grape skin **(Baron et al., 2021)**. Our results showed that 70% acetone was better than 70% methanol and 70% ethanol for the extraction of phenolic compounds from grape skin and seed, which is consistent with the results of previous works **(Yilmaz and Toledo, 2006)**.
The results of present study showed that the antioxidant activity and total phenolic contents of grape seed were significantly higher than those of grape skin. In a study, the antioxidant potential of the skin, seed and pulp of Turkish grape cultivar (Karaerik) was measured, and the results showed that the antioxidant potential of the grape seed was higher than that of the skin and pulp **(Kupe et al., 2021)**. This finding is in agreement with the results of Negro et al., who reported that the content of total phenolic compounds and total flavonoids in grape seed extract was higher than peel extract **(Negro et al., 2003)**. Total phenolic and anti-radical activity of red grapes in Turkey were investigated using acetone 70% containing 0.5% acetic acid as a solvent. According to the results, the total phenolic content of the seeds of grapes was in the range of 79.2 to 154.6 mg/g seed. All seed extract exhibited significant DPPH radical scavenging activity **(Bozan et al., 2008)**. In another similar study, the antioxidant potential and phenolic contents of the grape seed extracts from several Turkish grape varieties have been evaluated. Total phenol values range from 33945 to 58730 mg/100 g of the extract. The acetone extract of Narince showed the highest total phenolic content and DPPH radical scavenging activity while Alphonse Lavallee´ had the highest ABTS radical scavenging effect **(Yemis et al., 2006)**. Antioxidant capacity and phenolic compounds profile of different parts of native grape varieties in West Azerbaijan province (Northwest of Iran) has been investigated. The results showed that Ghara Shani grape skin had the highest content of total phenolic and anthocyanin as well as the strongest DPPH radical scavenging activity **(Farhadi et al., 2016)**.

CONCLUSIONS

The results of present study indicated that grape variety and grape tissue (skin or seed) may affect their phenolic content and antioxidant properties. According to the results, the antioxidant activity of red grape varieties (GS and RB) was higher than that of white grape varieties (H and G). It was found that acetone (70%) was the best solvent for extraction of phenolic compounds from both skin and seed of the grapes. The results also showed that the antioxidant activities of the seeds of all grape varieties were significantly higher than those of their skins. Total phenolic contents of the seeds were approximately 10 times higher than that of the skins. On the whole, Ghara Shira (GS) seed showed the strongest antioxidant activity among grape seeds, while Rish Baba (RB) skin exhibited the highest antioxidant potential among the grape skins. Then, GS seed and RB skin extracts could be considered as excellent candidates for food, nutraceutical, and medical applications. Fur-ther studies are suggested to investigate the antioxidant properties of other Iranian grape varieties.

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