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Effect of Adsorbent and Ion Exchange Resin Applications on Total Phenolic Content and Antioxidant Activity of White and Red Grape

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ABSRACT

In this study activated carbon, Dowex® 50Wx8-100 and Amberlite® XAD-16 were applied to white and red grape juices to determine effects on total phenolic and antioxidant activity of juices. Total phenolic and antioxidant activity (DPPH, ABTS and FRAP) analyses were performed in control and resin applied grape juices. Total phenolic content of white grape juice was found as 2.28 g GAE/kg dry weight. Total phenolic contents of white grape juices were decreased to 14.00, 14.00 and 23.24%, respectively, by activated carbon, Dowex® 50Wx8-100 and Amberlite® XAD-16 applications. Similar to white grape juice, the most reduction in the total phenolic content of the red grape juice were obtained by Amberlite® XAD-16 application. The antioxidant activities of both grape juices were also decreased by resin application According to the obtained results, the lowest antioxidant activity values were observed in white grape juices applied to Dowex® 50Wx8-100, and in red grape juices applied to Amberlite® XAD-16.

1. Introduction

Fruit and vegetable consumption has increased in recent years as a result of studies about the positive effects on health. Health benefits of fruits and vegetables are thought to arise from components such as phenolics, ascorbic acid and carotenoids. Phenolic compounds are secondary metabolites of plant metabolism, which is derived from phenylalanine or tyrosine (Beckman 2000, Ghasemzadeh and Ghasemzadeh, 2011). Phenolics have became increasingly important in human nutrition via protective effect on health. Grapes and grape juice are important sources of phenolic antioxidants (Burin et al. 2010) and it's considered to be one of the main sources of phenolic compounds in many fruits (Lima et al. 2014). Though fruits and vegetables are rich sources of phenolics, their content vary according to the processing and process conditions.

Pharmaceutical and food industry is utilized adsorbent and ion-exchange technology for many purposes, such as distillation and enrichment. Activated carbon, Dowex, Amberlite are most commonly used and known adsorbent and ion-exchange resins in fruit juice industry. The aim of this study was to determine the effect of resin application on total phenolic content and antioxidant activity of white and red grape juices.

2. Material and Methods

2.1. Materials

White and red grape juices were used as material. Grape juices were produced in the factory of TARGID Ltd. Co. in Mersin. For adsorption and ion exchange application, granulated activated carbon, Amberlite® XAD-16 and Dowex® 50Wx8-100 were used.

2.2. Resin application

Grape juices were treated with resins at 5 g/L dose in a shaking water bath set to 30 ^{o}C and 200 rpm for 120 min. Resins were removed by filtration after application.

2.3. *Determination of total phenolics*

Total phenolic content was determined by the Folin-Ciocalteu colorimetric method. 2.5 ml of 0.2 N folin-ciocalteu reagent and 2 ml of sodium carbonate (75 g/L) were put into 0.5 ml diluted samples and incubated 2 h in room temperature. After 2 h, absorbance was read at 675 nm. Results were given as g gallic acid equivalent/kg dry weight (Singleton and Rossi 1965).

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2.4. *Determination of total monomeric anthocyanin content*

Total monomeric anthocyanin content was determined by pH differantial method (AOAC 2005). 0.1 ml sample were tansferred to two tubes, and completed 10 ml with potassium chloride (pH=1.0, 0,25 M) and sodium acetate (pH=4.5, 0.4 M) seperately. Absorbances of solutions were measured at 510 and 700 nm, and results were calculated according to the following equation, and given as mg cyanidin-3-glucoside equivalents/ kg dry weight.

Monomeric anthociyanin content (mg/L)=(A x MW x D.F x 10^3)/(ε x l)

$A=(A_{510}-A_{700})_{pH\ 1.0}-(A_{510}-A_{700})_{pH\ 4.5}$

MW (Molecular weight)= 449.2 g/mol for cyanidin-3-glucoside

ε = 26,900 molar extinction coefficient, in L x mol^{-1} x cm^{-1}

l = pathlenght in cm

D.F=dilution factor

2.5. ABTS radical scavenging activity

ABTS radical scavenging assay is based on the inhibition of ABTS (2, 2'-azinobis-(3-ethylbenzothiazoline-6-sulfonic acid)) radicals, activated with potassium persulfate, by antioxidant compounds in samples and measurement of absorbance changes at 764 nm (Re et al. 1999). For this purpose, 990 µl $ABTS^{\bullet}$ solution (7 mM ABTS, activated with 2.45 mM potassium persulfate) was added to 10 diluted sample and absorbance was read at 764 nm 6 min later. Results were given as mmol trolox equivalent/kg dry weight.

2.6. DPPH radical scavenging activity

DPPH (2, 2-Diphenyl-1-picrylhydrazyl) radical scavenging activities of grape juices were determined according to the method of Sánchez-Moreno et al. (1998). 3.9 ml of $DPPH^{\bullet}$ solution (6 x 10^{-5} M) was added to the 0.1 ml diluted sample and after 30 min absorbance was measured at 515 nm. Results were given as mmol trolox equivalent/kg dry weight.

2.7. Ferric-ion reducing antioxidant power

FRAP assay was performed by incubation of sample with FRAP working solution at 37.5 ºC for 4 min. Briefly 1.5 ml FRAP working solution, prepared with 10 mM 2,4,6-tripyridyl-s-triazine (TPTZ), 300 mM acetate buffer and 20 mM $FeCl_3.6\ H_2O$, were put into the 50 µl diluted sample and incubated at 37.5 ºC. After 4 min absorbance was measured at 593 nm. Results were given as mmol Fe^{+2} equivalent/ kg dry weight (Benzie and Strain 1996).

3. Results and Discussions

Total phenolic contents of white and red grape juices are shown in Table 1 and Table 2. Total phenolic content of white grape juice was 1.83 g/kg dry weight and 14.50 g/kg dry weight in red grape juices. Total phenolic contents in red and white grape juices were decreased by application of Amberlite® XAD-16 and activated carbon. Amberlite® XAD-16 had the most reducing effect among the resins on the content of total phenolics in white and red grape juices. As shown in Table 2, after resin application, anthocyanin content of red grape juices decreased from 14.50 to 13.85 for activated carbon, to 14.17 for Dowex® 50Wx8-100 and to 13.33 for Amberlite® XAD-16.

Table 1

Effect of adsorbent and ion exchange resins on DPPH, ABTS, FRAP antioxidant activity and total phenolic contents of white grape juices

Treatments	DPPH (mmol trolox eq./kg)	ABTS* (mmol trolox eq./kg)	FRAP* (mmol Fe^{+2}/kg)	Total Phenolic* (g GAE/kg)
Untreated Juice	6.25±0.44	7.24±0.21a	7.64±0.11a	1.83±0.01a
Activated Carbon	5.98±0.57	6.98±0.20a	6.69±0.26b	1.71±0.01b
Dowex® 50Wx8-100	5.58±0.33	5.96±0.13b	7.58±0.02a	1.81±0.01a
Amberlite®XAD-16	5.53±0.45	5.71±0.43b	6.10±0.02b	1.51±0.03c

*p<0.01

Resin application is commonly used in fruit juice industry to control bitter taste and acidity of juices, and also to remove undesirable brown color. Gokmen et al. (2001) determined 58.5% decrease in the phenolic content of apple juice after activated carbon application. Coklar and Akbulut (2010) reported that total phenolic content of apple juices decreased from 265.96 mg/L to 67.76 mg/L by activated carbon application. To control the bitter taste of grapefruit juices, Lee and Kim (2003) and Cavia-Saiz et al. (2011) used Amberlite IR-400 and Amberlite-XAD-16 resins. They found that the resin application controlled the bitterness of juices and reduced the total phenolic content significantly. Similarly, Vivekanand et al. (2003) reported that total phenolic content of peach juices was reduced up to 92 % by using Amberlite IRA-95.

DPPH, FRAP and ABTS antioxidant activity results of white grape juices were given in Table 1. DPPH, ABTS and FRAP antioxidant activity data of white grape juice were 6.25 mmol trolox eq./kg, 7.24 mmol tolox eq./kg and 7.64 mmol Fe^{+2}/kg, respectively. According to the antioxidant activity results, all resins led to a decrease in the ABTS and DPPH antioxidant activity of white grape juices. While the FRAP value of white grape juice was decreased by application of activated carbon and Amberlite®XAD-16, Dowex®50Wx8-100 didn't lead to any change.

Table 2
Effect of adsorbent and ion exchange resins on DPPH, ABTS, FRAP antioxidant activity, total monomeric anthocyanin and total phenolic contents of red grape juices

Treatments	DPPH* (mmol trolox eq./kg)	ABTS (mmol trolox eq./kg)	FRAP* (mmol Fe^{+2}/kg)	Monomeric anthocyanin content* (mg Cyn-3-glu eq./kg)	Total phenolics (g GAE/kg)
Untreated Juice	94.26±5.75a	75.12±0.26	82.31±1.33a	367.97±5.91a	14.50±0.12
Activated Carbon	79.67±1.08b	71.71±1.02	54.92±1.23c	272.81±3.69c	13.85±0.79
Dowex® 50Wx8-100	88.07±0.89ab	70.10±0.71	64.62±3.38b	313.93±9.40b	14.17±0.11
Amberlite® XAD-16	81.39±0.27b	71.14±3.34	58.71±0.30bc	251.73±4.12c	13.33±0.52

*$p<0.01$

The antioxidant activity of red grape juices is given in Table 2. DPPH, ABTS and FRAP values were 94.26 mmol trolox eq./kg, 75.12 mmol trolox eq./kg and 82.31 mmol Fe^{+2}/kg, respectively. As seen in Table 2, all resins caused a decrease in red grape juice antioxidant activity. According the results of the DPPH and FRAP assay, the lowest values in juices were obtained by application of activated carbon. Similar to our results, Cavia-Saiz et al. (2011) reported that ABTS and FRAP values of grapefruit juice treated with ion-exchange resin were lower than the untreated juices.

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