

Mineral contents and nutritive values of the pomaces of commercial Turkish grape (*Vitis vinifera* L.) varieties

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RESEARCH ARTICLE

Abstract

Many by-products from food industries including grape pomace are generally used as animal feed or fertilisers. Grape pomace is considered as a valuable by-product for oil extraction, phenolics, tocopherols and antibacterial agents. Actually, the waste products could provide supplements for the food and drug industry. Our objective was to determine details of the nutritive values of grape pomaces of five commercial Turkish grape varieties to consider possible applications in the food and feed industry. In this study, some chemical properties and mineral contents, namely potassium (K), calcium (Ca), magnesium (Mg), sodium (Na), phosphorus (P), iron (Fe), zinc, copper, selenium, cobalt, chrome, lead and cadmium, of the grape pomaces were investigated. The results indicated that grape pomaces were generally acidic in nature with pH values of 3.82-4.30. Pomace is usually poor in sugar content and the variety of grape significantly affects the sugar content of the pomaces. Crude fibre was the major constituent of the grape pomace and ranged between 53.20 and 67.50%. Mineral analyses also showed that pomace samples had high K, Ca, Mg, Na, P and Fe contents. Consequently, the pomace samples of the grape varieties could be considered functional foods with high biological values.

Keywords: grape pomace, mineral content, nutritive value

1. Introduction

The use of by-products from food processing industries is of great interest because of its economic profitability, since residues may be available in large quantities and costly to dispose. Many agricultural by-products are commonly used as animal feeds or fertilisers. However, some could provide low cost supplements for the food industry.

The grape (*Vitis vinifera*) industry provides different processed products such as wines, juices, jams, jellies, raisins, vinegar, grape molasses, and by-products (pomace) which include grape skins and seeds. Grapes are usually crushed to obtain the juice, leaving fresh pomace as a residue. Grape seed and pomace are considered as a valuable by-products for oil extraction, phenolics, tocopherols and antibacterial agents (Gokturk-Baydar *et al.*

et al., 2004, 2007; Ozkan *et al.*, 2004). It is well known that waste products containing grape skins, seeds and stems, generated during wine and grape juice processing, are rich sources of polyphenols (Macheix *et al.*, 1990; Murthy *et al.*, 2002; Saito *et al.*, 1998). Polyphenols are able to donate a hydrogen atom to the lipid radical formed during the propagation phase of lipid oxidation (Shadidi, 1997). Besides the phenolics, grape seed and pomace are also an important oil source with unsaturated fatty acids and high tocopherol content (Gokturk-Baydar *et al.*, 2007; Schuster, 1992). Poly-unsaturated fatty acids such as linoleic and linolenic are essential for the human body since they cannot be synthesised in the body. From this point of view, grape seed and pomace oil which are very rich in linoleic acid may be a valuable source of dietary fat (Gokturk-Baydar and Akkurt, 2001; Gokturk-Baydar *et al.*, 2007). Tocopherols are also one of the most powerful natural fat-soluble antioxidants

and α -tocopherol shows the highest vitamin E activity, thus making it the most important for human health (Guthrie and Kurowska, 2001).

Constituents of grape pomace have great interest for the food industry because of the available carbohydrate fraction. In addition, the high dietary fibre content of grape pomace makes other applications possible. Grape pomace represents a rich source of various high-value products such as tartrates and malates, citric acid, grape seed oil, hydrocolloids and dietary fibre, important for human nutrition. Moreover, grape pomace is characterised by high-phenolic contents because of poor extraction during winemaking, making their utilisation worthy and supporting sustainable agricultural production (Kammerer *et al.*, 2004).

In the case of winery wastes, Diaz *et al.* (2002) reported that grape pomace, a primary waste of wine production, could be recycled as a soil conditioner in the view of its organic and nutrient contents. Moreover, when the best compost obtained from winery wastes is compared to those from other organic wastes, it was found that the chemical values of winery composts fell within the same range in most cases, the only exception was recorded for high-calcium value due to the nature of wine-making process (Bertran *et al.*, 2004; Soliva and Felipo, 2002).

Our objective was to determine details of the nutritive values of grape pomaces of commercial Turkish grape varieties (Emir, Gamay, Kalecik Karasi, Narince and Okuzgozu) with special attention to titrable acidity, pH, % moisture, oil, protein, total and invert sugars, dietary fibre, ash, water activity (a_w) and mineral contents to consider possible applications in the food industry.

2. Materials and methods

Sample collection

In this study, five samples of the pomaces of commercial Turkish grape varieties (*V. vinifera*) used for wine production were analysed for their basic composition and mineral content profile. Two samples from five grape varieties are white coloured (Emir and Narince) while the other three are red coloured (Gamay, Kalecik Karasi and Okuzgozu). Grape pomace was collected from the local wine processing industry in Turkey. They were dried at 65 °C for 3 days in an oven (Nuve, Ankara, Turkey) and ground to a fine powder.

Determination of macronutrients

Moisture contents of the samples were determined with oven at 105 °C. Soxhlet extraction using petroleum ether as a solvent was utilised for the determination of fat content of the samples (AOAC, 1997). Protein content of the samples

was estimated by the micro-Kjeldahl method (AOAC, 1997). The Luff-Schoorl method was used to determine the total and invert sugar contents in the samples (Cemeroglu, 2007). Crude fibre was determined by acid and alkaline digestion methods (AOAC, 1997). Ash content was analysed by incinerating the samples in a furnace (Protherm, PLF 12015, Ankara, Turkey) at 550 °C for 24 h. The pH was measured with a benchtop pH meter (Hanna Instruments, Milan, Italy) and the acidity was determined by titration with 0.1 M NaOH in the presence of phenolphthalein and expressed as percentage malic acid (AOAC, 1997). Water activity of the grape pomace powder was determined with an a_w meter (3TE; AquaLab, Pullman, WA, USA).

Determination of mineral contents

Phosphorus (P) was determined by UV Spectrophotometer (Agilent Technologies Deutschland GmbH, Böblingen, Germany). The determination of sodium (Na) and potassium (K) was carried out using a flame photometer (PFP7; Jenway, Staffordshire, UK). Calcium (Ca) and magnesium (Mg) contents of the samples were determined by the atomic absorption spectrophotometer method (Perkin Elmer 3110, USA). Cobalt (Co), chrome (Cr), lead (Pb), cadmium (Cd), zinc (Zn), copper (Cu), iron (Fe) and selenium (Se) were examined by the inductively coupled plasma technique (Liberty ICP-OES; Varian, Melbourne, Australia) (Tokalioglu *et al.*, 2001).

3. Results and discussion

Grapes pomace have a high value of indigestible fraction, which consists mainly of dietary fibre and minerals, oil, proteins and polyphenolic compounds associated with the polysaccharide matrix. Recently, grape seed extracts have popularly become a nutritional supplement due to their antioxidant potential (Alonso *et al.*, 2002; Bravo and Saura-Calixto, 1998; Goni and Serrano, 2005).

Proximate analyses of the pomaces of five commercial Turkish grape varieties are shown in Table 1. The percentage moisture levels of the pomace samples changed from 5.27 to 8.62. This value was lower than that of levels (47-66%) indicated by Arvanitoyannis *et al.* (2005).

a_w indicates the level of water in food available for microorganisms. Many microorganisms can grow at water activities between 0.91-0.99. Since the samples were dried before grinding, the water activity values of the pomaces were lower than 0.54, hence microbial growth is unlikely and their consumption as a food and food ingredient would be considered as safe. White coloured grape samples had much lower water activity values averaging 0.34, compared to the red coloured grape varieties with an average of 0.53. Pomace samples in the present study were acidic in nature

Table 1. Proximate composition of the pomaces of five commercial Turkish grape varieties.

Proximate analysis	Grape varieties				
	Emir	Gamay	Kalecik Karasi	Narince	Okuzgozu
Moisture (%)	5.27±0.33	6.1±0.10	8.55±0.03	5.90±0.10	8.62±0.07
Fat (%)	5.83±0.28	4.65±0.11	4.69±0.10	5.47±0.07	5.72±0.06
Protein (%)	7.86±0.08	7.71±0.04	8.09±0.11	7.63±0.02	8.08±0.05
Total sugar (%)	4.57±0.28	1.18±0.05	1.35±0.09	1.97±0.03	2.19±0.06
Invert sugar (%)	12.21±0.74	3.15±0.12	3.61±0.18	5.26±0.08	5.86±0.14
Crude fibre (%)	53.20±2.30	67.50±1.20	64.65±0.80	64.70±1.90	62.45±1.20
Ash (%)	7.85±0.03	6.96±0.22	6.81±0.02	6.50±0.20	4.00±0.01
Titrateable acidity (%)	3.00±0.10	3.30±0.00	4.20±0.15	2.10±0.15	1.80±0.10
pH	4.14±0.02	3.82±0.01	3.83±0.01	4.30±0.02	4.02±0.01
Water activity	0.36±0.00	0.51±0.001	0.54±0.0005	0.32±0.0005	0.53±0.001

and their pH values were in the range of 3.82-4.30. Karaca (2004) reported that the pH value of grape pomace was 6.5.

Grape seed oil can be derived from the grape seeds that are left in abundance in the wine-making process. Grape seed oil contains vitamin C, steroids (campesterol, β -sitosterol and stigmasterol), β -carotene, several fatty acids, omega-3 (ω -3), ω -6, ω -9, palmitic, stearic and palmitoleic acids and several tocopherols including vitamin E (Arvanitoyannis *et al.*, 2005). The fat content of the pomaces comes from the seeds and ranged from 4.65 to 5.83%. It was reported that the oil concentrations of five different Turkish grape seeds ranged from 12.35 to 16.00% while the oil concentration varied from 5.47 to 8.66% in pomaces (Gokturk-Baydar *et al.*, 2007). The results in the present study were lower than those values reported by above study.

Protein contents of the grape pomace samples ranged from 7.63 to 8.09%. Total protein contents of grape pomace were found to be 10.72% in a different study (Valiente *et al.*, 1995). The results of the protein analyses in the study were lower than those reported by Valiente *et al.* (1995).

Grape pomaces had low sugar contents since most of the sugar passes to the must during wine processing. Among the five varieties analysed, Emir contained the highest sugar content (4.57%) which was higher than that of the others which ranged from 1.18-2.19%. Another study presented the average total neutral sugar content of grape pomace to be 9.85% (Arvanitoyannis *et al.*, 2005), our findings were much lower than this value. It was reported in the literature that the main neutral sugar constituent of the grape pomace is glucose (Valiente *et al.*, 1995).

Crude fibre, the richest component of the samples, ranged between 53.20 and 67.50%. While the Emir variety was the richest in terms of total sugar, this sample had the lowest

crude fibre content with 53.20%. These values for crude fibre were approximately similar to those of Valiente *et al.* (1995). Valiente *et al.* (1995) and Acun and Gül (in press) indicated that the dietary fibre of grape pomace constituted 80 and 88.7% of dry matter, respectively, and insoluble dietary fibre was the major fraction. The major part of the insoluble dietary fibre was cellulose and the remainder part composed of xylose and xyloglucan. Valiente *et al.* (1995) noted that the dietary fibre of grape pomace might be considered a useful fibre-rich food ingredient.

The mineral contents and heavy metals of the samples are shown in Figures 1, 2 and 3. The grape pomaces were rich in P, Ca and Mg minerals, and their amounts in the samples were approximately 3,800, 2,400 and 1000 mg/kg, respectively. Additionally, while Fe and Na values of the samples were about 220 and 115 mg/kg respectively, Zn, Cu, Se, Cr, Co and Cd contents of the samples were rather low with less than 5 mg/kg. Total Cd, Cu, Ni and Zn amounts in grape pomace have been investigated by different researchers, and the results showed that Cd, Cu and Zn levels of grape pomace were 2.50, 46.00 and 77.00 mg/kg, respectively (Karaca, 2004). The Cd level found in this study was similar to that above study, but Cu and Zn levels were much lower compared to above study. The Pb values ranged between 9.25 and 32.00 mg/kg in grape pomaces. The highest Pb value was determined in Kalecik Karasi grape pomace. The heavy metal contents of the pomace samples were ranged in safety limit.

4. Conclusions

Our results showed that the pomace samples of Turkish grape varieties were rich in nutritive materials including minerals, dietary fibre, total sugar, protein and total fat. Therefore, it can be concluded that Turkish grape pomaces could be used as food supplement in food preservation

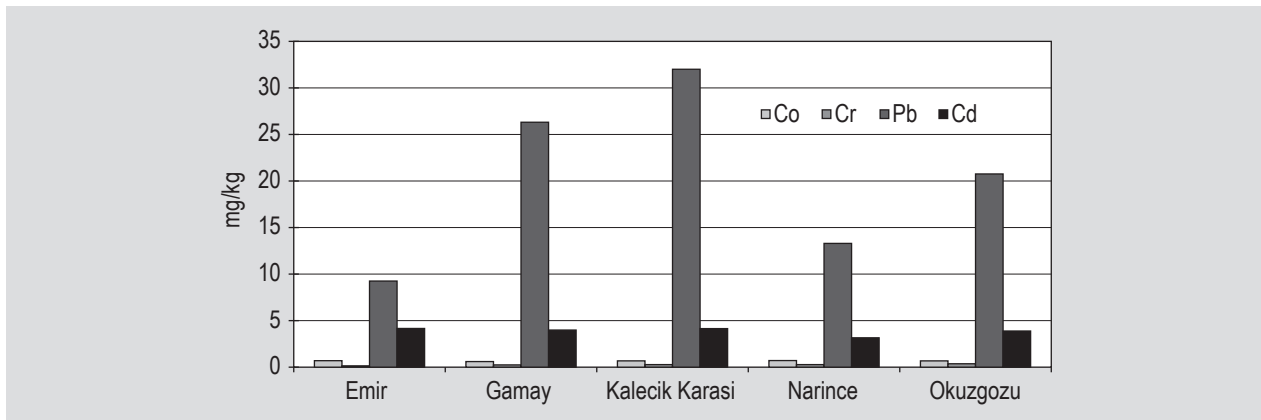


Figure 1. Heavy metal contents (cobalt; Co, chrome; Cr, lead; Pb, cadmium; Cd) of 5 grape pomace samples (mg/kg).

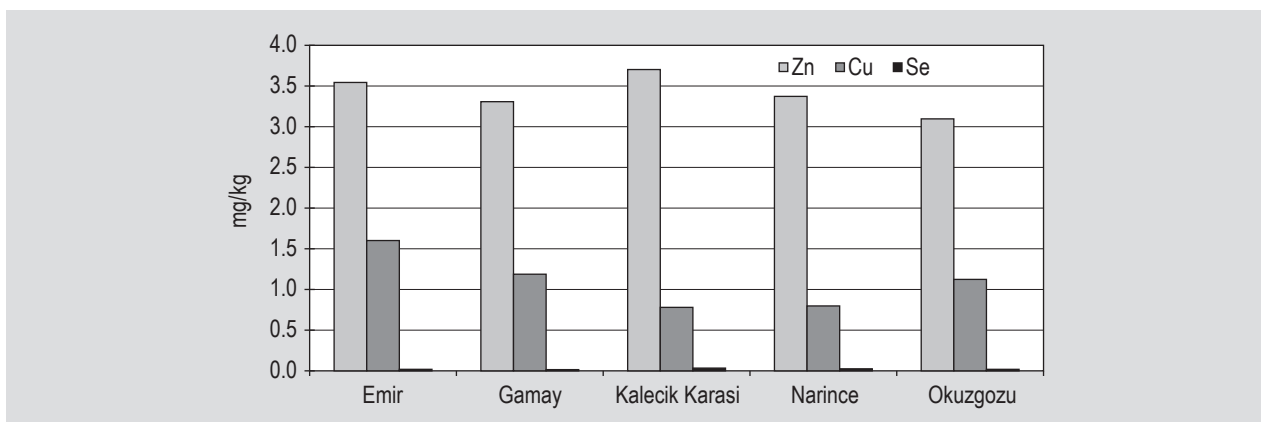


Figure 2. Zinc (Zn), copper (Cu) and selenium (Se) contents of 5 grape pomace samples (mg/kg).

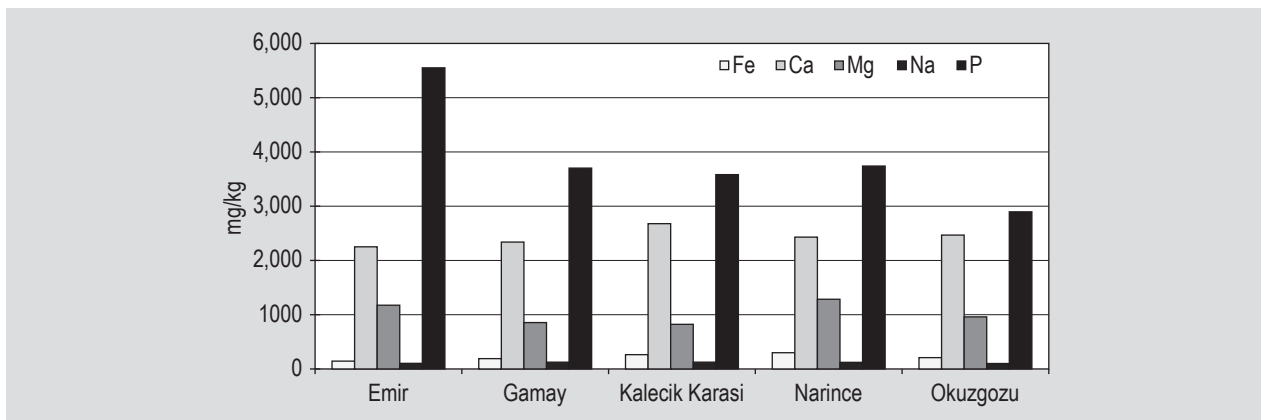


Figure 3. Calcium (Ca), iron (Fe), magnesium (Mg), sodium (Na) and phosphorus (P) contents of 5 grape pomace samples (mg/kg).

and enrichment practices for human nutrition. Hence the pomace samples of Turkish grape varieties can potentially be considered as functional foods having with high biological values.

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