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Analysis of Mineral Content in Pomegranate Juice by ICP-OES

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Along with olives, figs and grapes, pomegranates are among the first plants to have been cultivated by man. The perceived consumer value of pomegranate and its juice is due in large part to its scientifically supported health benefits. The fruit is believed to have significant effects for arteriosclerosis, cholesterol levels and cancer prevention. In this study, the mineral compositions of commercial 100 % pomegranate juices were determined. Although processing steps include clarification and filtration, the pomegranate juices were a good source for minerals such as potassium (1283.30 mg/L), calcium (107.53 mg/L), sodium (96.02 mg/L), phosphorus (76.54 mg/L) and magnesium (67.22 mg/L). The high mineral content of pomegranate juices could contribute to the total intake of these constituents in the human diet.

Key Words: Pomegranate juice, Mineral elements, Health benefits.

INTRODUCTION

Pomegranate (*Punica granatum* L.) is considered one of the oldest known edible fruits and is symbolic of abundance and prosperity. Pomegranates were cultivated in the Middle East more than 5000 years ago and Turkey is among the world's main pomegranate-producing countries[1]. The fruit is consumed directly as a fresh fruit or as juice, but it can also be used in jam production and as a flavouring and colouring agent[2].

The recent interest in this fruit is not only because of its pleasant taste but also because of scientific evidence that suggests the fruit's beneficial role in the prevention of the oxidation of both low density lipoprotein and high density lipoprotein[3-5], reductions in blood pressure[6], the prevention of prostate cancer[7,8], arthritis, anemia, diarrhea, inflammation, gynecological diseases, atherosclerosis development and the stimulation of T-cell functions and production of cytokines[9,10]. These beneficial effects were attributed to the antioxidative properties of pomegranate phenolic compounds as well as to those of sugar-containing polyphenolic tannins and anthocyanins[11-13].

Pomegranate juice is a popular drink in the Middle East and has begun to be marketed worldwide. The recent popularity and high price of pomegranate juice have led to concerns regarding the authenticity of some of the products in the market place. An important approach to determining the authenticity of pomegranate juice is to reveal its chemical composition and indicate its differences from other

juices[14]. The composition of pomegranate juice depends on the cultivar type, environmental and postharvest factors and storage and processing factors[15-18].

The edible part of the fruit (arils), which is 64 % of the whole fruit, contains a considerable amount of sugars, vitamins, polysaccharides, polyphenols and minerals[19-25]. The total mineral content of the edible portion, as represented by its ash, is 1.491 %, being mainly phosphorus, potassium, calcium, magnesium and iron[10,15]. There is an increased concern about the availability of high-juice-yield pomegranate cultivars with suitable juice compositions. Thus, it is crucial to acknowledge the fruit's characteristics to not only classify varieties but also meet current market demand. There have been relatively few references on the composition and particularly on the mineral constituents of pomegranate juice in the literature. Therefore, the aim of this work is to determine the mineral element composition of commercial pomegranate juices consumed in the Turkish market.

EXPERIMENTAL

Sample collection and preparation: Fourty-two pomegranate juice samples of 6 different brands, representing 100 % pomegranate juice, all in 1 L aseptic carton packages, were purchased from local stores during 2008 for use in this study. The samples were stored at ambient temperature and prior to analysis were thoroughly mixed. The juice samples were diluted 1:1 with 0.2 % (v/v) HNO_3 and centrifuged for 20 min at 2000 rpm (Hettich Universal 30F, Tuttlingen, Germany).

Standard solutions were prepared by dilution of each pure element standards obtained from Merck (Darmstadt, Germany). Nitric acid (65 % Merck) of analytical grade was used for the mineralization of the samples. All aqueous solutions and dilutions were prepared with ultrapure water (Milli-Q, Millipore, Bedford, MA).

Determination of mineral elements: The pomegranate juices were analyzed by an OPTIMA™ 2100 DV inductively coupled plasma-optical emission spectrometer (Dual View, Perkin-Elmer Life and Analytical Sciences, USA). The appropriate standards for each element were made within the concentration range of the elements in the samples. The operational conditions, the analytical lines used, measurement parameters and the wavelengths of the elements are shown in Table-1.

RESULTS AND DISCUSSION

The elemental concentrations of the samples of commercial pomegranate juices (100 % pure juice) are summarized in Table-2. The results (mg/L) are presented as a mean or average (Avg), standard deviation (Std dev.) and minimum (min) and maximum (max) value for each mineral.

The concentration of various elements in the present work are, in decreasing order, potassium > calcium > sodium > phosphorous > magnesium > iron > manganese > tin > copper > zinc = nickel > lead. Among the various elements, cadmium was also analyzed but was not detected in commercial pomegranate juices. There were high levels of potassium, calcium, sodium, phosphorus and magnesium and there were

TABLE-1
OPERATING PARAMETERS FOR ICP-OES

		Detection wavelengths (λ/nm)	
Nebulization gas flow rate	0.55 L/min	P	214.914
Auxiliary gas flow rate	0.2 L/min	Na	589.592
Plasma gas flow rate	17 L/min	K	766.490
Sample flow rate	1.5 mL/min	Ca	393.366
Operating power	1 450 W	Mg	279.553
View	Axial	Fe	259.940
Interface	Shear gas	Cu	324.754
Sample uptake rate	1.0 mL/min	Zn	213.857
Spray chamber	Cyclonic	Mn	257.610
Nebuliser type	Meinhard	Ni	221.647
Nebuliser set up	Instant	Pb	220.353
Replicates	3	Sn	235.485
		Cd	214.440

TABLE-2
ELEMENTAL COMPOSITION OF COMMERCIAL POMEGRANATE JUICES (mg/L)

Element	Minimum	Maximum	Average ± standard deviation
P	38.06	104.38	76.54±23.55
Na	51.28	208.56	96.02±66.06
K	708.33	1734.90	1283.30±329.16
Ca	60.28	171.70	107.53±44.44
Mg	35.17	97.39	67.22±22.13
Fe	0.99	2.73	1.81±0.88
Cu	0.03	0.21	0.10±0.06
Zn	0.00	0.24	0.04±0.10
Mn	0.31	1.68	0.96±0.58
Ni	0.02	0.06	0.04±0.02
Pb	0.00	0.02	0.003±0.008
Sn	0.58	0.84	0.74±0.10
Cd	Not detected	Not detected	Not detected

minor levels of iron, manganese, tin and copper; zinc, nickel and lead were found at trace levels.

The pomegranate juice appears to be a good source of nutrients and variation in the mineral composition could originate from the pomegranate cultivar as well as agro-climatic conditions, handling practices and manufacturing conditions[26,27]. Because pomegranate and its juice are consumed frequently for their phenolic compounds, which includes antioxidants, the data available is mainly on the chemical composition of the fruit itself rather than on that of the juice. Unal *et al.*[15] found very high amounts of chlorine in juices of different Turkish pomegranate varieties. Al-Maiman and Ahmad[16] reported that the potassium and sodium content were the

highest among the mineral elements in pomegranate juice. Recently, Eksi and Ozhamamci[10] investigated the chemical composition of 23 pomegranate juice samples from concentrate to contribute to the establishment of criteria for the authenticity and identity of pomegranate juice. The predominant mineral was potassium (2093-2517 mg/L), followed by phosphorous, magnesium, calcium and sodium at levels of 93-151 mg/L, 21-104 mg/L and 11-149 mg/L and 20-128 mg/L, respectively. Similarly, Orak[28] reported on antioxidant activity, colour and nutritional characteristics of pomegranate juice and its sour concentrate processed by conventional evaporation. The concentration process differently affected various mineral contents and the amounts of sodium, iron, zinc, copper and lead were lower in concentrated juice, whereas the potassium and magnesium contents significantly increased during concentration.

Most of the findings in the present study with regard to the mineral components of the pomegranate juice are consistent with the results of the other studies[10,15,16,28], based on the analysis of pomegranate juice samples prepared at the laboratory scale.

The elemental compositions of commercial pomegranate juices were generally in compliance with values in the AIJN proposal[29] with the exception of higher sodium content. Like most fruit varieties, fresh pomegranates contain traces of sodium by nature; however, the high sodium content of pomegranate juice might be related to the raw material growth conditions as well as the clarification process using bentonite, as mentioned in AIJN.

Conclusion

Mineral nutrients and phenolics that play an important role in maintaining fruit quality and determining a fruit's nutritive value are a natural component of many fruits. The enthusiasm over pomegranate is mainly based on its nutritional and antioxidant characteristics, as pomegranate fruit, especially arils, contain a substantial amount of polyphenols. The chemical composition of the fruit and the juice differs depending on the cultivar, the growing region, the climate, the fruit's maturity, cultural practices and manufacturing systems. There is rather limited data on the nutrition information, particularly with regard to the mineral constituents, of 100 % pomegranate juice and its role in human health. Therefore, knowledge about the mineral nutrients in commercial juices appears to be necessary to understand the quality, authenticity and potential safety risks of the juice.

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