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Statistical Analysis of Macro-Elements Contents of *Vitis vinifera* (Raisin) Samples Available in Pakistan

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Vitis vinifera (Raisins) are sweet, tasty and nutritious and people have been enjoying them from the very beginning of civilization. They are the most favorite food not only because of its taste but also due to its high micronutrient contents, highest concentration of total phenolic compounds, highest antioxidant activity among the solid food products and rich source of minerals including potassium, magnesium, calcium, iron, sodium, chromium, manganese, nickel and vitamins. Minerals are necessary for the proper functioning of our body. Deficiency of essential minerals can cause various diseases. So, proper intake of these essential minerals is the warranty of good health. In the present study, different samples of various varieties of raisin were collected from local markets and their mineral profile analysis was done. The results obtained were then compared with the values provided by USDA (United States Department of Agriculture). On the average, every 100 g of raisin produced in Pakistan contains 21.5 mg of Na^+, 673.5 mg of K^+, 63.75 mg of Ca^{2+}, 31.87 mg of Mg^{2+} and 1.36 mg of Fe^{2+}. The results of this analysis reflect that raisins are considered to be a healthy food and a potential source of important minerals which can efficiently meet the dietary requirements of human beings.

Keywords: *Vitis vinifera*, Raisin, Mineral profile, Flame emission spectroscopy, Atomic absorption spectroscopy, Metal concentration.

INTRODUCTION

Vitis vinifera is commonly called as Raisin, Kishmish, Bedana, Munaka, Songhi and Meva. Raisins are sweet, tasty and nutritious snacks which give taste and nutrition to our food. People have enjoyed raisins from the very beginning of civilization and its consumption dates back to prehistoric times. In the late 1400 s Spanish missionaries were the first to introduce raisins to the world. America and the eastern regions of Mediterranean including ancient Phoenicia and Persia were the places where the cultivation of grapes first began. In Anatolia, grapes were also important, where they were offered to gods by Hittites[1]. In the European regions along the Mediterranean due to countless vineyards and pre-existing tradition of viticulture the production of raisins was made easy[2]. Ancient Romans added raisins as a chief constituent along with olives and bread into their common meals. Roman doctors prescribed raisins as a cure of various diseases due to their medicinal importance. Raisins were so important that they became the reward of winner of athletes[3].

Raisins are produced in many regions of world and it is consumed by all demographic regions and cultures. United States is the world leading raisin producing country and California is responsible for 90 % of the total, which produces 400, 000 tons of raisins every year using nearly 3 million tons of grapes. After United States; Turkey, China, Iran, Chile, South Africa, Greece, Australia and Uzbekistan are the major producers of raisins[4,5]. In Pakistan, Quetta, Pishin, Kila Abdullah, Mastung and Kalat districts of Baluchistan province accounts for 95 % production of raisins.

Raisins have been the most favorite food due to its high micronutrient contents, highest concentration of total phenolic compounds, highest antioxidant activity among the solid food products and rich source of minerals including potassium, magnesium, calcium, iron, sodium, cadmium, arsenic, chromium, manganese, nickel and vitamin B[6-9]. Raisins have carbohydrates like glucose and fructose and also contain phytochemicals and antioxidants which act as protective barrier against cardiovascular diseases, constipation and cancer rehabilitation[10-12]. Fibers both soluble and insoluble are also present in raisins.

Raisins have been a potential research topic and many studies have been reported in order to find mineral profiles, antioxidant capacities and glycemic index, *etc*. Ghrairi *et al.* reported raisins as an appealing source of minerals like potassium ranging from 628-854 mg/100 g DW, calcium 49.6-95.2 mg/100 g DW and magnesium 28.67-41.79 mg/100 g DW[13]. Williamson and Carughi[5], studied polyphenol, phenolic acid and tannin (PPT) contents of raisins in order to know their bioavailability. Flavonols, quercetin, kaempferol, phenolic acids, caftaric and coutaric acid were the most important PPTs present in the raisins[14]. Bakkali *et al.*[15] observed that fruits components were strongly affected by storage and processing. In order to find influence of processing on the stability of grapes, microwave-assisted air drying and traditional methods were used for the production of raisins. Although greater antioxidant capacity was observed in microwave-assisted drying but as compared to traditional method, there was a reduction in the concentration of ascorbic acid. In another study, Meng *et al.*[16] determined the dietary antioxidant potential and phenolic compositions of raisins of nine grapes genotype by using different techniques such as cupric reducing antioxidant power (CUPRAC), 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging capacity, nitrite scavenging capacity (NTSC), hydroxyl radical scavenging capacity (HRSC) and potassium ferricyanide reducing power (PFRAP). Total phenolics, total flavonoids and oligo proanthocyanidin were present in higher concentrations. The predominant phenolic compound present in all the raisins was 3,4-dihydroxybenzoic acid. Kim *et al.*[17] investigated the glycemic index (GI) and insulin index (II) of raisins. The study was conducted on 11 aerobically trained adults, 10 healthy Sedentary individuals and 10 prediabetic adults. The GI of raisins was moderate (GI, 55-69) in the A group (62.3 ± 10.5) and low (GI, ≤ 55) in the S (49.4 ± 7.4) and P (49.6 ± 4.8) groups. The values for insulin index were 47.3 ± 9.4, 51.9 ± 6.5 and 54.4 ± 8.9 for the S, A and P groups, respectively. Thus it was proved that raisins were a low to moderate glycemic index food and correspondingly lowers insulin index food.

EXPERIMENTAL

Nitric acid, potassium chloride, sodium chloride, magnesium chloride, calcium chloride and iron(II) sulfate hepta hydrate were obtained from Sigma-Aldrich and used as received.

Perkin-Elmer (AAnalyst 100) Atomic Absorption Spectrometer equipped with air/acetylene flame having pre-mixed chamber was used for absorption measurements of Mg^{2+}, Ca^{2+} and Fe^{2+}. Sherwood Flame photometer 410 was used for the emission measurements of Na^+ and K^+.

Sample solutions preparation: Four samples of raisins were collected from Lahore, Quetta, Peshawar and Murree areas of Pakistan and numbered from 1-4, respectively, washed with distilled water and after air drying, dried at 100 ºC for 2 h. In order to remove the carbon contents, raisins were converted into the ash by taking a weighed amount in china dish and heated in muffled furnace at 300 ºC. Ash formed was grounded to a fine powder. About 10 mL of nitric acid was added to 5.0 g finely powdered ash and boiled for 15 min. After then distilled water was added and boiled again for 15 min. The whole sample solution was diluted to 100 mL by distilled water.

Standard solutions preparation: Stock solutions of potassium chloride, sodium chloride, magnesium chloride, calcium chloride and iron(II) sulfate hepta hydrate were prepared by dissolving respective amount of salts in distilled water and volumes were made up to the mark. From stock solution, standard solutions of different concentrations were prepared by making further dilutions with distilled water.

RESULTS AND DISCUSSION

In order to find the quantity of Na^+ and K^+ in raisin samples, flame emission spectroscopy was used and graphs were plotted between concentrations and emission signal. Whereas Ca^{2+}, Mg^{2+} and Fe^{2+} were quantified by using atomic absorption spectroscopy and graphs were plotted between concentrations and absorption signal. So, by regression analysis of calibration curves, the concentration of metal ions was determined. The concentration values of these metal ions are given in Table-1. Statistical analysis of data shows that the concentration of these minerals was almost same in all four samples because *p*-value is greater than 0.05 in all cases. Column chart in Fig. 1 is drawn for comparative study of four samples, whereas pie chart in Fig. 2 shows mineral profile of raisin samples in percentages.

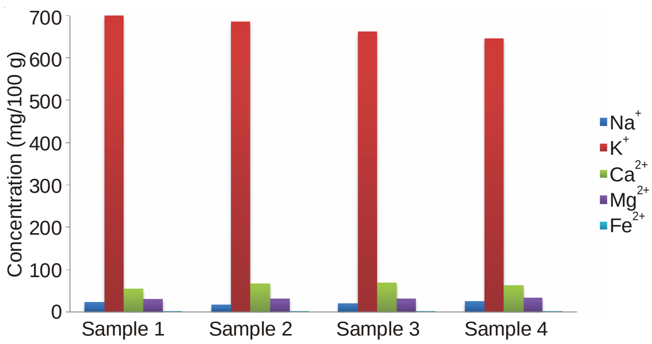

Fig. 1. Column chart of mineral profile of Raisin samples

According to results of analysis, the four raisin samples do not vary too much with respect to mineral quantities. The quantity of K^+ is greatest as compared to other minerals in all samples, constituting up to 86 % of total minerals. USDA (United States Department of Agriculture) has reported the 749 mg of K^+ in 100 g of raisin which is slightly greater than raisin produced in Pakistan. As far as concentration of Na^+ is

TABLE-1
CONCENTRATIONS OF METAL IONS IN RAISIN SAMPLES IN mg/100 g QUANTITY

Sample	Area of collection	Na^+ (mg/100 g)	K^+ (mg/100 g)	Ca^{2+} (mg/100 g)	Mg^{2+} (mg/100 g)	Fe^{2+} (mg/100 g)
1	Lahore	23	700	54	30	1.2
2	Quetta	17	685	68	31	1.7
3	Peshawar	20	662	70	32.5	0.91
4	Murree	26	647	63	34	1.65
Average concentration		21.5	673.5	63.75	31.875	1.365
Standard deviation (±)		3.87	23.59	7.14	1.75	0.37
p-Value of *t*-test		1.00	1.00	1.00	1.00	1.00

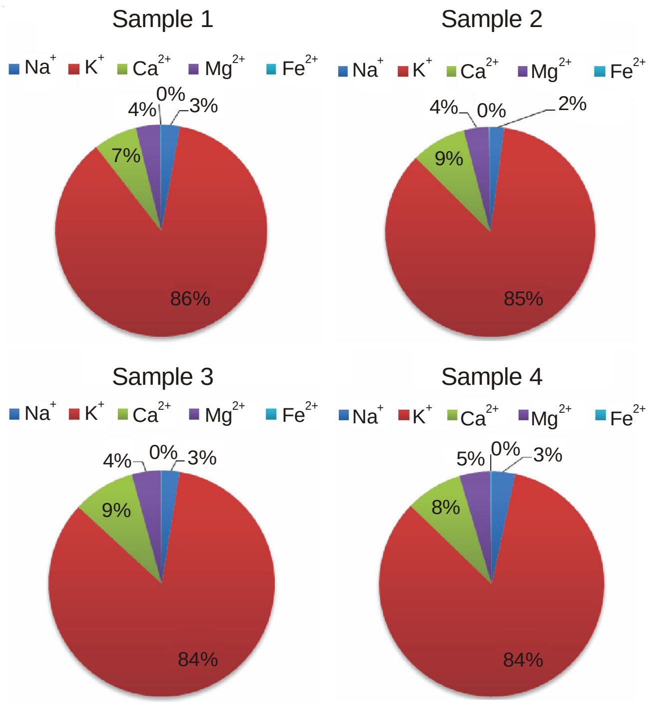

Fig. 2. Pie charts of mineral profile of four samples of Raisins

concerned, it is quite high and is almost doubled as compared to USDA reports which indicate 11 mg of Na^+ in 100 g of raisin. The greater amount of Na^+ may be attributed to the higher concentration of salts in soil. USDA has reported the standard value of 50 mg of Ca^{2+} in 100 g of raisin. The amount of Ca^{2+} in local raisin is almost 64 mg/100 g of raisin which is quite higher than standard values, whereas amount of Mg^{2+} is 32 mg/100 g of raisin which is almost equal to the value provided by USDA. Fe^{2+} is present in negligible amount as compared to other minerals in all four samples and its value is also close to USDA which is 1.88 mg/100 g of raisin.

Conclusion

Raisins are eaten by hand and mixed with other dishes and fruits and consumed all over the world. Today raisins have become a significant part of our daily diet because of their soluble and insoluble fibers, vitamins, anti-oxidants and minerals such as Na^+, K^+, Ca^{2+}, Mg^{2+} and Fe^{2+}. On the average raisin produced in Pakistan contains 21.5 mg of Na^+, 673.5 mg of K^+, 63.75 mg of Ca^{2+}, 31.87 mg of Mg^{2+} and 1.36 mg of Fe^{2+} for every 100 g of raisin. Raisins have attracted the attention of researchers working on lowering of blood pressure and prevention of cardiovascular diseases because of greater amounts of K^+ then Na^+. Calcium is required to strengthen the bones which form the basic structural frame work of our body. Magnesium is a macronutrient and is required to maintain muscle and nerve functions along with healthy immune system. Our blood contains iron and its deficiency causes anemia. Daily recommended values for the minerals show that raisins contribute significantly to the uptake of minerals. Due to the presence of these essential minerals and their importance in our body, raisins are considered to be a healthy snack.

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