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Heavy Metals Concentration (Copper, Chromium, Cadmium and Zinc) in Saffron of South Khorasan, Iran

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ABSTRACT

Heavy metals are stable contaminants that are not using through biological and chemical processes in nature and entry into food chain and reach a critical concentration leaves metabolic and physiological harmful effects on Living organisms. In our country, Saffron is known a health flower, Sultan spices and red gold that is among the most widely used plants in the household, pharmaceutical and industrial. So far, research has not done on the accumulation of metals in this popular and widely used plant and its effects on health in the country. Because of the main area of production and exports of this product is in East Country, A study is essential in it. In this research, community study is Saffron of South Khorasan cities (Ferdows, Ghaen, Birjand) that The 63 samples, 21 samples from each of the city and 7 samples of each product (Style, All-Red, Bunch) The amount of 2 g were harvested according to standard methods of Institute of Standards and Industrial Research of Iran (Standard 690). To measure the concentration of heavy metals, Necessary tests was conducted on the samples after extraction by hydrochloric acid and nitric acid according to standard methods of Institute of Standards and Industrial Research of Iran and samples analysis were performed by atomic absorption spectrophotometer(AAS). The results indicated that the accumulation of heavy metals in All-Red was more than Style and in Style more than Bunch. Also, a comparison were performed on product type (Style, All-Red, Bunch) and the average of concentration of heavy metals (Cd, Pb, Cr, Zn, Cu), Zn was greater than all heavy metals (in the All-Red =22.89 mg/kg), Cr was lower than all of them (in the Style = 21.2 mg / kg). In 63 samples were taken from the production of saffron, concentration of heavy metals was in Birjand more than Ferdows and in Ferdows more than Ghaen. Accordingly, changes in the concentrations of heavy metals (Cu, Cd, Zn, Cr, Pb) had a statistically significant difference ($p \leq 0.05$) in this research. It is necessary that continuously keep track occurs about the amount of heavy metals in food sources with the increase of heavy metals in the environment and in plants and a comparison with the threshold concentrations of metals, control measures are essential in it.

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INTRODUCTION

Saffron is known a health flower, is the most valuable vegetation in Iran and originates from the slopes of Alvand Mount. Saffron usually grows in India, Iran, Spain, Greece and other countries and grows successfully in many regions in China [1]. Saffron is currently confined to South Khorasan province (95 percent) and, Kerman, Markazi, Yazd, Esfahan and Fars provinces (%5). Saffron has various uses that its major consumption is food, medicinal, and chemical (industrial).

According to the Food and Drug Administration (FDA), the amount of saffron does not limit as natural scent and flavor and is allowed to use as a natural colorant to prepare foods such as sausage and margarine - butter, cheese and dairy industry - cakes and desserts, jelly and beverage - chocolate and drinks - soups and rice and chicken [2].

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Previous studies have focused on medical and pharmacological use of Saffron and all metallic elements have not studied and only one study in China, had investigated 7-8 metallic elements [1] around the world, many studies are done about contamination of soils and plants to heavy metals through irrigation with urban and industrial waste water [3]. Considering the last decade, the entry of pollutants has increased into the environment with human origin as heavy metals which are regarded as a serious threat to the organisms and since the entry of heavy metals into the environment are greater than the amount has removed by natural processes. Consequently, heavy metal accumulation is considered in the environment. The most fundamental problem related to heavy metal, are not metabolized them in the body. Because, heavy metals are stable pollutants that are not degradable through biological and chemical processes in nature [4] and their entry into the food chain and reach a critical concentration, have harmful metabolic and physiological effects on organisms [5].

Heavy metals are not excreted after entering to the body, but can accumulate in tissues such as fat, muscle, bones and joints that cause diseases and numerous complications in the body. Almost, all heavy metals put harmful effects in the body, including neurological disorders, renal and circulation of blood [6].

Now, by considering to this subject that saffron is the most widely consumed products in the country and with a growing population and increased demand (the current demand is about 170 tons and considering the many uses of saffron, if any person uses 0.25 g in a year, 6 Milliard of world population will need 1500 tons. This request is only for personal use and pharmaceutical applications and food will be added to the above figures.

Considering the increasing contaminations in the environment and the entering of contaminants to the human body through the food chain and therefore saffron. Therefore, a study should do to investigate heavy metals in South Khorasan saffron in three cities (Birjand, Ghaen and Ferdows) and requires comparing with existing standards.

MATERIALS AND METHODS

In this research, community study is Saffron of South Khorasan cities (Ferdows, Ghaen, Birjand) that The 63 samples, 21 samples from each of the city and 7 samples of each product (Style, All-Red and Bunch) The amount of 2 g were selected according to standard methods of Institute of Standards and Industrial Research of Iran (Standard 690). To measure the concentration of heavy metals, Necessary tests were conducted on the samples after extraction by hydrochloric acid and nitric acid according to standard methods of Institute of Standards and Industrial Research of Iran Sample analysis was performed by atomic absorption spectrophotometer (AAS).

The sample size in this study is determined on the results of the Malakootian's study and colleagues [8] and on the formula $N = \frac{d^2}{\delta^2}$ ($\delta = 4.78$ and $d = 1.2$). 21 samples are selected from each city, 7 samples are from each product and 63 samples (2 g) in the total 11 Sampling was done randomly in the saffron of distribution centers in cities

The collected data were entered into SPSS-15 software and were analyzed by descriptive statistics and statistical T-Test and ONE WAY-ANOWA in = P value 0.05

Results:

The results of the analysis, 63 examples of South Khorasan saffron (21 samples from each of the city of Birjand, Ferdows Ghaen) and three samples of adulterated saffron To determine the concentration of heavy metals (copper, chromium, cadmium, lead and zinc), and to compare with the standard value, is in the below tables and graphs. Table 1 represents the average of concentrations of heavy metals in the three towns. Changes in the concentrations of heavy metals (Cu, Cr, Pb) was a statistically significant difference (P value=0.00). Also, changes in the concentrations of Cd heavy metal was a statistically significant difference.(P value=0.018) and changes in the concentrations of Zn heavy metal was a significant difference. (P value=0.005) by ONE WAY-ANOWA test.

Table 1: Comparison of concentrations of heavy metals (Zn-Pb-Cd-Cr-Cu) in South Khorasan saffron production.

Metal City	Cu	Cr	Cd	Pb	Zn
Birjand(21 samples)	25.88±12.56	5±3.76	9.85± 60.86	2.72± 1.39	23.32±5.63
Ghaen (21 samples)	2.90 ± 2.98	1.53±1.25	1. 3± 0.59	1.03±1.56	18.38±3.99
Ferdows (21 samples)	1.42 ± 16.60	0.80±0.75	4.72± 6.25	7.21±4.23	22.56±5.83
Total	63 examples				

Cu concentration changes was a significant difference (P value=0.03) by ONE WAY-ANOWA statistical tests by product type. Cd concentration changes was a significant difference (P value=0.004) and also, Zn concentration changes was a significant difference(P value=0.021) After analyzing saffron samples and compare their concentrations of heavy metals with the existing standards was found that, the concentration

average of cadmium heavy metal was %80 more than standard level in All-Red, and %90 in Bunch, Style. The average of concentration of lead heavy metal was %40 more than standard level in All-Red and Style and %60 in Bunch. The average of concentration of chromium heavy metal was %5 more than standard level in Bunch(7).

Table 2: The average of heavy metals concentration is shown by the type of saffron.

Type of saffron	Number	Cu	Cr	Cd	Pb	Zn
All-Red	21	22.35±17.28	2.32±2.88	16.11±46.20	4.26±4.62	22.89±5.85
Bunch	21	14.90±12.60	3.02±4.14	4.57±9.37	2.48±2.03	19.77±5.02
Style	21	25.80±19.54	2.21±1.33	5.28±9.28	4.54±4.07	22.64±4.01
Fake saffron	3	0.100±.13	0.78±1.16	81.35±114.54	1.29±1.72	14.15±10.57
Total	66	20.06±17.25	2.44±2.94	11.96±37.06	3.65±3.75	21.42±5.58

The results are presented in Table 3.

Table 3: Frequency of the average of concentration of heavy metals (pb, zn, cd, co, cr) higher than the standard by the type of saffron production in South Khorasan Province.

Type of saffron	Number	Cu	Cr	Cd	Pb	Zn
All-Red	21	22.35±17.28	2.32±2.88	16.11±46.20	4.26±4.62	22.89±5.85
Bunch	21	14.90±12.60	3.02±4.14	4.57±9.37	2.48±2.03	19.77±5.02
Style	21	25.80±19.54	2.21± 1.33	5.28±9.28	4.54±9.07	22.64±4.01
Allowable amount on standard	150mg/kg (7)	12-13mg/kg(8)	0.4-0.5(9)	2.56(9)	40mg/kg(10)

Discussion:

In this research, the minimum and maximum amount of copper was respectively (0.3-57.28 mg / kg) ,(0.25-59 mg / kg), (0.27-35.88 mg / kg), (0-0.25 mg / kg) in the All-Red, Style, Bunch and fake, and the minimum and maximum amount of chrome was respectively (0-11.57mg/kg) ,(0- 4.88 mg / kg), (0-15.75 mg / kg), (0-2.13 mg / kg) in the All-Red, Style, Bunch and fake. Minimum and maximum value of the cadmium, was (0.13 - 212.5mg/kg) ,(0.66 -42.38mg/kg), (0.26 -33.63mg/kg), (0.91-212. 5mg/kg) in the All-Red, Style, Bunch and fake. Minimum and maximum level of lead was (0-14.5 mg / kg), (0-12.63 mg / kg), (0-6.13 mg / kg) in the All-Red, Style, Bunch, and minimum and maximum value of Zn was (0-28.25 mg/kg), (14.19-27.38 mg/kg), (11.34 -26.13mg / kg) in the All-Red, Style, Bunch.

In the results of Malakootian's study et to determine the concentration of heavy metals in black tea in Tehran (8), concentrations average of lead, chromium, copper was respectively, 6.97± 4.78, 5.75 ±1.08, 23.85± 9.68 mg/ kg in tea samples. The minimum concentrations of Pb, Cr, Cu were respectively, in Ahmed bags tea, Shilan and Golabi. In this study, the concentration of lead was 4.78 ± 6.97 mg kg in tea samples and this amount is over the allowable amount by the Ministry of Health of Iran, ie 1 mg kg. In the present study, lead concentrations was obtained (mg / kg 4.73), Cr (mg / kg 3.5) and Cu (mg / kg 20.59) in the Bunch that these values are lower than the concentrations of heavy metals in the Malakootian's study. The reason may be in the different nature of plant in absorption of heavy metals.

In the results obtained from a study in China to determine the concentration of heavy metals in Saffron of two areas (11), concentration average of lead, chromium, copper, cadmium, zinc was respectively (0.87 μ g/g, 0.34 μ g/g, 13.45μ g/g, 0.26 μ g/g, 104.25 μ g/g)in saffron samples in Henan region, and the average of them was respectively (0.37 μ g/g, 0.87 μ g/g, 8.76 μ g/g, 0.024 μ g/g, 36.27 μ g/g) in samples of Tibetan region that is quite different with The results of this study that The main reason is in the quality soil of areas.

In the results obtained from Said Nazmi 's study et to determine the concentrations of heavy metals in farmed vegetables of Shahrood city (12), Shahi has the highest concentration of lead (59.30 mg/kg) and radish leaves has the lowest concentration (4.72 mg/kg). The highest concentration of Cr is in Basil (8.82 mg/kg) and the lowest concentration is in fenugreek (2.94mg/kg).

The highest concentration of cadmium is in Leek 6.30 mg/kg) and the lowest is in Shahi (0.36 mg/kg) and the highest zinc concentration is measured in Leek (263.51 mg/kg) and the lowest in radish roots (106.42 mg/kg). Pb concentrations measured in this study have a value greater than the proposed standards for heavy metals absorbed by plants. This is clearly true in the chromium and cadmium metals and the fact is that the measured values of the two metals have much higher concentrations of the proposed standards by FAO and WHO. (12) and in the present study, the amount of lead and cadmium is higher than the proposed standards by (FAO and WHO).

This study showed that saffron has heavy metals such as copper, chromium, lead, cadmium, zinc. It should be noted that the amount of heavy metals is significantly in the decoction saffron less than dry saffron. Also, Available absorption percent of heavy metals is different on the gastrointestinal. Absorption percent of minerals is not clear in drink and food Saffron. Because of the amount of bio available metals is not clear in Saffron and is related to factors such as stomach PH. It is concluded that the absorption of these metals are greatly reduced in the body.

Conclusion:

Overall, these results indicate that saffron can be used without any worry to toxicity with these studied elements, as a beneficial nutrient. However, because of increase the release of heavy metals in the environment and accumulation of metals in plants, it is necessary to do constant monitoring of the concentration of heavy metals in different food sources and then compared with a threshold concentration of these metals in food. So, control measures should be to prevent the release of heavy metals in the environment. Preventive measures such as planted in locations away from industries, roads, and no use of chemical fertilizers.

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