Heavy Metals Levels in Strawberry and Sugar Beet of EGYPT

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Abstract: Strawberries are an economically export produce of Egypt. Crops contamination with Heavy metal contamination is a main threat to agricultural production in addition it might cause possible environmental risks which subsequently impacts on environmental and human health. The present study aimed to determine the levels of Cadmium (Cd), Zinc (Zn), Ferric (Fe), Nickel (Ni), Copper (Cu), Lead (Pb), Chromium (Cr) and Manganese (Mn) in strawberry and sugar beet samples of Egypt. The levels of heavy metals were detected by microwave Plasma Atomic Emission Spectroscopy (MP-AES) using Agilent technologies optical emission spectrometer. The results showed that the concentration levels of Zn values ranged from 0.110 - 5.84 mg kg^{-1} and 0.070 - 0.255 mg kg^{-1} in strawberry and sugar beet samples, respectively. Cadmium concentrations were from 0.001-0.007 mg kg^{-1} and not detected to 0.001 mg kg^{-1} in strawberry and sugar beet, respectively. The concentration of Fe, Cu, Ni, Pb, Mn and Cr ranged between (0.610-2.700 mg kg^{-1}), (1.000-2.100 mg kg^{-1}), (0.050-0.800 mg kg^{-1}) and (0.0300.270 mg kg^{-1}), (0.040-0.300 mg kg^{-1}), (0.018-0.099 mg kg^{-1}). (0.050 -0.120 mg kg^{-1}) and (0.019-0.097 mg kg^{-1}), (0.150-0.600 mg kg^{-1}) and (0.061-0.652 mg kg^{-1}), (0.020-0.050 mg kg^{-1}) and (0.014-0.048 mg kg^{-1}) in strawberry and sugar beet, respectively. Also, the concentration of levels of Zn, Cd, Cu, Pb, Mn and Cr were below the maximum permissible limits values for each element.

Keywords: Heavy Metals, Strawberry, Sugar Beet, Egypt.

1. INTRODUCTION

One of the top public health concerns is the quality and safety of food. Food producers as well as state governments and organisations that regularly check and regulate food quality are responsible for ensuring that food on the market is safe and free of any chemical pollutants that risk consumer health. **(Igwegbe *et al.*, 2013)**. Ismailia, Beheira, and Qaluobia are the primary governorates where strawberries are grown in Egypt's 5,245 feddan dedicated to strawberry cultivation. Egypt is one of the top five nations that export strawberries and leads the Arab world in both production and shipment. Internationally. About 40,000,000 tonnes of fresh and frozen fruits are exported from Egypt each year to the Middle East, Southern Asia, Gulf States, Europe, and the United States. Sugar is produced commercially from sugar beetroot roots because of their high sucrose content. Governorates in Lower and Upper Egypt have begun to grow sugar beets. To generate roughly 500,000 tonnes of sugar, the primary sugar plants in Kafer El-Sheikh, El Dakahlia, and El Fayoum needed more than 200,000 fedan of sugar beet. (**Hager El-Zayat, 2022**).

The continental mantle is the natural habitat for heavy metals, a significant environmental hazard. essentially, a heavy metal is any chemical element that is poisonous at an acceptable level and has a significantly greater density, such as mercury (Hg), cadmium (Cd), chromium (Cr), nickel (Ni), lead (Pb), and more. (**Jabeen *et al.*, 2022 and Sankhla *et al.*, 2016**). Heavy metals are toxic, persistent, non-biodegradable and accumulative, many of these metals have environmental and human health impact.

Vegetables are crucial parts of the human diet; hence heavy metal pollution should not be taken lightly. (**Elbagermi *et al.*, 2012**) In addition to being rich in antioxidants, vegetables are also abundant in vitamins, minerals, and fiber. However, consuming vegetables tainted with heavy metals may be harmful to one's health. One of the most important components of ensuring food quality is avoiding heavy metal contamination of food products. (**Marshall, 2004; Radwan and Salama, 2006; Khan *et al.*, 2008**) High amounts of heavy metals have been found in developing nations like Egypt's urban environment as a result of rapid and disorganised industrial and urban expansion. (**Radwan and Salama, 2008; Maleki and Zarasvand, 2008**). The present study aimed to determine the levels of Zinc (Zn), Cadmium (cd), Ferric (Fe), Copper (cu), Nickel (Ni), Lead (Pb), Manganese (Mn) and Chromium (Cr) in strawberry and sugar beet samples, Egypt.

2.MATERIALS AND METHODS

2.1. Chemicals Used

Merck standards 1000 mg/L concentration were used for preparing all stock and working solutions for tested metals (Merck, Darmstadt, Germany), Nitric acid (HNO_3), (SDS, France).

2.2.Collection of samples

Forty samples of fresh strawberries and 40 samples of sugar beet were harvested from various fields in the Egyptian cities of Itay El-Barud and Kom Hamada between 2020 and 2021, totaling more than 80 samples of both crops. For the same vegetable, three subsamples were gathered from different farms. According to their type, all gathered samples were stored in clean polythene bags before being brought to the lab for examination.

2.3. Sample Preparation

Strawberry and Sugar beet samples were washed with distilled water to prevent the effect of dust particles or any contaminants, then cut to small pieces and dried at 105°C, overnight. After grounding to fine particles samples were stored until analysis. All glass ware Bottles and flasks were cleaned with nitric acid then deionized water. One gram of dried sample was placed in a conical flask and digested to a constant volume with perchloric: nitric acid (1:4 v/v). After cooling, the digested samples were filtered and of 25 ml (**Issa *et al.,* 2018**). All the chemicals were of deionized water was used to make up the final volume analytical grade. Before usage, all plastics and glassware were soaked in nitric acid for 15 minutes and then cleaned with deionized water. For the best results, instrument calibrations with standard solutions were carried out.

2.4. Validation

For instrument Calibration, standards consisted of 5 levels ranged from 0.01 to 5 mg kg^{-1} for each metal tested were analyzed and regression coefficient were calculated, also, three levels of spiked samples and three replicates (n=3) each were analyzed too, with blank samples from each strawberry and sugar beet and recovery was calculated. All instrument readings corrected with blank.

2.5. Instrumentation

Determination was accepted by Microwave Plasma Atomic Emission Spectroscopy (MP-AES), Agilent technologies optical emission spectrometer equipped with nebulizer and spray chamber, coupled with an SPS3 auto sampler and controlled with MP Expert software version 1.3.0.3510. Pump speed 15 rpm, stabilization time 10sec and sample uptake 15 sec.

Table 1: Wavelength used and Correlation Coefficient for each metal in five calibration levels

Metal	Wavelength (nm)	Correlation Coefficient
Zn	**213.85**	**0.999**
Cd	**228.8**	**0.999**
Fe	**371.99**	**0.999**
Cu	**324.75**	**0.999**
Ni	**352.45**	**0.999**
Pb	**405.78**	**0.999**
Mn	**403.76**	**0.999**
Cr	**425.43**	0.999

Table 2: Recovery percentage of heavy metals in strawberry

Concentration (mg kg^{-1})	Heavy metals							
	Zn	**Cd**	**Pb**	**Mg**	**Cr**	**Fe**	**Cu**	**Ni**
Level 0.1 - 1	99.1	98	103	91	94	89.6	100.4	88
Level 0.1 – 2.5	94.4	84	94	92.8	98	97.4	96.4	94
Level 1 - 5	98.4	92	92	87.4	98	95	87	96

Table 3: Recovery percentage of heavy metals in sugar beat

Concentration (mg kg^{-1})	Heavy metals							
	Zn	**Cd**	**Pb**	**Mg**	**Cr**	**Fe**	**Cu**	**Ni**
Level 0.01 – 0.1	98.9	99	98	87.6	90	87.4	79.8	99
Level 0.1 – 0.5	91.92	94	98.6	98.68	86	90.4	85.2	90
Level 0.1 – 1.0	99.4	86	95	91.24	84	89	79	87

3.RESULTS AND DISCUSSION:

The levels of Zn, Cd, Fe, Cu, Ni, Pb, Mn and Cr were detected in all 80 samples of strawberry and sugar beet which collected from different market in Itay El-Baroud and Kom Hamada cities, El-Beheria

Governorate were showed in Table 4. The mean 0.720, 0.002, 1.102 ,0.250, 0.075 ,0.079,0.370 and -0.037 mg kg^{-1} in strawberry and 0.139, 0.002, 7.775, 0.139, 0.043, 0.050, 0.302 and 0.026 mg kg^{-1} in sugar beet which Zn concentration ranged from 0.110-5.840 mg kg^{-1} in strawberry and 0.070-0.255 mg kg^{-1} in sugar beet, respectively. The concentration of Zinc in concentration of Zn, Fe, Cu, Ni, Pb, Mn and Cr were strawberry samples and sugar beet were lower than the maximum permissible values (50 mg kg^{-1}) (**EU, 2013**). While Cd concentration ranged between 0.0010.007 mg kg^{-1} in strawberry and below detection limit (BDL) to 0.001 mg kg-1 in sugar beet, respectively. The concentration of Cadmium in strawberry and sugar beet were lower than the maximum limit value (0.1 mg kg^{-1}) (**FAO/WHO 2011**). The concentration of Ferric (Fe) ranged from (0.610-2.700 mg kg^{-1}) and (1.000 - 2.100 mg kg^{-1}) in strawberry and sugar beet, respectively. The concentration of copper (Cu) ranged from 0.050 to 0.800 mg kg-1 and 0.030-0.270 mg kg^{-1} in strawberry and sugar beet, respectively. The concentration of Copper (Cu) observed in strawberry and sugar beet samples were lower than the maximum permissible values (5 mg kg^{-1}) (**EFSA, 2018**). While Ni concentrations ranged from 0.040-0.300 mg kg^{-1} and 0.018-0.099 mg kg-1 in strawberry and sugar beet samples, respectively. The concentration of Pb ranged from (0.050-0.120 and 0.019-0.097 mg kg^{-1}) in strawberry and sugar beet samples, respectively. The concentration of Pb observed in strawberry and sugar beet samples were lower than the maximum limits values (0.1 mg kg^{-1}) (**FAO/WHO 2014**). The concentration of Mn ranged from (0.150-0.600 mg kg^{-1}) and (0.061-0.652 mg kg^{-1}) in strawberry and sugar beet samples, respectively. Mn concentration is present in strawberry and sugar beet were lower than the maximum permissible limit values (500 mg kg-1) (FAO/WHO 2011). Finally, Cr concentration ranged from (0.020-0.050 mg kg^{-1}) and (0.014-0.048 mg kg^{-1}) in strawberry and sugar beet samples, respectively. Chromium concentrations are present in strawberry and sugar beet samples were lower than the permissible limit values (0.05 mg kg-1) (**FAO/WHO 2011**). Our results agree with what **Bendarek *et al* (2006)** which discovered that the typical levels of heavy metals in strawberries grown in the Lublin region (0.023 mg Pb, 0.020 mg Cd,0.091 mg Ni, 1.228 mg Zn, 0.358 mg Cu, 0.0015 mg As, 0.00011 mg Hg /kg of fresh matter) suggests that it did not surpass the upper threshold of products of this type. Additionally, the range for the mean total contents of the components examined in sugar beet and various products derived from sugar beet had been:18.11-37510 mg kg-1 dry matter (d.m.) for K,6.54-8945 mg kg-1 d.m for Zn, 0.42 -360.4 mg kg-1 d.m for Fe and 0.07 -7.09 mg kg-1 d.m. for Cu (**Skrbic *et al* 2010**)

Table 4: Mean concentration of Zinc, Cadmium, Iron, Copper, Nickel, Lead, Manganese and Chromium in both Strawberry and Sugar beet edible parts (mg kg^{-1}) in Egypt.

Metal	Strawberry			Sugar beet			MRL (mg kg)	Reference
	Range	Mean	SD	Range	Mean	SD		
Zn	0.110-5.840	0.720	1.699	0.070-0.255	0.139	0.065	50	**(EU, 2013)**
Cd	0.001-0.007	0.002	0.002	BDL-0.001	0.002	0.001	0.1	**FAO/WHO., 2011)**
Fe	0.610-2.700	1.102	0.742	1.000-2.100	7.775	22.906	ND	
Cu	0.050-0.890	0.250	0.264	0.030-0.270	0.139	0.069	5	**(EFSA, 2018)**
Ni	0.040-0.300	0.075	0.075	0.018-0.099	0.043	0.023	ND	
Pb	0.050-0.120	0.079	0.022	0.019-0.097	0.050	0.022	0.1	**(FAO/WHO, 2014)**
Mn	0.150-0.600	0.370	0.137	0.061-0.652	0.302	0.177	500	**(FAO/WHO, 2011)**
Cr	0.020-0.050	0.037	0.009	0.014-0.048	0.026	0.011	0.05	**(FAO/WHO, 2011)**

CONCLUSION

Monitoring of Zn, Cd, Fe, Cu, Ni, Pb, Mn, and Cr elements in strawberries and sugar beet from the Egyptian cities of Itay El-Baroud and Kom Hamada. Using an optical emission spectrometer from Agilent Technologies, the amounts of heavy metals were measured using microwave plasma atomic emission spectroscopy (MP-AES). The findings demonstrated that strawberry and sugar beetroot contained lower concentrations of Zn, Cd, Cu, Pb, Mn, and Cr than was permitted for each element.

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مستويات بعض العناصر الثقيلة في الفراولة و بنجر السكر المصرى

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الملخص العربي:

الهدف من البحث هو تقدير مستويات الزنك و الكادميوم و الحديد و النحاس و النيكل و الرصاص و المنجنيز و الكروم في عينات الفراولة و بنجر السكر المصرى. وتم التقدير باستخدام جهاز الإمتصاص الطيفي فكانت النتائج المتحصل عليها كالآتي:-

تركيزات عنصر الزنك تتراوح من) ٠,١١٠-٥,٨٤ مليجرام /كجم (و) ٠,٠٧٠ -٠,٢٥٥ مليجرام/كجم (في الفراولة و بنجر السكر على الترتيب .

تركيزات عنصر الكادميوم يتراوح من) ٠,٠٠١ -٠,٠٠٧ مليجرام/كجم (و) أقل من حدود التقدير -٠,٠٠١ مليجرام/كجم(في الفراولة و بنجر السكر على الترتيب.

تركيزات عناصر الحديد -النحاس-النيكل-الرصاص-المنجنيز و الكروم تتراوح ما بين) ٠,٦١٠-٢,٧٠٠ مليجرام/كجم(و) ١,٠٠-٢,١٠٠ مليجرام/كجم(و) ٠,٠٥٠ -٠,٨٠٠ مليجرام/كجم(و) ٠٠٣٠.-٠,٢٧٠ مليجرام/كجم، ( ) ٠,٠٤٠-٠,٣٠٠ مليجرام /كجم(،)٠,٠١٨-٠,٠٩٩ مليجرام /كجم(،)٠,٠٥٠-٠,١٢٠ مليجرام/كجم(،)٠,٠١٩-٠,٠٩٧ مليجرام/كجم(،) ٠,١٥٠ -٠,٦٠٠(،) ٠,٠٦١ -٠,٦٥٢ مليجرام/كجم(،)٠,٠٢٠ - .٠٥٠(،)٠,٠١٤ -٠,٠٤٨ مليجرام/كجم(في الفراولة و بنجر السكر على الترتيب، أيضا مستويات التركيزات لكل من الزنك -الكادميوم-النحاس-الرصاص -المنجنيز -الكروم كانت أقل من الحدود المسموح بها لكل عنصر .

الكلمات المفتاحية: العناصر الثقيلة – الفراولة – بنجر السكر - مصر