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Article

Effects of age and breed on trace elements content in cattle muscle and edible offal

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Abstract: In this study, effects of age and breed on the trace elements content in different muscles (*M. longissimus dorsi, M. longissimus thoracis, M. psoas major, M. intercostalis internus, M. semispinalis capitis, M. biceps femoris, M. biceps brachii*) and edible offal (liver, kidney, heart) of cattle were investigated. Iron (Fe), zinc (Zn), copper (Cu), lead (Pb) and cadmium (Cd)contents of muscles and edible offal were determined by inductively coupled plasma-optic emission spectrometry (ICP-OES).According to the results obtained in this study, the content of Cu in *M. longissimus dorsi* of Eastern Anatolian Red (EAR) breed cattle was higher than Brown Swiss (BS) breed cattle, and the content of Cu in *M. longissimus dorsi* was statistically significant among the breeds ($p<0.05$). On the other hand, the highest Cu content in kidney and the highest Cd content in liver were observed the 4-year-old cattle, and the content of Cu in kidney and the content of Cd in the liver were statistically significant among the ages ($p <0,05$). Besides, the highest contents of Fe, Cu and Cd were found in the edible offal of EAR breed cattle aged 4 years. The mean values of the trace elements found in cattle muscles were ranked as Zn>Cu>Fe>Pb>Cd, whereas the mean values of the trace elements found in edible offal of cattle were ranked as Cu>Fe>Zn>Pb>Cd. Our results suggest that trace element content may vary in both muscles and offal depend on the breed and age of the cattle.

Keywords: cattle; edible offal; ICP-OES; muscle; trace element

1. Introduction

Meat and offal are not only an important source of protein, butalso of trace elements (Gerber *et al.,* 2009). Trace elements are important micronutrients which are required in very small quantities for human diet to maintain normal physiological functions but they cannot be synthesized in the body (Gerber, 2007). The offal, such as liver, heart and kidney, are richer in trace elements compared to meat (Forte and Bocca, 2007; Reykdal and Thorlacius 2001).

The essential trace elements play an important role in biological systems, but can also make toxic effects at high concentrations (Fe, Zn, Cu, I, Mg, Co, Se, Mo, F, etc.). However non-essential elements are potentially toxic (Ar, Cd, Pb, Hg, etc.), even at low concentrations (Surtipanti *et al.,* 1995; Uluozlu *et al.,* 2009). Iron, zinc and copper are important trace nutrientsin human, animals and plants nutrition. Deficiency of these elements is generally of greater concern than their toxicity, because toxicity is only observed when very high doses are ingested (Kessler *et al.,* 2003; Reykdal and Thorlacius, 2001; Pereira *et al.,* 2017).

Lead and cadmium are toxic forhuman and animals. This elements are ordinary constituents of nature but due to increased industrial activities there is a growing concern for levels in tissues of plants and animals consumed by

human. Concentrations of lead and cadmium in meat are considerably lower than in kidney and liver (Reykdal and Thorlacius, 2001; Pilarczyk, 2017).
The aim of this study was to determine effects of age and breed on the contents of Fe, Zn, Cu, Pb and Cd in the muscles and edible offal of cattle.

2. Materials and Methods

2.1. Samples

A total of 110 samples from seven different muscles (*M. longissimus dorsi*, *M. longissimus thoracis, M. psoas major, M. intercostalis internus, M. semispinalis capitis, M. biceps femoris, M. biceps brachii*) and three different edible offal (liver, kidney and heart) of 7 EAR and 3 BS breed cattle were collected from Erzurum slaughter house in Turkey. The cattle were different ages (2, 3 and 4) and, samples were taken from the same cattle. All samples were put into plastic bags for transport to the laboratory on the same day and were stored at-18˚C until used to analysis.

2.2. Microwave digestion

The samples were digested by a commercial Microwave Digestion System (Berghof Speedwave MWS-3) using vessels that are pressure resistant and manufactured entirely from is statically pressed TFM. Approximately 0.5 g sample was weighted and mixed with 6 ml HNO_3 (65%) and 2 ml H_2O_2 (35%) in a vessel. Blank digestion was carried out in the same way. First, digestion temperature was raised to 180°C within 15 minutes and held at this temperature for 15 minutes. After then, digested samples cooling, the content of the vessels were diluted to 25 ml with double deionized water (Gerber, 2007).

2.3. Trace elements analysis

Inductively coupled plasma-optic emission spectrometry (ICP-OES) was used to determine iron, zinc, copper, lead and cadmium contents in the muscle and offal samples of cattle. The Spectrometer (Optima 2000 DV Perkin Elmer-1350 W) was used with the following wavelengths: 238.204 nm for iron, 213.857 nm for zinc, 324.752 nm for copper, 224.688 nm for lead and 226.502 nm for cadmium. All trace element contents were determined on a wet weight basis.

2.4. Statistical analysis

All statistical analyses were performed using SPSS 13.0 software package. All data are presented as average values±SD. All variables were tested with one way Analysis of Variance (ANOVA) followed by Duncan's test. Independent-samples t-test was used to compare data between the two breed. Results were considered as significant when p-values were than 0.05.

3. Results

The mean values of Fe, Zn, Cu, Pb and Cd contents (mg/kg) in seven different muscles (*M. longissimus dorsi, M. longissimus thoracis, M. psoas major*, *M. intercostalis internus*, *M. semispinalis capitis*, *M. biceps femoris, M. biceps brachii*) and three different edible offal (liver, kidney and heart) of cattle depending on the age (2, 3, 4) and breed (SB, EAR) are given in Tables 1 and 2.
Although there were not significant differences in the Fe content among the age and breed groups, Fe concentration varied appreciably among the age and breed groups in the current study. The lowest and the highest content of Fe in muscles depend on breed were identified in *M. longissimus dorsi* (18.85 mg/kg) and *M. biceps brachii* (42.39 mg/kg) of BS breed cattle. At the same time, the highest and lowest Fe content was in *M. longissimus dorsi* of 3 and 4-year-old cattle (45.26 mg/kg, 10.14 mg/kg, respectively). The maximum content of Zn in muscle were *M. biceps femoris* (87.87 mg/kg) in 4 years old cattle as well as *M. biceps brachii* (76.61 mg/kg) in BS breed cattle. According to the results obtained in this study, the content of Cu in *M. longissimus dorsi* of EAR breed cattle was higher than BS breed cattle, and the content of Cu in *M. longissimus dorsi* was statistically significant among the breeds ($p<0.05$) (Table 1).
The results showed that the highest Fe content was in kidney of the 4-year-old cattle (84.25 mg/kg) and in heart of the BS breed cattle (70.34 mg/kg). On the other hand, the lowest Fe content in the offal samples was determined in the liver of the 3 years cattle and, in liver of BS breed cattle. The lowest and the highest levels of Zn in edible offal depending on age were found in kidney samples in the 3 and 4 years of age in cattle, respectively. Besides, according to breed, the maximum and minimum Zn levels in the offal samples were determined as 23.51 mg/kg for heart of EAR breed cattle and as 49.52 mg/kg for kidney of BS. On the other hand, the highest Cu content in kidney and the highest Cd content in liver were observed the 4-year-old cattle,

and the content of Cu in kidney and the content of Cd in the liver were statistically significant among the ages ($p<0.05$) (Table 2).

Table 1. Content of trace elements (mg/kg) in the muscles of cattle depending on the age and breed (mean ± standard devation).

Muscles	Trace Elements	Age			Breed	
		2	3	4	BS	EAR
M. longissimus Thoracis	Fe	32.52 ± 43.96	11.79 ± 11.36	32.46 ± 37.77	31.58 ± 44.60	24.15 ± 29.33
	Zn	56.45 ± 42.11	45.46 ± 3.90	56.82 ± 55.27	64.42 ± 35.56	47.40 ± 41.34
	Cu	48.20 ± 14.19	49.42 ± 19.85	44.34 ± 9.04	47.16 ± 18.38	47.11 ± 10.61
	Pb	0.13 ± 0.13	0.12 ± 0.07	0.12 ± 0.15	0.16 ± 0.13	0.10 ± 0.11
	Cd	0.02 ± 0.01	0.06 ± 0.06	0.05 ± 0.07	0.06 ± 0.05	0.03 ± 0.06
M. semispinalis Capitis	Fe	21.94 ± 32.96	12.96 ± 7.43	33.38 ± 48.88	23.77 ± 31.81	23.59 ± 37.05
	Zn	44.82 ± 27.30	45.03 ± 10.83	58.12 ± 67.50	54.76 ± 22.46	46.83 ± 49.85
	Cu	50.06 ± 16.67	51.05 ± 31.32	39.13 ± 21.97	42.05 ± 26.58	48.82 ± 19.74
	Pb	0.11 ± 0.08	0.10 ± 0.09	0.17 ± 0.26	0.11 ± 0.11	0.14 ± 0.19
	Cd	0.01 ± 0.01	0.02 ± 0.02	0.03 ± 0.02	0.02 ± 0.02	0.02 ± 0.02
M. psoas Major	Fe	19.82 ± 26.42	10.28 ± 9.71	30.05 ± 41.95	19.13 ± 26.87	21.97 ± 31.77
	Zn	29.43 ± 25.39	30.34 ± 10.15	77.43 ± 102.17	32.57 ± 22.03	55.46 ± 77.93
	Cu	41.65 ± 27.30	44.46 ± 20.86	85.47 ± 86.01	31.85 ± 8.76	73.50 ± 64.92
	Pb	0.13 ± 0.13	0.09 ± 0.05	0.42 ± 0.70	0.11 ± 0.13	0.29 ± 0.52
	Cd	0.02 ± 0.01	0.01 ± 0.01	0.03 ± 0.03	0.02 ± 0.01	0.02 ± 0.02
M. intercostalis internus	Fe	26.35 ± 34.59	17.35 ± 13.57	37.08 ± 56.31	26.38 ± 34.60	28.61 ± 41.93
	Zn	43.30 ± 46.55	42.69 ± 8.88	66.82 ± 85.79	50.34 ± 44.92	52.45 ± 63.40
	Cu	41.46 ± 20.09	51.64 ± 13.92	46.72 ± 28.70	46.76 ± 19.87	45.80 ± 22.60
	Pb	0.19 ± 0.14	0.10 ± 0.04	0.22 ± 0.38	0.19 ± 0.14	0.16 ± 0.28
	Cd	0.01 ± 0.01	0.01 ± 0.01	0.04 ± 0.03	0.02 ± 0.01	0.03 ± 0.03
M. longissimus Dorsi	Fe	20.52 ± 22.69	10.14 ± 8.72	45.26 ± 75.54	18.85 ± 23.61	31.17 ± 56.44
	Zn	31.68 ± 28.26	26.50 ± 1.71	70.41 ± 104.56	31.54 ± 26.90	51.68 ± 77.79
	Cu	55.38 ± 31.38	48.30 ± 1.69	89.38 ± 41.50	39.92 ± 12.09b	80.61 ± 34.28a
	Pb	0.17 ± 0.07	0.11 ± 0.02	0.43 ± 0.60	0.15 ± 0.07	0.30 ± 0.45
	Cd	0.02 ± 0.01	0.02 ± 0.01	0.08 ± 0.06	0.02 ± 0.01	0.06 ± 0.06
M. biceps Femoris	Fe	24.64 ± 32.29	11.90 ± 10.19	44.50 ± 68.85	23.79 ± 32.97	31.02 ± 51.76
	Zn	38.77 ± 28.14	31.18 ± 8.78	87.87 ± 133.06	42.62 ± 26.59	61.38 ± 99.75
	Cu	32.77 ± 19.50	36.33 ± 12.03	65.22 ± 58.03	34.91 ± 20.52	51.61 ± 44.75
	Pb	0.14 ± 0.13	0.07 ± 0.07	0.46 ± 0.71	0.16 ± 0.12	0.28 ± 0.55
	Cd	0.02 ± 0.01	0.01 ± 0.01	0.06 ± 0.08	0.02 ± 0.01	0.04 ± 0.07
M. biceps Brachii	Fe	40.26 ± 49.86	22.88 ± 7.94	34.91 ± 51.58	42.39 ± 48.43	29.97 ± 36.74
	Zn	71.91 ± 48.69	62.16 ± 4.09	78.64 ± 94.44	76.61 ± 46.17	68.89 ± 68.10
	Cu	31.85 ± 17.52	34.44 ± 13.74	53.20 ± 38.00	31.52 ± 17.91	45.35 ± 29.54
	Pb	0.10 ± 0.16	0.17 ± 0.02	0.26 ± 0.39	0.13 ± 0.15	0.16 ± 0.31
	Cd	0.02 ± 0.02	0.02 ± 0.01	0.05 ± 0.04	0.02 ± 0.01	0.03 ± 0.03
Mean	Fe	26.58 ± 32.31	13.90 ±9.48	37.16 ±49.36	26.56 ± 32.45	27.21±39.24
	Zn	45.20 ± 35.03	40.48 ± 13.30	70.87 ± 84.32	50.41 ± 33.37	54.87±66.49
	Cu	43.05 ± 20.87	45.09 ± 16.70	60.49 ± 45.43	39.17 ± 17.49	56.11± 36.69
	Pb	0.14 ± 0.11	0.09 ± 0.06	0.30 ± 0.46	0.15 ± 0.11	0.21 ± 0.36
	Cd	0.02 ± 0.01	0.02 ± 0.03	0.05 ± 0.05	0.02 ± 0.02	0.03 ± 0.04

a-b: Means followed by different letters in the same line are significantly different ($p<0.05$) according to Independent-samples t-test; for statistical analysis.

Table 2. Content of trace elements (mg/kg) in the edible offal of cattle depending on the age and breed (mean ± standard deviation).

Offal	Trace Elements	Age			Breed	
		2	3	4	BS	EAR
Liver	Fe	38.63 ± 23.95	25.25 ± 7.33	56.79 ± 42.96	35.19 ± 25.87	45.23 ± 33.81
	Zn	29.70 ± 24.96	21.22 ± 5.83	42.92 ± 34.02	34.43 ± 21.58	30.91 ± 28.36
	Cu	80.66 ± 22.63	44.66 ± 18.09	70.48 ± 2.77	64.94 ± 23.07	68. 40 ± 21.91
	Pb	0.25 ± 0.10	0.12 ± 0.09	0.25 ± 0.14	0.24 ± 0.11	0.20 ± 0.13
	Cd	0.04 ± 0.03b	0.01 ± 0.01b	0.08 ± 0.05a	0.02 ± 0.02	0.06 ± 0.05
Heart	Fe	73.71 ± 79.53	35.30 ± 13.06	68.59 ± 46.41	70.34 ± 81.71	56.25 ± 36.75
	Zn	43.75 ± 41.35	20.92 ± 11.33	31.23 ± 45.73	49.52 ± 36.35	23.51 ± 33.88
	Cu	56.25 ± 11.08	64.62 ± 15.22	36.01 ± 33.11	61.37 ± 16.94	45.35 ± 26.37
	Pb	0.17 ± 0.15	0.11 ± 0.01	0.17 ± 0.26	0.18 ± 0.15	0.14 ± 0.19
	Cd	0.03 ± 0.02	0.06 ± 0.07	0.03 ± 0.01	0.05 ± 0.06	0.03 ± 0.02
Kidney	Fe	60.72 ± 44.36	30.21 ± 15.39	84.25 ± 69.87	50.10 ± 50.60	67.16 ± 54.17
	Zn	23.77 ± 27.01	13.69 ± 1.82	69.65 ± 99.69	26.97 ± 24.56	43.84 ± 77.53
	Cu	49.11 ± 2.21b	32.22 ± 10.63b	70.64 ± 19.68a	38.39 ± 14.18	60.30 ± 19.03
	Pb	0.13 ± 0.11	0.06 ± 0.02	0.22 ± 0.25	0.11 ± 0.11	0.16 ± 0.19
	Cd	0.09 ± 0.03	0.06 ± 0.03	0.30 ± 0.43	0.08 ± 0.04	0.20 ± 0.33

a-b: Means followed by different letters in the same line are significantly different ($p<0.05$) according to Duncan's test; for statistical analysis.

Table 3. Content of trace elements (mg/kg) in the muscles and edible offal (mean ± standard devation).

Samples	Fe	Zn	Cu	Pb	Cd
Liver	41.58 ± 30.21	32.19 ± 25.01	67.14 ± 21.23	0.22 ± 0.12	0.05 ± 0.04
Kidney	61.37 ± 53.51	32.97 ± 35.46	51.17 ± 23.85	0.15 ± 0.17	0.04 ± 0.04
Heart	60.95 ± 51.02	37.71 ± 62.13	52.34 ± 20.00	0.14 ± 0.16	0.16 ± 0.26
M. longissimus thoracis	26.85 ± 33.57	53.59 ± 38.45	47.13 ± 13.00	0.13 ± 0.12	0.04 ± 0.05
M. semispinalis capitis	23.65 ± 33.57	49.71 ± 40.72	46.36 ± 21.39	0.13 ± 0.16	0.02 ± 0.02
M. psoas major	20.94 ± 28.71	47.13 ± 62.63	58.35 ± 54.71	0.22 ± 0.42	0.02 ± 0.02
M. intercostalis internus	27.80 ± 37.62	51.69 ± 54.94	46.15 ± 20.62	0.17 ± 0.23	0.02 ± 0.03
M. longissimus dorsi	26.69 ± 46.01	44.35 ± 62.86	65.81 ± 34.21	0.25 ± 0.36	0.04 ± 0.05
M. biceps femoris	28.39 ± 44.12	54.56 ± 79.20	45.54 ± 37.40	0.24 ± 0.43	0.03 ± 0.05
M. biceps brachii	34.49 ± 39.40	71.70 ± 58.63	40.32 ± 25.85	0.15 ± 0.25	0.03 ± 0.03
Mean	26.97 ± 36.68	53.25 ± 56.50	49.95 ± 32.04	0.18 ± 0.30	0.03 ± 0.04

Trace element concentrations in muscle and offal samples were quite variable as Fe: 10.14-45.26; 25.25-84.25 mg/kg, Zn: 26.50-87.87; 13.69-69.65 mg/kg, Cu: 31.85-89.38; 32.22-80.66 mg/kg, Pb: 0.07-0.46; 0.06-0.25 mg/kg, Cd: 0.01-0.08; 0.01-0.30 mg/kg, respectively. The order of trace element levels determined in muscle and offal samples were Zn>Cu>Fe>Pb>Cd and Cu>Fe>Zn>Pb>Cd, respectively (Table 3).

4. Discussion

Trace elements are essential food components that are not synthesized in the body and must be absolutely taken in from the outside sources. The most reliable and healthy way of taking in these elements from outside of the body is with food. The sufficient intake of the trace elements needed by the human body can only be supplied with adequate and balanced nutrition (Gropper *et al.,* 2016). Red meat, considered as one of the good food sources for nutrition, is very rich in essential trace elements for the human organism, except for calcium (De Smet and Vossen, 2016; Lombardi-Boccia *et al.,* 2005). In this study, in which the effects of age and breed on the content of trace elements in cattle muscle and edible offal were investigated. The content of Cu in *M. longissimus dorsi* was statistically significant among the breeds, and the content of Cu and Cd in the liver was statistically significant among the ages ($p<0.05$). On the other hand, the highest contents of Fe, Cu and Cd were found in the edible offal of EAR breed cattle aged 4 years. The mean values of the trace elements found in cattle muscles were ranked as Zn>Cu>Fe>Pb>Cd, whereas the mean values of the trace elements found in edible offal of cattle were ranked as Cu>Fe>Zn>Pb>Cd.

The Fe content of muscles obtained from this study were higher than Fe content in muscles Kotula and Lusby, 1982, but were lower than those recorded by Demirel *et al.,*2008 and López Alonso *et al.,* 2004. Furthermore,

the mean Zn content in liver observed in this study was lower than those reported by Sedki *et al.*, 2003 and López-Alonso *et al.,* 2004. Although Fe, Zn, Pb and Cd contents found in the cattle muscles and livers in this study were higher than the values obtained by Surtipanti *el al.,* 1995, they were found to be lower than the values obtained by Koréneková and Skalıcká, 2002.
Moreover, it was observed that the values of Fe in the muscles, and Cu, Pb, Cd in the livers, and Pb and Cd in the kidneys of the cattle fattened up in rural areas were higher in the study conducted by Abou-Arab, 2001 than the values obtained in this study. Although the trace element content that was identified by the same researcher in the livers of the cattle fattened up in industrialized areas was the same as that of the cattle fattened up in rural areas, the contents of Fe along with Zn in the muscles, the contents of Pb and Cd in addition to Fe and Zn in the kidneys, and the contents of Pb and Cd in the hearts of the cattle were found to be higher than the values we obtained in our study.
These studies conducted show that the difference in the contents of trace elements and heavy metals found in the muscle and edible offal of the cattle may be caused due to regional differences, on the other hand, may result in more accumulation in particular organs, especially in the liver and kidneys of animals fattened up close to industrial areas. This can be explained by the soil characteristics of the region, as well as the contamination status of pasture lands and waters with industrial wastes (Tangahu *et al.,* 2011; Trujillo-González *et al.,* 2017).
It was observed that the amounts of Pb and Cd found in the cattle liver and kidney tissues were higher in the study of Şenavcı *et al.,* 1997 that was conducted in Ankara and Bursa cities than the values we obtained in our study. This difference is explained by the study regions of the researchers which were much more intense than our study area in terms of both vehicular traffic and industrialization.
The partially polluted and highly polluted categories of Cd and Mn values according to a study conducted on the metal content of the Ankara streamlet (Başar, 2001) and the Pb, Ni, Cr and Sb values of the agricultural soils in South Marmara above the limit values support the result of the high amounts of Pb and Cd in the liver and kidney tissues of the cattle fattened up in the region (Dartan and Toröz, 2013). It is considered that the exposure of the soil and waters of the region to these heavy metals, especially by the effects of industrial wastes and exhaust gases which have a high heavy metal content, may cause an accumulation in certain organs of plants and animals in the region (Oymak *et al.,* 2009; Tangahu *et al.,* 2011).
The amount of Zn in the cattle muscles found in our study was very similar to the values obtained by López Alonso *et al.,* 2000, whereas the amounts of Cu in the muscle, liver and kidney tissues we found were much higher than the values obtained by López Alonso *et al.*, 2000 and Surtipanti *et al*., 1995. In addition, in a study by Leonhardt *et al.*, 2006, Fe content in cattle *M. longissimus dorsi* was lower than Fe content in our study, on the contrary, Zn content was higher.
Moreover, level of Zn in meat was found very high (210 ± 86 mg/kg) in the study conducted by Batista *et al.,* 2006. These differences in the trace element contents of the muscles and edible offal of the cattle are considered to be changing by the effects of factors such as biological (eg, family, breed, sex, age, muscle) and ecological (eg, type of fattening, place of fattening, season) factors. On the other hand, it was found that the amount of Fe in the cattle meat found in the study of Demirel *et al.*, 2008 was much higher than the value we obtained in this study, and the amounts of Zn and Cu were lower than in our study. Furthermore, in muscle of cattle determined the lowest Cu value (31.85 mg/kg) was higher than those reported many researcher (Domaradzki *et al.,* 20016; Doornenbal and Murray, 1981; Huerta-Montauti *et al.*, 2007; López Alonso *et al.,* 2000; Marchello *et al.,* 1984). This shows that there may be differences in different geographies, even in the same geographical region of a country, and that it makes it very difficult to standardize the trace element contents and to directly compare each other (Yıldırm, 1992).
The foods of vegetable and animal origin exposed to heavy metals may result in toxication by accumulating in certain organs as a result of being consumed by animals and humans. Our study also found that higher amounts of Cd and Pb accumulated in the cattle organs, such as liver and kidney, than in the muscles. It has been indicated by the European Commission Regulation (Anonymous, 2014; Anonymous, 2015) and Turkish Food Codex Regulation (Anonymous, 2012) that the maximum acceptable amount of Pb in the cattle meat and edible offal is 0,10 and 0,50 mg/kg, respectively, and the maximum acceptable amount of Cd in the cattle meat and liver is 0,05 mg/kg and in the kidney is 1.00 mg/kg. In this study, the amount of Pb in the analyzed samples was found to be above the limit values only in the meats. The value of Cd was found to be below these limits in both organs and meat.

5. Conclusions
A significant portion of daily recommended trace elements can be met by the consumption of meat and edible offal of the cattle fattened up in suitable environments, and they are particularly rich sources of iron, zinc and

copper in terms of human nutrition. The trace element content of cattle muscle and organs is considered to vary depending on the family, breed, gender, age, fattening pattern of the animal and on ecological and geographical characteristics of the region in which the animal is fattened up. It should not be ignored that the toxicities resulting from the consumption of the meat and organs of the cattle, which are not fattened up under suitable conditions, will reach to an extent that threatens the public health. In order to prevent this condition, it is highly important to take measures in terms of reducing the heavy metal spread of factories, and to ensure that industrial enterprises are not established in areas close to agricultural lands.

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Conflict of interest
None to declare.

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