UDC: 637.12.064:546.4/.8]:656.1(497.751)
Professional paper

IMPACT OF HIGHWAY TRAFFIC ON MILK CONTAMINATION WITH HEAVY METALS

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ABSTRACT

These days, food safety and traceability control during the production of milk and dairy products is becoming a key criterion for consumers due to new requirements for the prevention of various diseases. In this experiment, samples of raw cow's milk were collected from dairy farms stationed near highways and in rural farms in the Polog Region. Concentrations of selected heavy metals such as Cu and Mn were determined by Agilent 55A flame atomic absorption spectroscopy and Agilent 240Z graphite atomic absorption spectroscopy for Cd, Pb, Ni, Zn was used. The content of cadmium and lead showed higher concentrations in milk samples from areas with intense traffic than in milk from unpolluted green areas. The obtained results confirm that attention must be paid to circumstances that come to have a continuous emission of heavy metals into the environment.

Keywords: milk, heavy metals, AAS, highway traffic.

INTRODUCTION

Milk has a positive impact on human health. It is considered an almost complete food because it is a source of protein, fat, vitamin supplements, and minerals (Enb et al., 2009; Qin et al. 2009; Yuzbas et al., 2009; Salah & Ahmed, 2012; Seyed & Ebrahim, 2012).

Contamination of milk has been considered one of the main dangerous aspects in the last few years (Malhat et al., 2012).

These metals are taken up by plants and consequently accumulate in their tissues. Animals that graze on such contaminated soils and drink from contaminated waters also accumulate such metals in their tissues and milk if they are lactating (Yahaya et al., 2010). A large amount of these metals coming from plants and animals are subsequently found in the food chain and cause concern due to the introduction of harmful metals into the human body.

Cow's milk, as part of the daily human diet, is one of the biggest possible sources of heavy metals (Farid et al., 2004). Increased environmental pollution contributes to increased contamination of milk and impairment of milk quality and safety (Farid & Baloch, 2012).

Contamination of milk worldwide through environmental pollutants and xenobiotic compounds, through animal feed in the form of toxic metals, mycotoxins, dioxin, and other pollutants is considered to have an increasing impact on public health (Seyed & Ebrahim, 2012; Ruqia et al., 2015).

In this experiment, samples of raw cow milk were collected from dairy farms stationed near highways and in rural farms in the Polog Region.

MATERIALS AND METHODS

Individual milk samples (five from each farm) were taken in sterile plastic containers with caps (500 ml) according to a random selection of cows.

The samples were taken seasonally from the farms located near the highway and regional roads with heavy traffic, which means that a total of 100 samples were analyzed from all farms, from five (5) individual samples were taken from five farms or total (5X5) 25 samples.

A total of six (6) heavy metals were examined Cd, Pb, Cu, Mn, Zn, and Ni.

Assessment of the heavy metals an Atomic Absorption Spectrometry technique (Agilent Technologies 55) with a deuterium background corrector was used. The concentration of heavy metals in the solutions in the tested tubes was determined using Agilent 55A flame atomic absorption spectroscopy for Cu and Mn and Agilent 240 Z graphite atomic absorption spectroscopy for Cd, Pb, Ni, and Zn. The preparation of samples and determination of the concentration of heavy metals in milk consisted of two laboratory phases:1) digestion (combustion, decomposition) of the material and 2) determination of the concentration of heavy metals in the

digested material using atomic absorption spectrometry. Milk was digested using the wet combustion method according to Soylak et al. (2004). Statistically, the obtained results were interpreted using variation-statistical methods, which are applied to scientific research purposes (ANOVA).

RESULTS

The annual mean value of heavy metals and macroelements according to the obtained mean values by seasons from all locations, and their distribution curve are shown in Table 1.

Table 1. Mean value of heavy metals and macroelements in raw cow's milk for selected locations from all seasons (Cu, Mn, Zn, - mg/L) and (Cd, Pb, Ni -µg/L).

	S	P	B	N	T
Cu	0,120	0,141	0,127	0,132	0,160
Cd	0,220	0,163	0,425	0,130	0,091
Pb	20,713	21,786	32,791	24,865	27,573
Mn	0,120	0,143	0,082	0,063	0,092
Ni	47,676	36,876	56,167	28,361	31,864
Zn	3,399	3,503	3,023	3,416	3,631

The mean value of copper calculated from all seasons was the lowest in the Slatino location and was 0.120 mg/L, while the highest was in Toplice 0.160 mg/L. The cadmium values were the lowest in the milk from the Toplice location 0.091 µg /L / 0.000091 mg/L, and the maximum concentration of cadmium was registered in the samples from the Bogovinje location 0.425 µg /L / 0.000425 mg/L.

The mean value of lead showed minimal values in milk from the location Slatino 20.713 µg/L / 0.020713 mg/L. The highest lead content was registered in the samples from Bogovinje location 32.791 µg /L / 0.032791 mg/L, Toplice 27.573 µg /L / 0.027573 mg/L and Negotino 24.865 µg /L / 0.024865 mg/L.
The value of manganese was the lowest in the location Negotino 0.063 mg/L, while the highest is in Poroy 0.143 mg/L and in Slatino 0.120 mg/L.
Maximum values of nickel were registered in the milk from the location Bogovinje 56.167 µg /L / 0.056167 mg/L, and in Slatino 47.676 µg /L / 0.047676 mg/L and the lowest concentration of nickel was registered in the samples from the location Negotino 28.361 µg/L / 0.028361 mg/L.
The average value of zinc was the lowest in the location Bogovinje at 3.023 mg/L and in, while the maximum content was determined in Toplice at 3.631 mg/L and in Poroj at 3.503 mg/L.

Table 2. Order of sites according to the concentration of heavy metals (from the highest to the lowest mean) in raw cow's milk for selected sites from all seasons (Cu, Mn, Zn, - mg/L) and (Cd, Pb, Ni -µg /L).

	T	P	N	S	B
Cu	0,16	0,141	0,132	0,127	0,12
	B	S	P	N	T
Cd	0,425	0,22	0,163	0,13	0,091
	B	T	N	P	S
Pb	32,791	27,573	24,865	21,786	20,713
	P	S	T	B	N
Mn	0,143	0,12	0,092	0,082	0,063
	B	S	P	T	N
Ni	56,167	47,676	36,876	31,864	28,361
	T	P	N	S	B
Zn	3,631	3,503	3,416	3,399	3,023

In our results for the annual average value of the elements, we found that the content of all elements except lead was within the normal prescribed permissible limits.
The distribution of lead in milk was according to the following order of locations: B> T>N >P>S. Average lead levels of all seasons ranged from 0.021 to 0.083 mg/L, from which the maximum mean values were determined in Bogovinje Toplice and Negotino.
As for the content of cadmium in the milk samples, it was below the permissible prescribed values and had the following distribution by location: B > S >P>N> T.

om the table, the following distribution of Copper by location can be ascertained as follows: T> P> N> S> B.

The distribution of manganese by locations was in the following order: P> S> T> B> N. From all seasons, the distribution of manganese by locations followed the order:
P> S> T> B> N.

The concentration of nickel in the milk samples from the selected locations was determined in the following order: B> S> P> T> N.

The distribution of zinc in the analyzed samples had a decreasing content as follows: T> P> N> S> B.

DISCUSSION

Cadmium, lead, and mercury are very dangerous to humans and are considered the greatest threat to food in terms of industrial use. To determine the content of lead, copper, zinc, mercury, and iron in milk samples collected from three different regions, an industrial region, a rural region, and a region with high traffic intensity around Bursa, Turkey an extensive study was carried out by Simsek et al. (2000).

The average concentrations in the samples from these three regions were as follows: for lead 0.032, 0.049, 0.018 mg/kg; for zinc 4.49, 5.01, 3.77 mg/kg; for copper 0.58, 0.96, 0.39 mg/kg; and Fe 1.78, 4.27, 1.01 mg/kg, while no mercury was detected in the samples. The highest content of heavy metals was found in the milk samples collected from the industrial region, followed by intensive traffic and also in the rural region.

Our results are similar to the published results of the authors, except for the lead content, which in the milk samples is above the permitted prescribed values.

Debashis et al. (2009) found that the lead content of milk samples collected from farms near processing industrial units was higher than that of milk samples taken from rural farms. Our research is in agreement with the authors as the lead content compared between locations was highest in milk from Bogovinje and Toplice locations which are located close to the E-65 highway with values (0.032791 and 0.027573 mg/L).

Swarup et al., (2005), found that lead content was significantly higher ($p < 0.05$) in urban milk samples than in rural milk samples.

In our research, the values for copper and cadmium were below the prescribed permissible limits, but the content of lead was increased probably as a result of the location of the farms close to the highway and the regional road, while the cows drank clean and hygienic water from the water network.

In our research, the highest cadmium content was registered in Bogovinje at 0.425 μg/L / 0.000425 mg/L, and the lowest value in samples from Toplice at 0.091 μg/L / 0.000091 mg/L, however, the values do not exceed the prescribed permissible limits according to FAO / WHO.

In the research of Elsaim & Yahya (2018), the concentration of selected heavy metals (Cu, Cr, Cd, Pb, and Zn) in fresh cow's milk samples available in northern Sudan-Merow was investigated using atomic absorption spectrophotometry (AAS).
The elements Cd, Cr, and Pb were not detected in all samples of fresh cow's milk. Also, there was no significant value in the average concentrations of Cu and Zn between fresh cow's milk samples from the three farms. From the obtained results, the average concentration of Cu was determined in farm A = 0.111, B = 0.180, and C = 0.130 mg\L, while the average concentration of Zn was in farm A = 1.13, B = 1.42, and C = 1.62 mg \L.

Similarly, as stated by the authors Elsaim & Yahya (2018), in our research the values for copper and zinc were also below the maximum allowed values. Only in our country was an increased value for lead that exceeded the prescribed limit of 0.02 mg/L imposed by the European Union (0.02 mg/kg) (EC, 2015).

In his research, Zhou Xuewei (2019) found that the average levels of Pb in milk produced in the ten study areas showed a decreasing average content as follows: E> D> A> G> J> C> B> F> H> I. The average levels of Cd ranged from 0.02-0.09 μg /L, (0.00002 - 0.00009 mg/L), and the highest average content was determined in areas J and A. Maximum Pb levels were recorded in a sample from area C, while Cd was highest in area J.

CONCLUSION

According to the obtained results for the mean values of heavy metals in raw milk for selected locations from all seasons, we concluded the following:

In our research on the annual average value of the elements, we found that the content of all elements except lead was within the normal prescribed permissible limits. The highest lead content was recorded in the samples from Bogovinje location 32.791 μg /L / 0.032791 mg/L, Toplice 27.573 μg /L / 0.027573 mg/L and Negotino 24.865 μg /L / 0.024865 mg/L.

It was recommended to prevent the construction of farms and the raising of livestock near the source of pollution, as well as arable areas for the production of fodder. In our case, the lead content compared between the locations was the highest in the milk from the farm near the Bogovinje and Toplice locations, which are located close to the E-65 highway, to make more frequent analyzes and quality controls of the fodder and milk for the presence of heavy metals and other contaminants and Raising awareness among farmers and the general public about the importance of food safety, environmental protection, and public health preservation.

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