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Research Article

Detection of Lead and Cadmium in Milk from Holstein Cattle Located in Mexico City

Silvia D Pena Betancourt[1]* and S Denise Posadas Pena[2]

[1]*Agricultural and Animal Production Department, UAM-Xochimilco, Mexico*

[2] *Instituto Tecnológico y de Estudios Superiores de Monterrey, ITESM-CCM, Mexico*

***Corresponding Author:** Silvia D Pena Betancourt, Agricultural and Animal Production Department, UAM-Xochimilco, Mexico.

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Abstract

In Mexico City, it is estimated that 15,000 metric tons of lead are deposited annually in the environment, mainly from industrial waste. Cattle can be exposed to heavy metals such as Cadmium (Cd) and Lead (Pb) for long periods of time by ingesting contaminated forages and water, which are eliminated through the milk. In this study, the levels of lead and cadmium in bovine milk located in Mexico City were determined. The results showed a mean Pb content of 0.1392 mg/L and 0.0181 mg/L for Cd. It is concluded that Pb is outside the maximum limit allowed by the Codex Alimentarius, so it is necessary to establish the safety margins in milk. The concentrations of these metals (Cd and Pb) in bovine milk, should be taken into account, in order to ensure the health of consumers, mainly children.

Keywords: *Lead; Cadmium; Milk; Holstein Cattle*

Introduction

Latin America and the Caribbean contribute 14% of the world's lead production. In Mexico City, it is estimated that 15,000 metric tons of lead are deposited annually in the environment [1], mainly from mining waste. The bovine dairy producers consume fodder and water which can be a source of water contamination from heavy metals such as lead (Pb) and cadmium (Cd) [2] which were exposed to the environment [3] and will be eliminated through milk [4], children are the most at risk to the toxic effect of lead because is at the level of the nervous system causing neuronal damage [5,6], Gonzáles., *et al*. [7] mentioned a reduction of the IQ, lack of concentration, decalcification and hyperactivity, so the objective of this work was to determine the concentration of lead and cadmium in milk of cattle, located in Xochimilco.

Materials and Methods

Description of the study area

The Xochimilco Basin is located in the Chinampera region in Mexico City. The basin has a total area of 5.74 hectares, with silty soil and an approximate altitude of 2220 meters above sea level.

Sampling population

The population of this study was 5 female bovines between 3 and 4 years old.

Sampling

Five samples of 10 mL of milk, each one, were collected in conical tubes of 15 mL with thread. The udder was previously disinfected using cotton and ethanol. The milk was collected by manual milking using sterile gloves. Those were kept refrigerated at a temperature of 3 - 7°C until they were taken to the laboratory for analysis.

Analytic technique

The determination of Pb and Cd was analyzed by flame emission atomic absorption spectrophotometry (AA).

Procedure of the milk sample

From 1 mL was made an acid digestion in microwave and all samples were made by duplicate.

Experimental design and statistical analysis

A completely randomized experimental design was used, with two repetitions. A student's T test was performed in order to compare the means from Pb concentrations in blood and milk and Cd concentrations in blood and milk with a confidence level of 95%.

Results

Concentration of Pb and Cd in milk

The concentration of Pb in milk is presented in table 1 individually.

Experimental units	Pb (mg/L)	Cd (mg/L)
1	0.0294	0.3674
2	0.0527	0.3549
3	0.0884	0.3674
4	0.0616	0.3549
5	0.0348	0.3596
$\underline{x}$	0.05338	0.36084
σ	0.02353	0.0062

Table 1: *Detected levels of Pb and Cd in blood.*

Experimental units	Pb (mg/L)	Cd (mg/L)
1	0.1392	0.019
2	0.1392	0.0165
3	0.1392	0.019
4	0.1392	0.019
5	0.1392	0.017
$\underline{x}$	0.1392	0.0181
σ	0	0.00124499

Table 2: *Detected concentrations of Pb and Cd in milk.*

	Pb (mg/L)	Cd (mg/L)
Mean	0.05338	0.36084
Variance	0.000553672	3.9543E-05
Observations	5	5
Df	4	
t	-28.22718457	
P(T<=t) one tail	5.22533E-07	
Critical value of t (one tail)	2.015048373	
P(T<=t) two tails	1.04507E-06	
Critical t value (two tails)	2.570581836	

Table 3: *T student for 2 samples assuming unequal variances in blood.*

The T student test was made using Data analysis of Microsoft Excel. It showed slightly significant difference between the means of independent variables (P <= 0.05).

	Pb (mg/L)	Cd (mg/L)
Mean	0.1392	0.0181
Variance	0	0.00000155
Observations	5	5
Df	4	
t	217.5020208	
P(T<=t) one tail	1.34031E-09	
Critical value of t (one tail)	2.131846786	
P(T<=t) two tails	2.68063E-09	
Critical t value (two tails)	2.776445105	

Table 4: *T student for 2 samples assuming unequal variances in milk.*

Discussion

In Mexico there is no regulation of lead and cadmium in raw milk. However, other countries established a level of: 0.10 mg/L for lead; Codex and the European Union, a level of 0.02 mg/L and for cadmium a maximum level of 0.01 mg/L. In this study, the presence of these two metals was observed in all the analyzed samples, with a mean of 0.1392 mg/L and of Cd of 0.0181 mg/L, for lead and Cadmium respectively, in which lead is found outside the established LMP [6]. These findings differ from that reported by Reynoso., *et al.* [8] since they determined Lead in raw milk from Holstein cattle in the Comarca Lagunera, Mexico, reporting values that ranged between 0.937 mg /L to 4.53, probably by intense activity of the metal industry in the region; meanwhile Rodríguez., *et al.* [9] reported lead concentrations on average of 0.7406 mg/L and cadmium of 0.2955 mg/L, in Nuevo León, Mexico [10]. The levels of two metals found in blood are in average between 0.05338 mg/L and 0.36084 mg/L respectively. It wasn't found any significant differences between the studied variables coinciding with other reported studies. Therefore, it is recommended to carry out a study of the contamination by metals in the water and food of cattle in the region since the growing urban development in Mexico City has caused an environmental deterioration of the water resource,

indicating the presence of Pb with minimum and maximum concentrations of 0.069 and 0.056 mg/L [1]. In Mexico the consumption of pasteurized milk in children is low, approximately 340 mL per day, however, lead affects the nervous system causing serious alterations, so a prolonged exposure even in low consumption can deteriorate children's health [11-15].

Conclusion

The concentration of Cd and Pb in milk is out of the maximum limit allowed by international regulation. Pb in milk is 7 times higher than the allowed value in the regulation, however Pb concentration in blood is inside the allowed value in the regulation. Cd concentration levels are higher than the ones found in other studies. The Cd and Pb levels in milk raw found in this study, are a possibly risk in children's population. Therefore, it is imperative to monitor the sources of contamination such as food and water used in the feeding of cattle, in order to ensure the quality and safety of milk.

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