Relationships between Pb, As, Cr and Cd in soil and water in agricultural and industrial areas with heavy metals contents from individual cow milks

Abstract#: 78687

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OBJECTIVE

This study investigated the relationships between milk heavy metals' contents in individual cows with that in soil and water in industrial and agricultural areas.

MATERIALS & METHODS

Sixty milk samples (10 per farm) were collected from the udder during milking. Six underground water and six soil samples were collected at the same farm that milk sampling. Levels of Pb, As, Cr and Cd in milk and water samples were measured by ICP-MS. Lead, Cr and Cd in soil were measured by AAS, and As was detected by AFS. Heavy metal contents in milk from agricultural and industrial areas were compared using Kruskal-Wallis tests. Spearman correlations were calculated between the studied metal contents in milk with that in water and soil.

RESULTS

Ranges of Pb, As, Cr and Cd in milk were 0.025-10.45, 0.002-1.53, 0.017-5.01 and 0.006-0.27 μg/L. Mean levels of Pb, As, Cr and Cd were 0.07, 3.58, 1.80, 0.01 μg/L in water and 17.57, 7.91, 39.93, 0.15 mg/kg in soil, respectively. Contents of Pb and Cd in milk from agricultural area were significantly lower ($P<0.01$) than that from industrial area. Significant ($P<0.01$) higher As residue was observed in milk from agricultural area.

No difference showed for Cd. Levels of As ($r=0.37$) in milk and water were positively correlated. Those results suggested that As could be partially introduced into milk by cows' drinking water. A moderate positive correlation was found for Cr ($r=0.60$) and Cd ($r=0.66$) between milk and soil; and a negative value was observed in water for Cr ($r=-0.60$) and Cd ($r=-0.75$). Therefore, the contents of Cr and Cd in milk can be related to cows' feed that produced in Cr and Cd polluted soil. Lead ($r=-0.37$) levels in milk showed a negative correlation with Pb in soil, this leading no firm conclusions about the origin of Pb contamination in milk. The obtained results indicated that Pb, As, Cr and Cd in milk have complex source; water and soil in the farm had a partial contribution based on the obtained correlation amplitude.

ACKNOWLEDGEMENT

This study was financially supported by the Project of Risk Assessment on Raw Milk (GJFP2019026), the Modern Agro-Industry Technology Research System of the PR China (CARS-36).

Table 1 Mean concentrations (μg/L) of Pb, As, Cr, and Cd in milk samples from unpolluted and industrial farms.

Areas	Pb	As	Cr	Cd
Unpolluted (N=10)	0.16**	0.10	0.83	0.04**
Industrial (N=50)	1.43	0.05**	0.88	0.10

**Significant difference according to Kruskal-Wallis test for different areas ($P < 0.01$)

Table 2 Spearman correlation coefficients among heavy metals contents in milk, water, silage and soil (N=6).

	Pb	As	Cr	Cd
Milk-water	0.03	0.37	-0.60	-0.75
Milk-soil	-0.37	-0.03	0.60	0.66
Water-soil	0.03	-0.03	0.14	-0.32