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REGULAR ARTICLE

ACCUMULATION OF SOME HEAVY METALS (PD, CD AND CR) IN MILK OF GRAZING SHEEP IN NORTH-EAST HUNGARY

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ABSTRACT

Food safety and traceability control in the production of agricultural primary products becomes more important criteria for the consumers because of the novel requirements of foods as tools for disease prevention and health. The objective of this study was to investigate the accumulation of lead, cadmium and chromium in milk of ewes during pasture condition. In present study, the amounts of the heavy metals in grass samples were lower than the highest acceptable limits according the regulations. Moreover, lead, cadmium and chromium concentrations were 0.023 mg, 0.012 mg and 0.290 mg/wet weight kg in milk samples, respectively. 50% and 40% of the milk samples the lead and cadmium values were out of the permissible limit. However, the amount of the heavy metals in grass and other forages samples were lower than the highest acceptable limits, concentration of Pb and Cd in milk samples were higher than the maximum acceptable limits of the EU regulation. These results suggested that necessary control the heavy metal contents of primary food products for food safety.

Keywords: heavy metals, grass, sheep, milk

INTRODUCTION

Food safety and traceability control in the production of agricultural primary products becomes more important criteria for the consumers because of the novel requirements of foods as tools for disease prevention and health. Main target of the research program was to establish a pasture-based keeping technology, with special regard to evaluate the critical points which can have effect on the quality of products and at least on the health of consumers. Accumulation of non-essential investigated heavy metals (e.g. Pb, Cd, Cr) in the environment could be useful indicators of the possible toxic effects for the consumers **(Liu, 2003; Tasi, 2005; Phillips *et al.,* 2005)**. Lead is toxic to such as the nervous, gastrointestinal and genital systems **(Abou-Arab, 2001)**. Cadmium is mainly hepatic and renal, toxicity **(Pathak and Khandelwal, 2006).** In addition, it is implicated in high blood pressure **(Perry *et al.,* 1979)**, prostatic cancer and spontaneous mutations **(Pitot and Dragan, 1996)**. Trivalent chromium (Cr^{3+}) was found as essential mineral **(Schwartz and Mertz, 1959)** and identified as co-factor of chromodulin **(Wada *et al.,* 1983)**, which is the so-called insulin-resistance factor and plays an important role in some physiological functions of human beings and animals **(Vincent, 2000)**. Otherwise hexavalent chromium (Cr^{6+}) is toxic, particularly because it causes oxidative DNA damage **(Cohen et al., 1993)**. Industrial developments, intensive use of raw materials and novel agricultural technologies have all somehow improved our lifestyle while simultaneously polluting the natural environment. According to the above mentioned findings, in present study the amount of accumulated heavy metals (Pb, Cr, Cd) in forages and in milk of ewes was investigated in traditional pastured technology. The Ile de France breed was chosen to this investigation, although this breed not milk type sheep, but the milk production of them was good (maternal breed). These animals were used for pilot study of sheep milk food safety investigations. The objective of this study was to investigate the accumulation of lead, cadmium and chromium in milk of ewes during pasture condition.

MATERIAL AND METHODS

Experimental animals were selected from a traditionally pastured mixed sheep flock of Ile de France (ewes: n=20, average age 1.93 years) genotypes kept on a farm in Szendrő (Northeast part of Hungary), near industrial areas. Ewes were kept on pasture during the vegetation period and they were fed exclusively with pasturing from April to July and additionally 600-700 g concentrate during suckling period. Out of grazing period the ewes fed 2.5-3.0 kg/day good quality meadow hay and also 600-700 g concentrate.

Representative samples of grass (3 m^2 sample area), concentrate and meadow hay were taken for chemical analysis. Milk samples were taken during the suckling period (at 4th week of lactation) from all of the ewes investigated. All forages samples of each tissue were weighed accurately and dried in a furnace between 50-60°C to obtain a constant weight. The milk samples for heavy metals analysis were dried overnight at 102°C and ashed at 550°C for 6 h. All sample amounts was 0.50 g. Preparations of the samples were made in Milestone Microwave Acid Digestion apparatus using 6 cm^3 65% (v/v) nitric acid and 1 cm^3 30% (v/v) hydrogen-peroxide according to the instrument manual. Shattering was done by the instructions of MIILESTONE "Microwave Acid Digestion Cookbook". The shattering was strainer by MN 640d type filter paper. A Jobin Yvon JY24 ICP-OES indicatively coupled plasma-optical emission spectrometer was used to measure Pb, Cd and Cr concentrations. Wavelengths for each element were: Pb: 283.3 nm, Cd: 228.8 nm and Cr: 267.2 nm. Standard solutions for lead, cadmium and chromium were provided by Merck (Darmstadt). Data were statistically evaluated by SPSS 14.0 program package.

RESULTS AND DISCUSSION

The mean concentrations of lead, cadmium and chromium in forages are shown in Table 1.

Table 1 Lead, cadmium and chromium concentrations of the forages (n=10) (mg/12 % wet weight kg±SEM).

	Lead	Cadmium	Chromium
Grass at 4th month	0.282±0.003	0.017±0.001	0.431 ± 0.079
Grass at 5th month	1.144±0.072	0.045±0.003	0.106 ± 0.019
Grass at 6th month	0.510±0.089	0.044±0.001	0.123 ± 0.018
Grass at 7th month	0.484±0.078	0.040±0.002	0.097 ± 0.018
Concentrate	2.121±0.473	0.009±0.003	0.070 ± 0.106
Hay	0.950±0.167	0.097±0.003	0.044 ± 0.009

Fluctuations of the heavy metal content were the highest in the case of grass. The cadmium level increased, while the chromium level decreased by the vegetation time. The lead and cadmium levels were increased by the vegetation time.

The amount of the heavy metals in grass samples were lower than the highest acceptable limits according the regulations **(2005/87/EC)** where the maximum concentration in green forage has been proposed as 30 mg/kg and in other forages as 10 mg/kg for lead, and 1 mg/kg for cadmium (12% moisture content), respectively. Heavy metals accumulated in the plants also in herbivorous animals and at last they present themselves in the food chain **(Güler, 2006)**. The maximum chromium concentration has no threshold limit, but in the different reports suggested a concentration between 0.03 to 1 mg/kg in samples **(Csathó, 1994; Güler, 2006).**

The concentrations of lead, cadmium and chromium in milk of ewes are shown in Tables 2.

Table 2 Lead, cadmium and chromium concentrations of the milk samples of ewes (mg/wet weight kg±SEM).

Samples	Lead	Cadmium	Chromium
Milk	0.023±0.002	0.012±0.001	0.290±0.022
Minimum	0.007	0.006	0.107
Maximum	0.040	0.020	0.467
Range	0.033	0.014	0.360
Permissible limit in milk	0.02	0.01	n.a.
Out of permissible limit in milk	50%	40%	-

Legend: n.a.= no data available

According to the products, the amounts of the heavy metals were compared to the maximum acceptable limits in milk of farm animals according to the European Union regulation **(1881/2006/EC)**. In present study, lead, cadmium and chromium concentrations were 0.023 mg, 0.012 mg and 0.290 mg/wet weight kg in milk samples, respectively. 50% and 40% of the milk samples the lead and cadmium values were out of the permissible limit, although, the difference are relatively small.

The maximum lead concentration in milk is 0.02 mg/L **(1881/2006/EC)**. With regard to these limits, the heavy metal concentrations of milk were higher than the limits. The lead concentration in milk was higher than was found by **Liu (2003)** and **Abou-Arab (2001)** as reported from rural areas, but it was lower as compared to values of samples from industrial areas.

The maximum cadmium concentration in is 0.01 mg/L **(EÜM, 1999)**. Regarding to these limits, the cadmium concentration of milk was higher a bit in our investigated samples. The values of cadmium content of milk in the present study were lower than in a previous study of **Güler (2006)**, whereas, our results were higher compared to the reports of **Rodriguez et al. (1999)**. Lead and chromium concentrations were approximately twice as high compared to the results of **Güler (2006)** and **Rodriguez et al. (1999)**. This may be due to relatively high heavy metal contents of concentrate and hay. Although the amount of the chromium in milk samples were lower than the values that was reported by **Csathó (1994)** and **Güler (2006)** (0.03 to 1 mg/kg).

CONCLUSION

Accumulation of the heavy metals in grass samples was lower than the highest acceptable limits, concentration of lead and cadmium samples higher than the threshold limit of the EU regulation. However, the amount of the heavy metals in grass and other forages samples were lower than the highest acceptable limits, concentration of Pb and Cd in milk samples were higher than the maximum acceptable limits of the EU regulation. These results suggested that necessary control the heavy metal contents of primary food products for food safety.

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