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COMPARATIVE LEVELS OF LEAD AND CADMIUM IN SHEEP WOOL AND COW HAIR

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Abstract

This study aimed to examine the use of wool from sheep and hair from cows raised in the commune of Bran, Romania as a possible indicator of environmental exposure to lead and cadmium. In addition, the samples collected from sheep and cows were analysed both unwashed and washed in order to determine a possible difference between lead and cadmium concentrations. The samples were analysed for heavy metal concentrations using Inductively Coupled Plasma Mass Spectrometry. Statistical analysis showed that there are no significant differences between the concentrations of lead and cadmium in washed and unwashed sheep wool and cow hair, respectively.

Key words*: lead, cadmium, sheep, cows, ICP-MS.*

INTRODUCTION

Lead and cadmium are heavy metals that can cause severe health hazards in both humans and animals when consumed in high concentrations. Lead and cadmium toxicity have been extensively studied and have been found to cause a range of health problems, including developmental delays, anemia, and neurological disorders in individuals exposed to lead, or kidney damage, respiratory illness, and cancer in individuals exposed to cadmium. Exposure can occur through contaminated food, water, and air. Prevention efforts, such as reducing industrial emissions and monitoring food safety, are essential to minimize exposure (De Francisco et al., 2003; Flora et al., 2012; Godt et al., 2006; Klaassen et al., 2009; Satarug et al., 2003; Satarug et al., 2011).

The contamination of the environment with these metals is a global concern, and the contamination of the food chain is a significant source of exposure for humans and animals. (Chary et al., 2008; Kumar et al., 2019; Sonone et al., 2020). Several studies have researched the possibility of using animal hair as a bioindicator of environmental pollution (Kośla et al., 2003; Kozak et al., 2002; Skibniewska et al., 2011; Skibniewski et al., 2013).

Comparative levels of lead and cadmium in sheep wool and cow hair have been a subject of research for many years. Several studies have been conducted to determine the concentration of these heavy metals in animal hair and their potential risks to human and animal health. The results of these studies have shown that both sheep wool and cow hair can accumulate significant amounts of lead and cadmium from the environment (Hristev et al., 2008; Patra et al., 2007; Patra et al., 2006; Tuncer, 2019).

The variation in the concentration of lead and cadmium in sheep wool and cow hair may be attributed to several factors, including the geographical location, the type of soil, the type of vegetation in the grazing areas, and the feed that the animals receive. Additionally, the age of the animals, the breed, and the nutritional status of the animals can also influence the accumulation of heavy metals in hair or wool.

In this context, this study aimed to assess the level of contamination of cows and sheep raised in the rural region of Bran, Romania by analysing cow hair and sheep wool samples. The samples were analysed both unwashed and washed to see if the environmental exterior contamination of the samples could influence the concentrations of Pb and Cd found in hair and wool.

MATERIALS AND METHODS

Wool and hair samples were collected from sheep (n = 6) and cows (n = 6) that were raised in the commune of Bran, Romania. Two samples were collected from each individual, so that the first sample was analysed unwashed, while the second sample was washed prior to analysis. Wool and hair samples were washed with warm water, then left to soak in water for 48 hours, drained, and soaked in water for an additional 48 hours. Samples were then drained, and left to soak in 98° alcohol for 24 hours. After this process, all samples were rinsed with distilled water and left to dry at room temperature. All wool and hair samples were weighed to 0.5 g and placed in polypropylene tubes. Samples were then disintegrated by cold wet mineralisation; 5 ml of HNO_3 and 1 ml of HCl were added to each sample. After mineralization was complete, in two weeks at room temperature, ultrapure water was added in each sample to 10 ml.

All hair samples were analysed using a Perkin-Elmer Elan DRC II ICP-MS (RF Power 1500 W; Nebulizer PFA-100; Sample Uptake Rate ≈175 µL/min - self aspiration; Spray Chamber Cyclonic; Nebulizer Flow Set for ≤1.5% oxides CeO+/Ce+). Calibration curves were developed using standard solutions of 0.005 ppm, 0.01 ppm, 0.1 ppm, 1 ppm, 5 ppm, 10 ppm, obtained by dilution from a multi-element ICP MERCK standard solution containing 100 mg/L of Pb and Cd. Statistical analysis was performed using SPSS software. For a higher accuracy, given the small number of samples in each group, the median was used to compare Pb and Cd concentrations between groups. The Mann-Whitney test was applied to the obtained values of Pb and Cd concentrations in wool and hair samples.

RESULTS AND DISCUSSIONS

Lead and cadmium median concentrations in cow hair and sheep wool samples depending on the method of preparation of samples, along with the results of the statistical analysis, are presented in Table 1.

Figures 1 and 2 show the mean concentrations of lead and cadmium depending on sample method of preparation in cow hair and sheep wool samples, respectively.

The median concentrations of Pb in cow hair samples was different for washed and unwashed samples. It was visible that unwashed samples had higher concentrations of Pb (365.30 ppb) than washed samples (172.41 ppb), however these differences were not statistically significant.

The median concentrations of Pb in sheep wool were also higher in unwashed samples (298.88 ppb) compared to washed samples (234.45 ppb), but still with no statistical significance.

Table 1. Lead and cadmium median concentrations (ppb) in cow hair and sheep wool samples depending on the method of preparation of samples

Sample type		N	Pb	Cd
Unwashed	Cattle	6	365.30[a]	37.07[a]
	Sheep	6	298.88[a]	36.73[a]
Washed	Cattle	6	172.41[a]	31.03[a]
	Sheep	6	234.45[a]	36.84[a]

Values with different superscripts between rows in a column vary significantly at $p < 0.05$.

Hristev et al. (2008) studied the lead content in washed and unwashed wool of sheep. The obtained concentrations were much higher compared to the ones found in the present study, the authors also finding a significant statistical difference between the concentrations of Pb in unwashed wool (15.3 ppm) versus washed wool (8.15 ppm).

Regarding Cd concentrations in cow hair, the difference between unwashed samples (37.07 ppb) and washed samples (31.03 ppb) was not statistically significant.

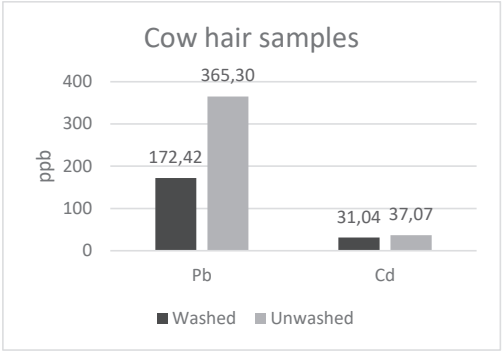

Figure 1. Mean Pb and Cd concentrations in cow hair samples depending on sample method of preparation

Median Cd concentrations in sheep wool samples were 36.84 ppb in washed samples, and 36.73 ppb in unwashed samples, however these differences were not statistically significant.
Hristev et al. (2008) also studied the cadmium content in washed and unwashed wool of sheep. The obtained concentrations were a bit higher compared to the ones found in the present study, and the authors also did not find a significant difference in the concentration of Cd between unwashed wool (0.69 ppm) and washed wool (0.53 ppm).

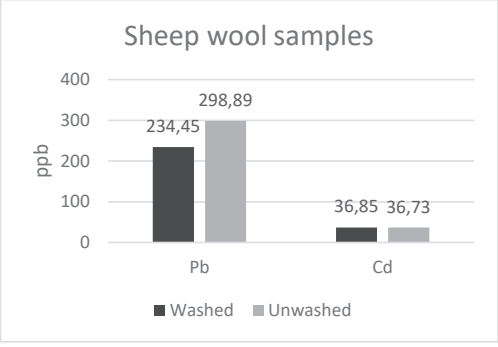

Figure 2. Mean Pb and Cd concentrations in sheep wool samples depending on sample method of preparation

The present study found that statistical analysis showed no significant differences between Pb concentrations in cows compared to sheep, nor in Cd concentrations in cows compared to sheep, as is visible in Table 1.
Patra et al. (2007) evaluated the concentrations of Pb and Cd in tail hair samples in cows raised in different polluted and non-polluted environments. Cows raised in unpolluted areas registered 2.99 ppm Pb and 0.52 ppm Cd, while the highest concentration of Pb was found in cows raised near a lead-zinc smelter (15.09 ppm) and the highest concentration of Cd was found in cows raised near a closed lead cum operational zinc smelter (5.72 ppm), with even the lowest concentrations of both heavy metals still being much higher than those found in the present study.
Rogowska et al. (2009) studied the concentrations of different heavy metals in the hair of cattle living in the area contaminated by a copper smelter, in unwashed and washed samples, over the course of 3 years. In the unwashed samples, Pb concentrations were higher compared to the concentrations found in the present study, while Cd concentrations were similar to the ones found in the present study. However, Rogowska et al. found statistically significant differences between the unwashed and washed samples, for example Cd concentrations in unwashed samples were 0.03 ppm, significantly higher ($p < 0.01$) compared to washed samples (0.014 ppm).
Tuncer (2019) evaluated the concentrations of lead and cadmium in wool samples taken from sheep raised in Centrum (industrial area) and Özalp (rural area) districts of Van province in Turkey, and concluded that sheep raised in the Central district of Van (Pb - 49.05; Cd - 0.37 ppb) had statistically significant higher levels ($p < 0.01$) of Pb and Cd than those of the sheep Özalp district (Pb - 47.02; Cd - 0.15 ppb), with the concentrations of both Pb and Cd for both districts being much lower compared to the findings of the present research.

CONCLUSIONS

Heavy metal level analysis of cow hair and sheep wool is a non-invasive method of analysis, which can be of use for environmental pollution assessment. Neither Pb nor Cd concentrations were significantly different between the two studied species, which suggest a similar level of contamination of both species.
The present study found no statistically significant differences between the concentrations of neither Pb nor Cd based on the preparation technique of the samples. Although washed samples usually had lower concentrations of both Pb and Cd, the differences were not significant. Taking into account the fact that the cows and sheep were raised in a rural, non-industrial area of Romania, it can be considered that the heavy metal pollution in the area was reduced, so further research should be performed, by analysing samples taken from animals raised in polluted areas as well, in order to be able to determine whether external contaminants present on the hair samples can significantly increase the concentrations of the analysed elements.

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