

INFLUENCE OF INDUSTRIAL AIR POLLUTANTS ON THE CONTENT OF CADMIUM IN LUCERNE AND COW MILK

Ljiljana Andjušić*, Zvonko Spasić, Božidar Milošević

Faculty of Agroculture, Jelene Anžuske bb, Zubin Potok, Serbia

*lunaa.ns@gmail.com

In the industrial zone of Obilić the thermal plants “Kosovo A” and “Kosovo B” are located, as well as a heating station, which with their emissions pollute Obilić and its vicinity. Additionally, a daily coal mine, a separation, a drier and a nitrogen fertilizer plant there are placed. This thermo energetic giant represents a strong source of SO₂, smoke and flying dust, as well as products of coal combustion. The goal of this investigation was to investigate, in the area of Obilić where air pollution exists on a higher level, the content of cadmium (which is very toxic) in lucerne and cow milk at different locations and distance from the source of pollution in 6 different localities. By the method of Absorbic Spectrophotometry it has been determined that the average presence of cadmium in the investigated samples of lucerne was 0.07 mg/kg DM and the average value of cadmium presence in milk samples amounted to 0.04 mg/l. The established values exceed regular standards so that in relation to them, milk from these areas should not be used for human nutrition, especially children.

Key words: air pollution; cadmium (Cd); lucerne; milk

ВЛИЈАНИЕ НА ИНДУСТРИСКИТЕ ЗАГАДУВАЧИ НА ВОЗДУХОТ ВРЗ СОДРЖИНАТА НА КАДМИУМ ВО ЛУЦЕРКАТА И КРАВЈОТО МЛЕКО

Во индустриската зона на Обилиќ се лоцирани термоцентралите „Косово А“ и „Косово Б“, како и топланите, кои со своите емисии го загадуваат Обилиќ и неговата околина. Освен тоа, таму се наоѓа и рудник за јаглен. Овој термоенергетски гигант претставува силен извор на SO₂, чад и летечки прав, како и продукти на согорување на јагленот. Целта на ова истражување е во околната на Обилиќ, каде што постои загадување на воздухот на повисоко ниво, да се истражи содржината на кадмиумот (кој е многу токсичен) во луцерката и во кравјото млеко на различни локации и растојанија од изворот на загадувањето. Истражувањето е извршено за 6 различни локации. Со методот на апсорпциона спектрофотометрија беше утврдено дека просечното присуство на кадмиум во испитаните примероци на луцерка изнесуваше 0,07 mg/kg сува материја и просечната вредност на присуството на кадмиум во примероците од кравјото млеко изнесуваше 0,04 mg/l. Утврдените вредности ги надминуваат регуларните стандарди толку што во релација со нив млекото од овие места не треба да се користи за човекова исхрана, особено не за децата.

Клучни зборови: загадување на воздухот; кадмиум (Cd); луцерка; млеко

INTRODUCTION

Scientific-technology revolution and other events related with it, rapidly increased industrial production, and in many aspects contributed to a complex relationship between the man and environment, introducing a significant change and deterioration of the natural ecosystem, which has been replaced by artificial systems, that mostly

transformed into "urban deserts". Scientific achievements in the field of industrial technology, had as a consequence troublesome environmental pollution with different chemical substances.

Regarding that, the modern man has been increasingly concerned about heavy metals pollution, especially lead and cadmium, as well as non-essential biological and very toxic metals, which express tendency of bioaccumulation.

Airpollutants, which have been emitting from primary sources, transport to short or long distances, and modified or in the same form (like secondary) return to the earth surface. The recipients, besides the land, are water, plants, animals and humans.

One of the most important environmental pollutants in the area of Kosovo and Metohia is the industrial facility in Obilić, where thermal plants "Kosovo A" and "Kosovo B" are located, as well as a heating station. Considering undisputable Cd toxicity for living beings, special interest has been increased regarding the Cd level in plants and, consequently, its increased level influences the health of animals and humans. Although the acute poisoning is very rare, continuous exposition to higher amounts of cadmium, throughout a longer period, increases its accumulation in various body tissues and organs. The danger is higher, as, its toxicity comes into sight just about after several decades. Humans using such food indirectly adopt these substances which may act destructively, generating diseases if present in amounts higher than allowed.

The aim of these studies was to examine the Cd content in lucerne and cow milk in the region with different geographical position and different distances from pollution sources, in the Obilić area, where air pollution exists at a higher level for a long time.

MATERIAL AND METHOD

As lucerne is the most prevalent source of cattle food in this area, in a green condition or as hay, and because of its leaves structure and higher foliage propensity, samples of this plant were collected. On the basis of the investigation goals, and concerning the fact that foliage absorption is more pronounced when gasses are under consideration 12 samples of green lucerne were taken, in the middle of the season (15–20 July), from each checkpoints. At the same time, samples of cow milk have been collected towards determining the way lucerne as a food source for cattle influences on transmitting cadmium in milk, which, as it is well known, represents the basic condition of young animal population survival (including the human population).

All samples (green lucerne and raw cow milk) were processed according to the standard procedure, after which cadmium content was re-

ceived from the solution using atomic absorption spectrophotometer (AAS).

Table 1

Number and disposition of checkpoints to take samples

No. of checkpoints	Locality	Average distance from polluter (km)	Type of samples
1.	Prilužje	8	Green lucerne, milk
2.	Babin Most	7	Green lucerne, milk
3.	Miloševo	5	Green lucerne, milk
4.	Obilić	–	Green lucerne, milk
5.	Lepina	14	Green lucerne, milk
6.	Skulanevo	15	Green lucerne, milk

Regarding the examined factors, basic statistical parameters were calculated, while testing of the total variability among some investigated checkpoints was done by the analysis of variance according to Stanković (1990). Where statistically significant differences were established by the F-test, LSD-test was used for testing the significance.

The relationship of studied heavy metals concentrations in lucerne and consequently in milk has been determined by correlation coefficients.

RESULTS AND DISCUSSION

The established Cd concentrations in lucerne and milk in the area of Obilić observed by taken samples at different localities, are presented in Tables 2 and 3. The highest Cd concentration in lucerne, has been determined in the Obilić locality, which has been expected, for the reason that the main sources of pollution are located there. However, we expected that with distance, the level of this element would decrease, but it wasn't the case at the locality Skulanevo 15 km away from the source of pollution (high variation interval from 0.01 to 0.40 mgCd/kg DM). Since there are facilities with very tall chimneys and as distribution of pollutants depends on it, emissions are transported on greater distance wherewith the level of cadmium increases considerably. To this the north-east wind contributes significantly as it is prevalent in that area, which suggests a very important role disseminating a harmful product from the source of the pollution.

Table 2
Average value and variability of Cd content in lucerne in the Obilić region, mg/kg

Locality	Distance in km	$\bar{X} \pm S_x$	SD	CV	min.-max.
Prilužje	8	0.06 ± 0.01	0.03	49.49	0.01 – 0.12
Babin Most	7	0.06 ± 0.01	0.04	69.84	0.03 – 0.20
Obilić	0	0.10 ± 0.01	0.04	55.97	0.02 – 0.20
Miloševo	5	0.06 ± 0.01	0.04	68.04	0.00 – 0.14
Lepina	14	0.07 ± 0.01	0.03	47.14	0.01 – 0.11
Skulanevo	15	0.09 ± 0.03	0.10	121.40	0.01 – 0.40
Average	-	0.073 ± 0.01	0.05	68.16	0.00 – 0.40

lsd_{0.05} = 0.092 lsd_{0.01} = 0.122

Stojanović et al. (1981) identified higher values of Cd in red clover that grows beside motorways, which are also modern pollutants of the environment. By comparing our values with Mirić's (1995) and Biočanin's (2004) for the region of Štrpce, it can be noticed that they are higher, which is expected, because the Obilić region is exposed to the main sources of pollution. The results of Jung et al. (1996) and Ognjanović et al. (2001) show higher concentrations of cadmium in tobacco and soybean growing near the mines in comparison with our results.

Observing the level of Cd in cow milk (Tab. 3), depending on the distance to the main sources

of pollution, it can be noticed that it reduces with the distance increase (the highest values in the area of Obilić – 0.07 ± 0.03 mg/l with variation from 0.00 – 0.40 mg Cd/l). Statistical significance at the level of 5% has been estimated only among locality of main sources and the last north locality Prilužje, where the established Cd concentration in cow milk (0.02 mg Cd/l) was the smallest. Although this locality is not farthest from the main sources of pollution, similar as regarding the cadmium content in the dry matter of lucerne, for the reason of wind direction (mostly north-west wind) which is carrying air pollutants on south, it has lower values.

Table 3
Average value and variability of Cd content in milk in the Obilić region, mg/l

Locality	Distance in km	$\bar{X} \pm S_x$	SD	CV	min.-max.
Prilužje	8	0.02 ± 0.00	0.02	89.58	0.00 – 0.05
Babin Most	7	0.03 ± 0.01	0.03	78.20	0.00 – 0.10
Miloševo	5	0.05 ± 0.02	0.05	108.13	0.00 – 0.20
Obilić	0	0.07 ± 0.03	0.11	159.20	0.00 – 0.40
Lepina	14	0.04 ± 0.01	0.03	80.74	0.00 – 0.11
Skulanevo	15	0.03 ± 0.01	0.02	68.70	0.00 – 0.06
Average	-	0.045 ± 0.01	0.04	97.11	0.00 – 0.40

lsd_{0.05} = 0.040 lsd_{0.01} = 0.054

Lower Cd concentrations in raw cow milk are reported by Wenk et al. (1996), but much higher values than ours were reported by Mitrović et al. (1994).

The coefficient of correlation between cadmium content in lucerne and milk in the area of Obilić is presented in the Table 4.

Table 4

Coefficient of correlation between the content Cd in lucerne and milk in the Obilić region

No. of samples	Coefficient of correlation	Critical value
72	0.4054**	$t_{0,05} = 0.1592$ $t_{0,01} = 0.1890$

According to the average values of correlation between Cd content in lucerne and milk in the region of Obilić, it can be noticed that there is a complete correlation, which is statistically very significant ($P < 0.01$). The estimated average cadmium content value in the dry matter of green lucerne were not significantly higher, provided that cadmium values in cow milk from the studied region are four times higher than MPL (0.05 ± 0.01 mg/l with variation $0.01 - 0.16$ mg/l). Thus, we have considerably higher cadmium content values than expected in the Obilić region, which can be explained by the fact that surrounding topography and frequency of the winds contribute to the diffusion of harmful gasses from the pollution sources.

The question is to what extent the increment of cadmium content of lucerne samples may influence its increment in cow milk fed by lucerne from these areas.

The answer to that question can be obtained through the regression analysis using the following formula:

$$y = 0.0338 + 0.0055x.$$

CONCLUSIONS

According to the research results regarding the cadmium content in lucerne and cow milk in the area of Obilić, we have come to the conclusion as follows:

1. The average Cd content of studied samples of green lucerne for all localities amounted to 0.073 mg/kg DM. It can be concluded that established values in the studied region are within the limits of maximum allowed levels. However, there are high deviations, with cadmium concentration in some localities that exceeds the allowed limit by five times.

2. The average Cd content in the studied samples of cow milk amounted to 0.045 mg/l. Variations in Cd content in some studied samples

are much higher and amounted from $0.02 - 0.07$ mg/l in the area of Obilić.

3. Cadmium levels in cow milk decreased with the distance increment from the main sources of pollution, which isn't the case when cadmium content in green lucerne is in question.

4. The established middle and positive correlations, with Roemer-Orphal's classification, have shown that with the increased cadmium content in green lucerne an increase in cow milk can be expected.

5. Established values exceed regular standards so that in relation to them, milk from these areas should not be used for human nutrition, especially children.

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