BIOSOLIDS INFLUENCE IN METALS BIOACCUMULATION IN BARLEY GRAINS

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ABSTRACT

The level of heavy metals from the cultivated lands depends on the anthropogenous activities of the region, mining activities, rhythm and duration of fertilizer with anaerobic stabilized wastewater sludge, known as biosolids. The increase of heavy metals concentration from soil determines the increase of bioaccumulations in grains, as in *Hordeum vulgare* (barley) species. Repeatedly adding organic matter as fertilizer (containing heavy metals) to the land can increase Cd and Pb ions bioavailability with 28-32% and for Zn up to 58%. Adding Tuf-Al_n pillared volcanic tuff to biosolids determines a decrease of bioavailability of Cd with 60%, of Zn with 40% and does not influence Pb ions bioaccumulation compared with the bioaccumulation in crops from an untreated polluted soil.

INTRODUCTION

Barley occupies the fourth ranking in world's grain production after wheat, rice and corn. It represents 10% of the total grain crop. Up to 85% of barley crop is intended to animal feeding and the rest is used for malt production, human feeding and for seeds. Grains are used for pig and cattle feeding, especially in areas where corn is lacking. /1/. Repeated fertilization with biosolids of the land increases the metal quantities in the soil. Even if the fertilization proceedings respect the imposed norms for biosolids concentration in soil, after a while, a significant amount of metals is accumulated /2/. In general, lead is less bioavailable for plants, due to the presence of phosphorous salts from fertilizer with which it forms less soluble compounds. Under normal conditions of pH and salinity etc., cadmium and zinc can diffuse from soil to plants. Metal concentration from agronomical plants tolerated in the animal diet is 0,5 mg Cd/kg diet for cattle, sheep and poultry; in the case of Zn 300 mg/kg for cattle and 1000 mg/kg for poultry and sheep /3/. In the present study is analyzed the bioaccumulation level of some metals (Cd, Pb, Zn) from industrial polluted soils with the addition of biosolids from anaerobic stabilized wastewater sludge. The organic fertilizer was used as is or mixed with Tuf-Al_n pillared volcanic tuff aqueous suspension.

MATERIALS and METHOD

The study was carried out on experimental lots of 10 m^2/lot. The land was prepared and sowed in 2007, September-October. Four soil types were studied: soil polluted with heavy metals (Cd, Pb, Zn), soil polluted and treated with pillared indigenous volcanic tuff (patent pillared indigenous volcanic tuff aqueous suspension,), soil polluted and fertilized with biosolids (anaerobic stabilized wastewater sludge), and soil polluted and fertilized with biosolids mixed with pillared volcanic tuff. The quantity of anaerobic stabilized wastewater sludge added on the experimental lots was of 5 t/ha dries matter, on a 1-1.5 cm stratum. The sludge was from Timisoara Municipal Wastewater Treatment Plant, with a 95% humidity.
The amendment adding of pillared volcanic tuff (prepared in laboratories of INCD ECOIND Timişoara) was done as aqueous suspension, in quantity of 2 to/ha d.m. Experimental lots polluted, fertilized and amended were ploughed and left for biogeochemical stabilization for 30 days within September 10 – October 10. The seed was in concordance with required quality indicators, with a purity of 90% and a 90% germination. Previously, the seeds were treated against diseases and pests.
Sowing density was 400-500 germinated seed/m^2. Distance between rows was 12.5 cm and depths was of 3.5 cm. 160 t seed/ha were sowed. The plants enter the winter deep-rooted and the culture resists to frostiness of -14°C. Analysis of plant metal accumulation in the aerial parts of the plants (stem, leaves, and grains) and root parts was done on dried plants. Plant sampling was done according to the methodology described in STAS 9597/1-74, and the sample analysis was done according to STAS 9597/17-86. Soil samples analysis was done by determination of metal quantity according to the analysis method ISO 11047/99.
Plant and soil extracts analysis was done using a spectrophotometer with atomic absorption, Varian Spectra AAS.

In table 1 some characteristics of the studied soils are presented.

Table 1. Metals content from soil experimental parcels

Soil type	pH	Metals content mg/kg d.m.			Biosolids fertilizing addition t/ha	Pillared volcanic tuff aqueous suspension, addition t/ha
		Cd	Pb	Zn		
Control	6.9	nd	32.0	55.0	-	-
Polluted	6.7	11.3	62.8	988.4	5.0	-
Polluted, amended with pillared volcanic tuff	6.8	11.2	66.0	964.6	5.0	2.0
Polluted, fertilized with biosolids	6.5	9.7	52.0	980.0	5.0	-
Polluted, fertilized with biosolids, amended with pillared volcanic tuff	6.8	11.4	190.0	1140.0	5.0	2.0

RESULTS

In table 2 are presented the metal content in barley grains, harvested in ripening phase.

Table 2. Metal content in *Hordeum vulgare* barley grain, from plants harvested at a length of 100-170 cm, ripening phase

Parcels	Metals content in grains mg/kg s.u.		
	Cd	Pb	Zn
Control	0.1	0.27	26.7
Polluted	0.5	1.57	13.48
Polluted, amended with pillared volcanic tuff	0.5	2.32	32.88
Polluted, fertilized with biosolids	0.7	5.01	29.21
Polluted, fertilized with biosolids, amended with pillared volcanic tuff	0.2	1.7	8.9

The following were concluded:

1. Barley grain uptake of Cd and Pb is higher for the polluted soil then the unpolluted one. Zn quantity uptake in grains from polluted soils probably decreased due to metals bioavailability competition in soil.

2. For the barley grain of polluted, amended with pillared volcanic tuff variant, there is an increase of the bioavailability of Pb and Zn. Bioaccumulation is probably due to total osmotic pressure created by the tuff presence.

3. Adding organic matter determines the increase of metals bioavailability from higher polluted soils compared to polluted, amended with pillared volcanic tuff variant, probably through chelating agents action formed with the present organic acids. Cd and Pb accumulation increased with 28-32% and of Zn with 58% compared to the barley cultivated on polluted, amended with pillared volcanic tuff variant.

4. Adding a mixture of biosolids and tuf-Al_n pillared tuff determines the reduction of metals bioaccumulation with 60% for Cd and with 40% for Zn in comparison with unfertilized soils.

CONCLUSIONS

- Metals bioaccumulation level in the barley grains firstly depends on the soil pollution level.
- Adding either organic fertilizer, or amendments of Tuf-Al_n pillared volcanic tuff or their mixture can significantly change the level of metals accumulation in barley grains. It increases in the case of the organic or inorganic substances use or decreases in the case of mixture of biosolids and Tuf-Al_n pillared volcanic tuff.

LIST OF REFERENCES

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