SELENIUM AND ARSENIC IN SELENIUM – ACCUMULATOR PLANTS

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This paper presents data showing a relationship between selenium (*Se*) and arsenic (*As*) in *Se*-accumulator plants *Cynodon sp* and *Astragalus sp*, these species being considered indicators of soils relatively rich in these two elements. Excepting selenium, the elemental composition of *Astragalus* is poorly known so far. Our study shows that plants from *Cynodon* gender contain more *As* in their tissues (foliar mesophyllum, flowering tissue, seminal tissue, stem cortex) as compared to that belonging to *Astragalus* gender.

Key words: Selenium; Arsenic; Astragalus; Cynodon; Selenium methylselenocysteine; Selenium methylselenomethionine.

INTRODUCTION

The present study intended to bring a contribution to the knowledge on *Se* and *As* spreading in indicator plants for soils on which these are growing.

Se is detected in biosphere according to data presented in the Table 1 [1,2] :

Table 1

Data for *Se* detected in Biosphere[3,4]

	Se in soil	Se in soil water	Se in plants	Se in humans*
normal	< 2 ppm	< 50 ppb	< 1.0 ppm	1.3 ppb
selenipherous soil	≥ 2 ppm	≥ 50 ppb	≥ 1.0 ppm	–

MATERIALS AND METHODS

Foliar mesophyllum, flowering tissue, seminal tissue and stem cortex from *Cynodon sp. and Astragalus sp.* in flowering and seed formation – which is the status for species recognition –, were collected during June and July from 11 locations (sites) situated at the ground of the Curvature Hills near Merei and Vernesti villages, limitrophe to Buzau town. To reduce the decrease of *Se* and *As* levels by volatilisation – the organic compounds of these 2 elements are relatively unstable at temperatures > 35^0C – plants were dried at 40^0C and their above mentioned organs were separated and constituted as samples for *Se* and *As* analyses.

Samples were prepared according to the method of Rosenfeld and Beath[13]. *Se* and *As*, together with *germanium*, and *tellurium* were separated from the other elements by distillation with HBr and Br_2 from acidic solutions. The distillate was analysed for *Se* and *As* levels using an atomic absorbtion spectrophotometer equiped for such analyses. The method error was between 2 and 5%. Determinations for some biochemical parameters (% carbohydrates, % lipids, % proteins, mg%g chlorophyll) were done using standard methods such as: lipids – by Soxhlet method[14], soluble proteins – by the Biuret method[15], carbohydrates – by the modified Somogy method[16], and total chlorophyll – spectrophotometrically[17].

The analysis of variance (ANOVA) was based on mean arsenic concentrations in plant parts of the two species used in our experiments.

RESULTS AND DISCUSSIONS

Mean levels of *Se* and *As* detected in different plant organs are presented in Table 2.

At sampling, some plants were in the flowering stage (*Astragalus*), while others were in seed formation stage (*Cynodon*). Because we considered

(taken) both species, we presented in Table 2, third column, flower-seed. Roots were not taken into consideration, regarding the possibility of passive absorbtion of the elements in radicular tissue. Se toxicity in plants is given by the chlorophyllous tissue consumed by human and animals.

Table 2

Se and *As* quantities (mg/kg of air dried weight) of plant parts for *Astragalus* and *Cynodon,* respectively

	Leaves	**Flowers Seeds**	**Stems**	**Total Mean***
Astragalus sp.#				
No. of samples	11	8	11	30
As: Mean	1.5	1.1	1.2	1.3*
Range	1.0-1.8	0.8-1.3	0.8-1.4	0.8-1.8
Se: Mean	554	824	665	710*
Range	45-948	65-914	42-2021	42-2021
Cynodon sp.				
No. of samples	11	11	11	33
As: Mean	2.5	3.5	2.1	2.7*
Range	0.8-3.9	2.4-5.3	1.5-4.1	0.8-5.3
Se: Mean	424	587	485	465*
Range	12-689	25-812	55-778	12-812

Same data are presented more clearly as histograms in Figure 1.

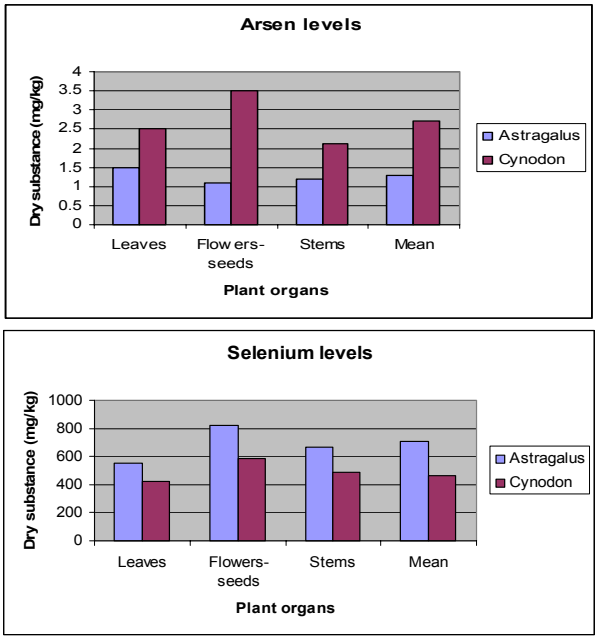

Fig.1. *Se* and *As* mean levels in different plant organs collected from *Astragalus* and *Cynodon*.

Table 3 contains the statistical results of ANOVA test based on mean *As* concentrations in various plant parts. It may be concluded that the variations in *As* concentration between plant parts is slightly significant, just beyond the 10% level. Differences in As concentration between Se-accumulators plant parts at the two species is hightly significant, well beyond the 0.5% level.

Table 3

Analysis of variance table based on mean *As* concentrations in plant parts of *Astragalus* and *Cynodon* species

Variation Source	**df**	**Sum of Squares**	**Mean Squares**	**F Test**	**Significance**
Plant parts	2	1.412	0.7083	6.44	Beyond 10% level
Plant type	1	9.680	9.680	88.0	Beyond 0.5% level
Error	2	0.220	0.110		
Total	5	11.312			

In Table 4 and Figure 2, respectively, mean levels of carbohydrates, lipids, soluble proteins as well as chlorophyll are reported as percentages (g% or mg%) from fresh plant substance.

Table 4

Mean levels of carbohydrates, lipids, soluble proteins and chlorophyll from fresh plant substance

	Leaf	**Flower-seed**	**Stem**	**Total Mean***
Astragalus sp.				
No. of samples	11	8	11	30*
Carbohydrates %	2.4	2.4	3.5	2.8
Lipids %	0.2	0.3	0.3	0.26
Proteins %	1.2	1.3	1.3	1.26
Chlorophyll (mg%)	2.4	–	2.2	2.3
Cynodon sp.				
No. of samples	11	11	11	33*
Carbohydrates %	2.8	2.7	2.6	2.7
Lipids %	0.2	0.4	0.3	0.3
Proteins %	1.7	2.1	1.8	1.53
Chlorophyll (mg %)	2.5	–	2.3	2.4

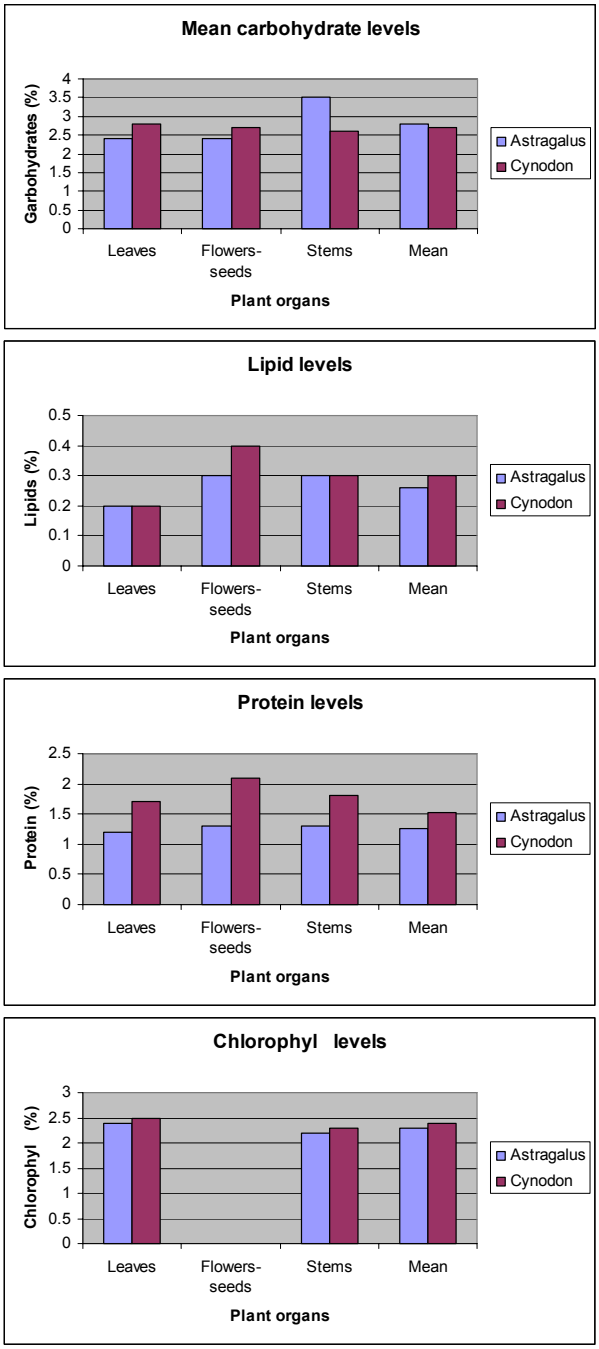

Fig.2. Histograms illustrating the percentages of carbohydrates, lipids, soluble proteins as well as chlorophyll, as expressed from fresh plant substance.

Se accumulating plants from *Astragalus* gender contain *Se* as *methylselenocysteine* and *methylselenomethionine*. It was demonstrated that *selenomethionine* enhances the ethylene production in some plants[18]. This hormone was noticed as being influenceable in every phenophase of plant growth and development[18]. It was also shown that containing *As* substances owe their toxic effects to the ability to inhibit the thiolic metabolism by interacting with thiol (-SH) groups[19].

Our study shows that plants from *Cynodon* gender contain more *As* in their leaves, seeds, stems as compared to that belonging to *Astragalus* gender. It was proposed that *As* might function as an indicator in seed production in such a way that the maximum *Se* level would be reached by plant accumulators in their full flowering stage because the phosphorus contained in nucleic acids may be theoretically substituted by As[20].

It was previously shown that plants which do not accumulate *As* may absorb volatile *Se* from *As* accumulating plants[21]. This hypothesis is sustained by the observation that many of the plants which do not accumulate *Se* are usually late in their flowering process, but in the same time the *Se* accumulating plans are reaching the full flowering stage.

It is well known that the link between an *As* containing substance and a thiol group is a dissociable one[21,22]. This implies that the thiol excess should induce a reverse effect to Se and hence an attenuation of toxic reactions caused by *As*.

This process could play a protective role for high *As* concentrations in *Se* accumulating plants, especially regarding that these accumulators contain in their aerian parts almost three time more sulfur as compared to *Se* nonaccumulating plants[9,12] .

CONCLUSIONS

Except the data on *Se* and *As* levels from *Cynodon* gender, that for *Astragalus* are similar to that reported in the literature. The values are smaller because the level of these elements in the soils tested by us are smaller in comparison with certain soils from USA[9,23].

The high *As* levels detected in *Cynodon* gender confirm data reported in the literature on *Se* nonaccumulating plants such as *Astragalus*. High densities of these two genders in different zones generally certifies the higher *Se* presence in the respective habitats. The relatively high differences between samples confirm the nonuniform spreading, knowing the fact that geochemically the habitat accumulates the material eroded from the adjacent slopes.

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