Rapid monitoring of Ca and K in plants by X-ray fluorescence spectrometry method

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Abstract Literature contains numerous data on the distribution of minerals in soil and plants from spontaneous flora or cultivated in different geographical areas, as well as a series of mineral analysis techniques. The aim of this study was to determine the concentrations in K and Ca of Cirsium arvense, Agropyron repens and Medicago sativa using x-ray fluorescence spectrometry. This study was conducted on a cambic chernozem, in seven location in Dumbravita (Timis County) area. The tested plants accumulated Ca and K differently. The mineral content of whole plants are expressed on a dry matter basis. In Cirsium arvense and Medicago sativa total calcium content is higher than total potassium content but in Agropyron repens the ratio is reversed. The average values of the content of Ca (mg/kg d.w.) has a downward trend: Cirsium arvense > Medicago sativa > Agropyron repens. The trend for K (mg/kg d.w.) is: Medicago sativa > Agropyron repens > Cirsium arvense. Comparing our results, obtained by using x-ray fluorescence spectrometry with literature, the values are similar, so we consider that this method can be used for a rapid monitoring of the mineral contents in forages, but it is necessary to make other researches in future on this theme.

Material and Methods

This study was conducted on a cambic chernozem, in seven location in Dumbravita (Timis County) area. The forages were harvested in October 2014. The collected samples of plants were washed with double distilled water. The samples of whole plants were oven dried at 80°C to constant weight, than they were taken into our study. The forages were harvested in autumn 2014. Analysis by atomic fluorescence X-ray is a modern method of determination of mineral elements, for environmental samples, geological, biological (solid and liquid), without processing [1].

Key words

Cirsium arvense, Medicago sativa, Agropyron repens, elemental analysis

Minerals play major role in the development and maintenance of the skeletal system and perform many other physiologic functions. The health benefits of potassium include relief from stroke, blood pressure, heart and kidney disorders, anxiety and stress, as well as enhanced muscle strength, metabolism, water balance, electrolytic functions, and nervous system [4]. Nearly 99% of the calcium in the body is found in the skeleton, while 80% of the phosphorus is in bones and teeth. The remaining Ca is extracellular and plays a role in nerve conduction, muscle contraction, blood clotting and immune system activation [5]. Potassium (K) is essential for human and animal life. Potassium is involved in many body functions and is required for proper muscle development. Adequate K is also important for good heart function [4].

The literature show that minerals such as magnesium, manganese, copper, zinc, boron, cobalt and selenium were often significantly higher in species such as chicory, narrow-leaved plantain, dandelion, broad-leaved dock (Rumex obtusifolius), Californian thistle (Cirsium arvense) and hairy buttercup (Ranunculus sardous) than the perennial ryegrass (Lolium perenne) and white clover (Trifolium repens) components of the sward [8].

The aim of this study was to determine the concentrations in K and Ca of Cirsium arvense, Agropyron repens and Medicago sativa, by using x-ray fluorescence spectrometry. Seven location in Dumbravita (Timis County) area were taken into our study. The forages were harvested in autumn 2014.

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Literature contains numerous data on the distribution of minerals in soil and plants from spontaneous flora or cultivated in different geographical areas, as well as a series of mineral analysis techniques [2,3,7,10]. There are a lot of studies about the importance of calcium and potassium for humans and animals. Minerals play major role in the development and maintenance of the skeletal system and perform many other physiologic functions. The health benefits of potassium include relief from stroke, blood pressure, heart and kidney disorders, anxiety and stress, as well as enhanced muscle strength, metabolism, water balance, electrolytic functions, and nervous system [1,11]. Nearly 99% of the calcium in the body is found in the skeleton, while 80% of the phosphorus is in bones and teeth. The remaining Ca is extracellular and plays a role in nerve conduction, muscle contraction, blood clotting and immune system activation [5]. Potassium (K) is essential for human and animal life. Potassium is involved in many body functions and is required for proper muscle development. Adequate K is also important for good heart function [4].

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were carried out by applying the measurement window of the device directly on the surface of the polyethylene bags of samples. The levels of Ca and K, expressed as ppm (mg/kg dry weight), were read directly from the screen of the device.

Results and Discussions

The experimental data obtained for Ca and K (mg/kg d.w.) in the tested plants and detected by using atomic fluorescence X-ray are shown in Figures 1, 2 and 3. The results are expressed as mg/kg dry weight.

Fig.1. Ca and K (mg/kg d.w.) in *Cirsium arvense*

Fig.2. Ca and K (mg/kg d.w.) in *Agropyron repens*

Fig.3. Ca and K (mg/kg d.w.) in *Medicago sativa*

Analysing the Figure 4, we see that the tested plants accumulated Ca and K in their tissues differently. In *Cirsium arvense* and *Medicago sativa* total calcium content (mg/kg d.w.) is higher than total potassium.
content (mg/kg d.w.), but in *Agropyron repens* the ratio is reversed. Comparing the average values of the content of Ca (mg/kg d.w.) in the three plants studied, it has a downward trend: *Cirsium arvense* > *Medicago sativa* > *Agropyron repens.*

Regarding the average values of the content of K (mg/kg d.w.) in the studied plants, they are relatively similar, with the downward trend *Medicago sativa* > *Agropyron repens* > *Cirsium arvense.*

![Fig 4. Mean values of Ca and K (mg/kg d.w.) in studied plants](image_url)

In *Cirsium arvense* and *Medicago sativa* total calcium content (mg/kg d.w.) is higher than total potassium content, but in *Agropyron repens* the ratio is reversed. Comparing our results, obtained by using x-ray fluorescence spectrometry with literature, we observed that regarding K, the values are similar, but for Ca, our values are higher.

**Conclusions**

The tested plants accumulated Ca and K differently. In *Cirsium arvense* and *Medicago sativa* total calcium content is higher than total potassium content but in *Agropyron repens* the ratio is reversed. The average values of the content of Ca (mg/kg d.w.) in the studied plants, has a downward trend: *Cirsium arvense* > *Medicago sativa* > *Agropyron repens.*

The trend for the average values of the content of K (mg/kg d.w.) is: *Medicago sativa* > *Agropyron repens* > *Cirsium arvense.* Comparing our results, obtained by using x-ray fluorescence spectrometry with literature, our values are similar, so we consider that this method can be used for a rapid monitoring of the mineral contents in forages, but it is necessary to make other researches in future on this theme.

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