# MINERAL CONTENT OF NATIVE VEGETABLES OBTAINED BY ENERGY DISPERSIVE X-RAY FLUORESCENCE SPECTROMETRY

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***Abstract.*** *In this work the non-destructive methodology based on Energy Dispersive X-ray fluorescence (EDXRF) has been applied for the determination of some major and minor elements (K, Ca, Fe, Mn, Cu, Zn) in different vegetation species: Atriplex hortensis, Rumex patientia, Lactuca sativa, Spinacea oleracea . From data obtained about the mineral content of analyzed samples it could be concluded that all of these plants can be use in supplementary mode as a very high nutritional foodstuffs. The EDXRF measurements were made using the Elvax spectrometer having an X-ray tube with Rh anode and a solid state Si-pin-diode X-ray detector with a 140 μm Be window and 200eV at 5.9 KeV ($Fe^{55}$ line) energy resolution.*

***Keywords:*** *EDXRF, concentrations, foodstuffs.*

## 1. Introduction

X-ray fluorescence (XRF) [1,2 ]is a powerful quantitative and qualitative analytical tool for elemental analysis of materials. It is ideally suited to the measurement of film thickness and composition, determination of elemental concentration by weight of solids and solutions, and identification of specific and trace elements in complex sample matrices. XRF analysis is used extensively in, food, pharmaceuticals, cosmetics, agriculture, plastics, rubbers, textiles, fuels, chemicals, environmental and many industries including semiconductors, telecommunications, microelectronics, metal finishing and refining analysis. The method is fast, accurate, non-destructive, and usually requires only minimal sample preparation. When elements in a sample are exposed to a source of high intensity X-rays, fluorescent X-rays will be emitted from the sample at energy levels unique to those elements. The X-ray intensities emitted by the elements contained in a sample give information about the concentration of elements in sample.

Energy Dispersive X-ray fluorescence (EDXRF) [1, 2] is one of two general types of X-ray Fluorescence techniques used for elemental analysis applications. In EDXRF spectrometers, all of the elements in the sample are excited simultaneously, and an energy dispersive detector in combination with a multi-channel analyzer is used to simultaneously collect the fluorescence radiation emitted from the sample and then separate the different energies of the characteristic radiation from each of the different sample elements.

Studies about the elemental composition of native vegetables are relevant, because the vegetables are nutrients suppliers, acting on a metabolism of several functions in the human organism. So, it is very important to find different vegetables with a great nourishment value and different analytical methods can be use to determine the elemental composition of this vegetables. These papers intend to demonstrate the potential of Energy Dispersive X-ay fluorescence to demonstrate the nutritional value of foodstuffs.

## 2. Experimental

### 2.1. Sample preparation

*Atriplex hortensis, Rumex patientia, Lactuca sativa*, *Spinacea oleracea* leaves were collected on a field plantation in Romania from plants harvested at mature development stage [3].

The samples were washed throughly with deionised water; oven-dried at $60^0$C for 24 hours and powdered.

Two grams of each sample (n=5 for each species) were pressed manually, without any chemical treatment, in a plastic vial with Mylar in the bottom and then analysed

### 2.2. Experimental condition

The elemental content of samples was determined by Energy Dispersive X-Ray Fluorescence (EDXRF) technique, using the Elvax spectrometer having an X-ray tube with Rh anode, operated at 50 kV and 100µA.

Samples were excited for 300 s and the characteristic X-rays were detected by a multichannel spectrometer based on a solid state Si-pin-diode X-ray detector with a 140 µm Be window and an energy resolution of 200 eV at 5.9 KeV. ElvaX software was used to interpret the EDXRF spectra (figure 1).

The accuracy and precision of the results as evaluated by measuring a certified reference sample (NIST SRM 1571- Orchard leaves).

## 3. Results and discussions

Mean concentrations (ppm d.w.) of elements in analyzed samples are presented in table I;

The K concentrations in the samples ranged from 2.9 to 4.75 %; *Atriplex hortensis* and *Rumex patientia* presented higher value; Calcium (Ca) concentration range from 1.2 to 2.15% with the highest value attributed to *Spinacea oleracea;* The highest Fe concentration were 1002.5 and 952.05 ppm from *Lactuca sativa* and *Rumex patientia*; toxic elements. The variation in elemental content of leafy vegetables analysed is presented in figure 2.

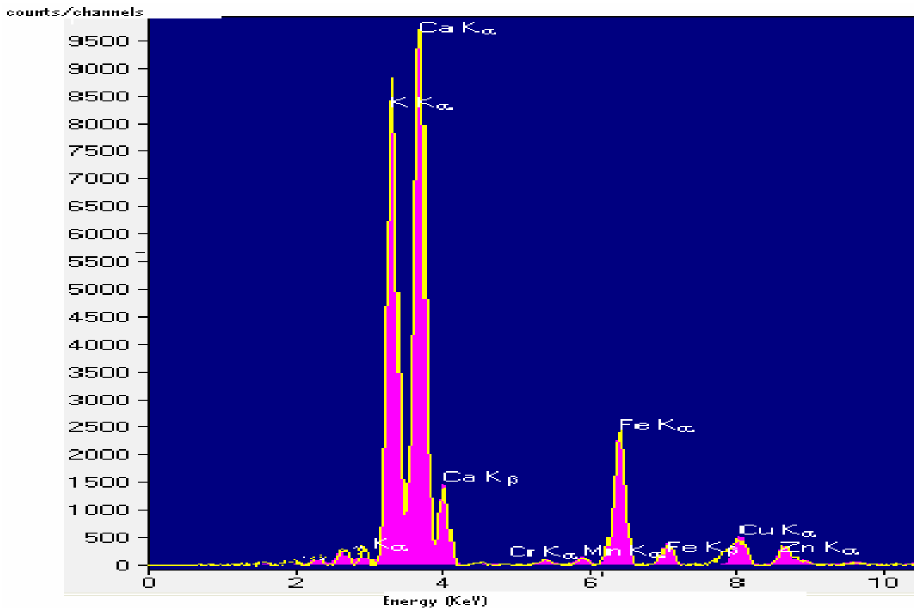


**Fig. 1. Spectra obtained with EDXRF analysis on *Spinacea oleracea***

**Table 1. Mean concentrations (ppm d.w. ± s.d.) of elements in leafy vegetables**

| Samples (n=5) | K % | Ca % | Mn | Fe | Cu | Zn |
|---|---|---|---|---|---|---|
| *Atriplex hortensis* (orache) | 4.75±1.6 | 2.05±0.2 | 81.5±4.6 | 944.2.±12 | 15.2±4.6 | 84.5±6.8 |
| *Rumex patientia* (patience) | 4.55±2.3 | 1.72±0.5 | 72.04±10.2 | 952.05±17.25 | 19.06±7.9 | 80.12±9.6 |
| *Lactuca sativa* (salad) | 2.9±0.6 | 1.2±0.4 | 89.2±5.5 | 1002.5±14 | 25.5±1.7 | 45.5±3.6 |
| *Spinacea oleracea* (spinach) | 4.20±1.2 | 2.15±0.8 | 75±1.2 | 945.5±14.2 | 17.4±4.6 | 82.4±15.2 |

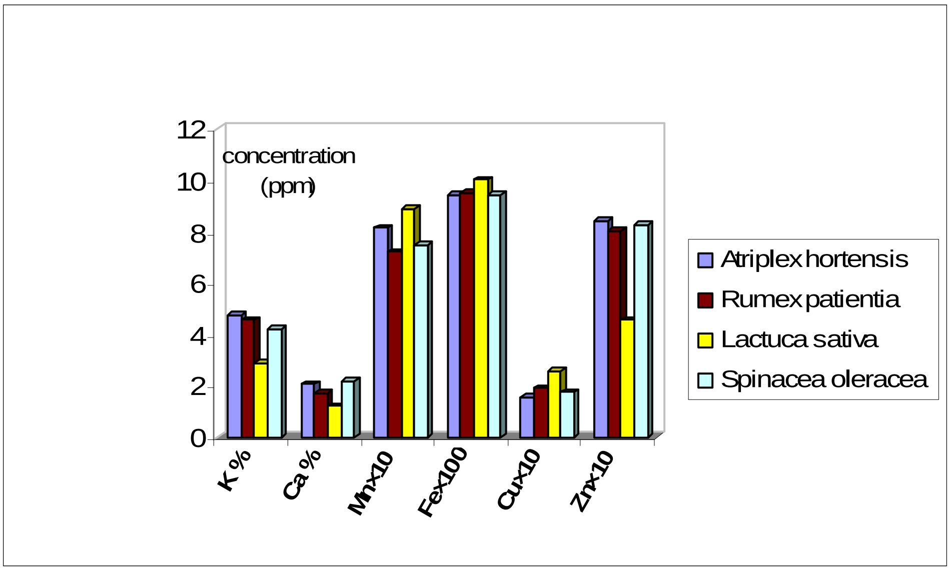


**Fig. 2. The variation in elemental content of leafy vegetables**

## 4. Conclusions

The macro (K and Ca) and micro ( Mn, Fe, Cu, and Zn) elemental content in native leafy vegetables were within ranges of vegetables [4,5] ;

*Atriplex hortensis* and *Rumex patientia* can substitute or supplement *Spinacia oleracea* as a leafy vegetable, due to similar chemical composition and a higher leaf yield;

Energy Dispersive X-ray Fluorescence (EDXRF) technique is a promising analytical technique for simultaneous determination of chemical composition in different vegetation species as an alternative to the classical destructive analytical methods.

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