1st International & 28th National Conference on Nuclear Science & Technology 2022 (ICNST22)
Nuclear Science & Technology Research Institute

Multi element analysis of Ziziphora medicinal plant by instrumental neutron activation analysis

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Abstract

In this work, some elements concentrations of Ziziphora medicinal plant were analyzed by instrumental neutron activation analysis (INAA) technique. The Ziziphora plant samples were collected in Eynali mountain region in north of Tabriz, Iran and irradiated at the 5 MW Tehran Research reactor. The induced activities were counted by a well calibrated γ-spectrometer equipped with a high efficiency coaxial high-purity germanium (HPGe) detector. The concentration of elements was determined with the relative method using multielement standards. The essential nutrients, macro-, micro-, and trace elements (K, Ca, Mg, Na,Cl, V, Ti and Mn) and potentially toxic element (Al) were determined. The concentration levels, their variations with collection locations and the correlations among different elements in these samples are discussed.

Keywords: Instrumental neutron activation analysis, Relative method, Ziziphora medicinal plant, essential nutrients, toxic element

Introduction

The pharmacological properties of the medicinal plants have been attributed to the presence of bioactive and active compounds which are responsible for important physiological function in living organisms. Reports have shown that major and minor elements play an important role in the reactions which will lead to the formation of these active constituents [1]. one of the important medicinal plant product in Iran is “Kakuti” that is used for several disorders. Scientific name of the Kakuti is “Ziziphora”. Ziziphora is the name of one genus of plants in the family Lamiaceae. Ziziphora (Kakuti,) is a plant used in Iran traditional medicine for its antibacterial activity, sedative and stomach soothing properties [2]. Neutron activation analysis (NAA) methods [3,4] are being used in geological studies and in medical application for the determination of concentration of elements and is a sensitive analytical technique for determining the amount of different elements (major, minor, or trace) present in a sample. The technique is attractive since it is with high sensitivity and non-destructive in nature, thus eliminates a significant source of error due to incomplete digestion of the sample and foreign contaminations introduced during sample preparation and dissolution steps by wet chemical methods. The aim of the present research was to determine the element concentration of Ziziphora by instrumental neutron activation analysis (INAA) with relative method. In this work, quantitative determinations of 9 elements Al, K, Ca, Mg, Na,Cl, V, Ti and Mn in Ziziphora samples were done.

Experimental:

Preparation of the materials: In this work, the experimental procedure for determination of element concentration in sample by INAA technique is based on four steps:

Step1: sample collection and preparation: Arial parts of Ziziphora samples (stem, flower and leaf) were collected from Eynali mountain region in north of Tabriz (Iran) during the spring. The plant was dried in the air for one week. After dried, the sample was crushed, ground and milled to pass through a 125 μm sieve and then heated in the oven at 85 ^{0}C for 24 hours. The powder sample was weighted by means of a precision balance (we need about 100 mg of powder) and transferred into pure silica vials.

Figure 1. Ziziphora plant and some instrumental for preparation of samples

Step2:Irradiation: Neutron irradiations of Ziziphora plant and standard sample were done by using of pneumatic transfer system in beam tube B of the 5MW Tehran research reactor. For short lived radioisotopes, 50- 100 mg of sample and standard reference material were weighted and packed in plastics bag and placed in cleaned polyethylene capsules and irradiated for 20 second. The sequence of events occurring during the most common type of nuclear reaction that used for NAA, namely the neutron capture or (n, gamma) reaction. In many cases, this final neutron irradiated products were a radioactive nucleus which also de-excites (or decays) by emission of one or more

characteristic delayed gamma rays. The half-life of the radioactive nucleus was depending upon the particular radioactive species. The certified reference materials IAEA/V-10 Hay (Power), V-9 (cotton cellulose) and IAEA-Soil5 was irradiated in order to evaluate the precision and accuracy of the results.

Step 3: Gamma-ray spectrometry system consists of a semiconductor detector, associated electronics, and a computer-based multi-channel analyzer (MCA/computer).

Figure 2. Gamma-ray spectroscopy systems in NAA laboratory

After irradiation, the Ziziphora and standard sample were repacked into inactive polyethylene. Irradiated samples were counted for 5- 10 minutes with subsequent cooling time ranging from 5 to 120 minutes by a high resolution HPGe with 20 % relative efficiency. Gamma spectrum of the samples was recorded by Gamma Vision software.

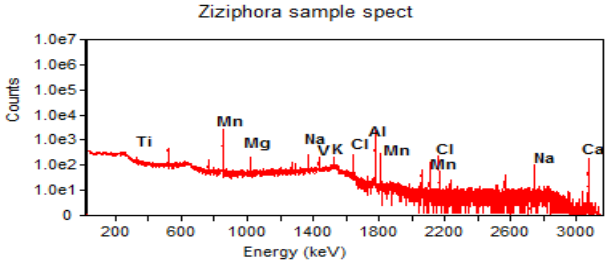

Figure 3. Gamma-ray spectrum of short-lived elements from the activation of Ziziphora sample

Step 4: In this work, identification and determination of concentration of element were performed by Span Software using relative method. Based on the relative method in the NAA technique, by comparison of the net peak area in the two measured spectra (unknown and standard samples) the concentration of the interest elements was calculated [3]:

$$\frac{C_{sam}}{C_{st}} = \frac{W_{st}}{W_{sam}} \times \frac{A(net)_{sam}.e^{\lambda t_d}}{A(net)_{st}} \qquad (1)$$

Where W_{sam} is the weight of unknown irradiated sample and W_{st} is the weight of standard reference material. C_{sam} and C_{st} are concentration of unknown and standard samples, respectively.

Results and discussion

The mean values of the elemental concentrations obtained in Ziziphora medicinal plant by NAA technique are presented in Table 1. Ca, K, Mg and Cl were the most abundant elements present in Ziziphora samples, and were found in % levels. The elements Al, Mn, Na, V and Ti were found in ppm level. Ca, Mg, Na, K and Cl are macronutrient elements which are essential to human health and nutrition. Aluminum is potentially a toxic element that plays a causative role in Alzheimer's disease or causes pathological alterations[5].

Table 1. Elemental contents (µg/g) of Ziziphora medicinal plant determined by INAA

Element	Concentration (ppm)	Uncertainty (%)
Al	250	0.8
Ca	18.8×10^3	2.6
K	14×10^3	7.7
Mg	7.54×10^3	5.1
Mn	69	2.6
Na	0.44×10^3	3.4
V	2.95	6.8
Cl	1.78×10^3	2
Ti	87	16.9

Conclusions

In this study, concentrations of Al, Ca, K, Mg, Mn, Na, V, Cl and Ti elements were determined in powdered Ziziphora plant by INAA method. The Essential and trace element contents in the Ziziphora sample were found at different levels (ppm to %). The results show that Ziziphora plant are rich in some essential element such as Mg, K and Ca which are vital importance for human health. This study show that concentration of the potentially toxi element content of this plant i.e Al element were below the level allowed by World Health Organization (WHO).

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