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Elemental analysis of *Anethum gravedlens*, *Sismbrium Irio* Linn and *Veronia Anthelmintica* seeds by instrumental neutron activation analysis

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HIGHLIGHTS

- Elemental contents of three medicinal seeds have been analyzed using INAA.
- All three seeds contain K as major element with ample contents of Fe and Na.
- This baseline data that can be used in future research for medicinal preparations.

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ABSTRACT

Instrumental neutron activation analysis has been used to characterize As, Ba, Br, Ce, Cl, Co, Cr, Cs, Eu, Fe, Hg, K, Mn, Na, Rb, Sb, Se and Zn, and Sc in seeds of *Anethum graveolens* (Dill), *Sisymbrium irio Linn.* (Wild Mustard) and *Vernonia anthelmintica* (Iron Weed). Dill seed was found to contain high K while Wild Mustard has high Fe, Mn and Na levels. Iron Weed has highest Cl, Co, Cr and Zn content with least concentration of Fe.

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1. Introduction

Herbs have been used in many developing and underdeveloped countries as part of food and to cater for health needs of the common people. Herbs are more accessible, affordable and ubiquitous based on natural substances designed to stimulate and strengthen the body immune system for natural healing responses. Due to global economic recession in the recent past, inflation in the developing nations has affected the purchasing cost of allopathic drugs. This has fostered the resurgence of the use of herbal medicine for the treatment of various ailments together with belief that these herbal products are without any adverse side-effects. Another reason for adoption of herbal therapy was lack of general medical facilities mostly in the rural dwellings where the consumers were compelled to the use of herbal or plant medicines. Moreover, the use of different plant fragments to provide relief from disease, to provide energy and as supplements is a ritual in different folk cultures throughout the world. World Health Organization (WHO) has also recognized the role of traditional medicine and played an important role in authenticating and promulgating the use of herbal medicine being used for past thousands of years (WHO, 1996, 2008). Many medicinal herbs have also played an imperative role in the development of today's contemporary medicines (Shirin et al., 2010). Herbs have compatibility to nourish the body and efficacy to provide vitamins, minerals and many trace elements in bioavailable form that is easy to absorb. Minerals and inorganic trace elements are required by living beings for numerous biological and physiological processes that are necessary for the maintenance of good health (Prasad, 1993; Marler and Wallin, 2006; Soetan et al., 2010). Severe impacts of increasing industrialization and environmental pollution have been observed on the soil, water and all types of vegetations therefore some of the resultant herbal products contain contaminants in addition to the natural ingredients. It is therefore important that apart from the essential nutrients it has become prerequisite to monitor the level of toxic elements present in the medicinal plants. The concentrations of these trace elements varies in different parts of the plants, especially in roots, seeds, fruits and leaves that are consumed as

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food, as therapeutic, as nutritive and as well as in medicinal preparations (Kirmani et al., 2011). The relative availability of trace elements from each part of plant needs to be investigated and documented for their safe and adequate intake. Moreover this will also help in standardization of the traditional medicines.

The aim of this study was to investigate the essential and toxic trace element contents in frequently used herbs with therapeutic properties. In the present study three types of herbal plants whose seeds are commonly used in our region as household and medicinal antidote were selected. Non destructive and sensitive technique of Instrumental neutron activation analysis (INAA) was employed to characterize trace elements in *Anethum graveolens, Sisymbrium irio Linn. and Vernonia anthelmintica*.

2. Experimental

2.1. Sampling and sample preparation

Three types of herbal seeds namely *A. graveolens*, *S. Irio* Linn., and *V. Anthelmintica* with respective local names of Soya, Khubkalan and Kali Zeeri were purchased from the local markets of Islamabad. Botanical classification and nomenclature of these herbs are presented in Table 1. The herbal seeds were washed with distilled de-ionized water and air dried at room temperature in a clean fume hood. Moisture contents were determined after oven drying samples at 60 °C for 72 h. The dried samples were ground to fine powder. Fe, Cr, Mn, Mo and Ni contamination was minimized by grinding samples using Teflon coated blades. All three processed herbal seed samples were stored in clearly marked clean polyethylene bottles with tightly sealed screw caps. The within bottle homogeneity was assessed for all three seed samples and portions of the dried and homogenized samples weighing about 250 mg each, taken in triplicate, were sealed in precleaned polyethylene capsules along with suitable reference materials. The reproducibility of the concentrations of Mn, and K were determined by INAA. No significant difference was observed for within bottle variance and the variation was found to be less than 5% for these two elements indicating the material homogeneity.

2.2. Standard preparation

Synthetic standards of appropriate concentrations for all the elements under investigation were prepared from the stock solutions of the respective elements under investigation containing 1 mg cm^{-3} ultra pure spectrographically standardized substances (from Johnson, Matthey & Co., Limited, London). The solutions were diluted accordingly to give a wide range of standards for each element and dried on ash less filter papers. These dried standards were sealed in polyethylene and silica capsules along with blank filter papers and irradiated to determine the contributions of any element and necessary corrections were made.

2.3. Target irradiation

Herb samples, each weighing about 250 mg, in triplicate were taken in pre-cleaned polyethylene vials for short irradiations and in silica vials for longer irradiation times. Herbal seed samples, synthetic comparison standards along with suitable matrix-based reference materials IAEA-V-10 (Hay powder) and NBS/NIST-1572 (Citrus leaves) were irradiated at a thermal neutron flux of 5×10^{13} cm^{-2} s^{-1} in a 10 MW swimming pool type Pakistan Atomic Research Reactor (PARR-1). Matrix reference materials were used in the study for quality assurance and validation of the adopted analytical methodology. All targets were irradiated for 2–30 min in pneumatic tube facility and in the reactor core for longer irradiations of 5 h. After appropriate cooling, the irradiated samples and standards were transferred to pre-weighed polyethylene capsules and re-weighed to determine the exact weight. Table 2 presents the optimized irradiation and radio-assay scheme adopted for this study.

2.4. Gamma-ray spectrometry

Gamma spectrometric system comprising of 4k series 85 Canberra multichannel analyzer (MCA) coupled with ORTEC coaxial Ge(Li) detector was used for all measurements with resolution of 2.1 keV for 1332.5 keV peak of ^{60}Co and peak to Compton ratio of 40:1. For the calibration of the system two radionuclide sources, Eu-152 and Co-60 were used covering energy range from 121.8 keV to 1332.51 keV. The data from MCA was transferred to central computer facility and calculations were performed employing validated in-house computer programs. Care was taken to apply background subtraction for each irradiation during the calculations and to obtain the overall uncertainty in the results. Overall combined uncertainty was measured taking into account uncertainties in peak area, background, weighing, balance calibration, detector calibration, and

Table 2
Optimum experimental conditions and nuclear data* employed.

Isotopes	Half life	γ-Peak used (keV)	Irradiation time	Cooling time	Counting time
^{38}Cl	37.2 m	1642.4, 2167.5	2 m	30 m	5 m
^{56}Mn	2.58 h	846.8	2 m	1 h	30 m
^{42}K	12.36 h	1524.7	30 m	24 h	1 h
^{24}Na	15.0 h	1368.6	30 m	24 h	1 h
^{76}As	26.32 h	559.1	30 m	2 d	2 h
^{82}Br	35.3 h	776.5	30 m	2 d	2 h
^{122}Sb	2.70 d	564.1	30 m	2 d	2 h
^{141}Ce	4.2 d	145.5	5 h	2–3 w	16 h
^{131}Ba	11.8 d	496.3	5 h	2–3 w	16 h
^{86}Rb	18.66 d	1076.6	5 h	2–3 w	16 h
^{51}Cr	27.69 d	320.1	5 h	2–3 w	16 h
^{59}Fe	44.63 d	1099.2, 1291.6	5 h	2–3 w	16 h
^{203}Hg	46.6 d	279.2	5 h	2–3 w	16 h
^{46}Sc	83.82 d	889.3	5 h	2–3 w	16 h
^{75}Se	119.8 d	264.7	5 h	2–3 w	16 h
^{65}Zn	244 d	1115.5	5 h	2–3 w	16 h
^{134}Cs	2.062 y	795.8	5 h	2–3 w	16 h
^{60}Co	5.27 y	1173.2, 1332.5	5 h	2–3 w	16 h
^{152}Eu	12.7 y	344.3	5 h	2–3 w	16 h

Where m=minutes, h=hours, d=days, w=weeks and y=years.

* Corte, F. D., Simonits, A., Wispelaere, A. D., Hoste, J., Moens, L., Demeter, A., A complilation of K_0, Au-factors and related nuclear data for 112 radionuclides of interest in NAA, INW/KFKI interim report June (1986).

Table 1
Botanical classification and nomenclature of the medicinal herbs analyzed.

Local Name	English name	Botanical name	Family	Parts used
Soya	Dill	*Anethum Graveolens*	Apiaceae	Seed
Khub Kalan	Hedge Mustard, London Rocket.	*Sisymbrium Irio* Linn	Cruciferae	Seed
Kali zeeri	Iron Weed, Purple Fleebane	*Vernonia Anthelmintica*	Asteraceae	Seed

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