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Analysis of Essential Trace Elements by EDXRF in Selected Medicinal Plants Used in Kenya

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Abstract:
Kenya is endowed with nature where hundreds of medicinal plants are available. During photosynthesis in plants, and respiration in animals and other organisms, metal elements play a major role with a few of the elements being essential to the body as nutrients. Trace elements for example Zn, Cr, V and Se with known immunological response and healing properties were analysed in selected medicinal plants available in Kenya. These plants were; Prunus africana, Urtica massaica (stinging neetle), Maytenus obscura, Maytenus putterlickiodes, Azadiracta indica (Neem), Mondia whytei, Zanthoxylum usambarense, Maerua edulis, Trigonella foenum-graecum (fenugreek) and Glycyrrhiza glabra(licorice). The concentrations of elements were determined using Energy Dispersive X-ray Fluorescence Spectrometer (EDXRF). The levels of zinc varied from 25.94±1.89 to 70.58±4.70 mg/kg (mean 45.94± 12.42 mg/kg). Vanadium from 1.69±0.18 to 9.99±0.86 mg/kg with an average level of 5.89± 2.09 mg/kg. Chromium from 1.44±0.30 to 6.94±0.59 mg/kg with a mean of 3.49±1.32 mg/kg. Selenium (53.21±5.45 to 124.01±4.41 µg/kg, mean of 90 ±19.17 µg/kg). The levels of the trace elements were compared with recommended dietary intake (RDI) and were found to provide these essential elements as part of therapeutic utility. The levels in different plant parts were found to vary significantly (P<0.05) in some plants and not significantly (P>0.05) in others for a given species. The plants can provide can provide the elements as per required daily intake(RDI).

Keywords: *Trace elements, EDXRF, Medicinal plants*

1. Introduction

The world population is experiencing an upsurge of diseases whose cure is becoming elusive. Among this disease are HIV/AIDS, tuberculosis, cardiovascular and a myriad of cancers. As a response to these challenges great effort is being expended in the study of herbal medication as a possible source of cure. Today, there is widespread interest in herbal drugs. This interest primarily stems from the believe that herbal medicines are safe, inexpensive and have no adverse effects (Kumar *et al.*, 2012).

World health organization estimates that 80% of the world population currently uses medicinal plants for some aspect of their primary healthcare (Obianjuwa *et al*., 2004). Trace elements such as selenium, chromium, zinc and vanadium play a major role in improving body immunity (Al Durtsch,1999 & American Cancer Society, 2004). Available and reliable sources of these minerals are plant sources. Medicinal plants contain essential trace elements in amounts that are helpful to the body.

Selenium is effective in cancer prevention, an antioxidant, slows aging process and stimulate the formation of antibodies in response to vaccines. (American Cancer Society, 2004 & Mahyar et al. ,2010)). Zinc is essential to human body growth and development of normal brain function (Rink &Gabriel, 2000). Zinc deficiency may affect bone metabolism and gonadal function (Nishi, 1996). Chromium is found in the body in tiny amounts and has the function of glucose metabolism. (Al Durtsch,1999). Vanadium helps promote healthy glucose levels in people with lack of insulin sensitivity (Cohen et al. ,1995).

Many conventional drugs and their precursors are derived from plants but there is a fundamental difference between administering a pure chemical and the same in a plant matrix. "There exist advantages of chemical complexity in herbal medicines that form a synergy with the human body" (Ron *et a*l., 2000). Generally herbal formulations involve use of fresh or dried plant parts. Comprehensive knowledge of such crude drugs is a very important aspect in preparation, safety and efficacy of the herbal product. Trace elements with known immunological and curative properties are part of this chemical complexity. .

Though many metal complexes are used in medicine for example zinc antiseptic creams, magnesium drugs for treatment of ulcers and metal clusters as anti-HIV and cancer drugs (Kupka and Fawai,2002; Mocchegiani and Muzzioli,2000), there are side effects when they are excessively administered and without due care.

The objective of this study was to analyze the levels of trace elements in medicinal plants for their quality control (Arceusz *et al*.,2010) and bring awareness for their use in provision healthcare.

2. Materials and Methods

2.1. Sampling

Trigonella foenum-graecum, Glycyrrhiza glabra, Mondia whytei were sourced from Nairobi Central Business District. *Prunus Africana, Zanthoxylum usambarense, Maytenus obscura, Azadiracta indica(*neem*)* and *Urtica massaica* were sourced from Thogoto forest in Kiambu county and Ngong forest in Nairobi. *Maerua edulis* and *Maytenus putterlickiodes* from Embu and Machakos counties. The samples were collected from mature plants. The leaves for analysis were evenly mixed between young and old ones to provide a reliable average. All the samples were collected in
clear plastic paper bags, washed with distilled water, chopped or cut into small pieces and dried in an oven (at 80^{o}c) before being ground and packaged awaiting further sample preparation and analysis.

2.2. Sample Preparation

Plant samples were ground using an electric blender (Glen Crescent company, England) repeatedly until the sample was relatively fine. The sample was then passed through sieves of different sizes to obtain a sample of particles sizes of approximately less than 50 µm. For each sample, fine pellets 2.5cm in diameter weighing 200 mg/cm^2 were prepared for EDXRF analysis. This was done by adding approximately 0.5g of sample in a steel die and applying 10-15 tones of pressure. The weights of sample pellets were determined. For each sample, three pellets were prepared for analysis.

2.3. Instrumentation and Sample Analysis

The prepared pellet was irradiated with Cd-109 radioisotope source for 5000 seconds and 100 seconds for corrections for absorption with a molybdenum target. The personal computer was used for spectral data storage and quantitative analysis using AXIL and QAES software (Van and Markowicz 2002). The resolution of the Si (Li) detector used was 190 eV for manganese (Mn) Kα line at 5.9 Kev. For each pellet, the intensity measurements were taken on sample alone and sample with multi-element target accordingly for correction of absorption matrix effects. Corrections were applied using Emission Transmission Technique. Subsequently, elemental concentration values were calculated using the intensity equation developed for intermediate samples based on fundamental parameters (IAEA, 2005).

3. Results and Discussions

The levels of trace elements in all the samples are presented in table 1.

Sample	Part(s) used	Zinc mean±SD	Vanadium mean±SD	Chromium mean±SD	Selenium mean±SD**
Urtica massaica	Leaves	70.58±4.70^a	5.31±1.36^a	3.61±0.29^a	86.75±7.94^a
	Roots	65.61±4.13^a	4.26±0.48^a	3.36±0.34^a	124.01±4.41^b
Maytenus obscura	Leaves	59.97±4.68^a	7.83±0.59^a	2.47±0.22^a	115.55±7.72^a
	Bark	43.47±3.90^a	5.05±0.23^b	2.16±0.21^a	104.57±2.78^a
Maytenus Putterlikiodis	Leaves	43.59±2.12^a	5.38±0.53^a	4.00±0.29^a	99.56±5.03^a
	Roots	40.48±1.52^a	5.29±0.44^a	4.39±0.41^a	83.86±2.05^b
Azadirachta indica	Leaves	45.18±5.10^a	6.74±0.49^a	5.09±0.46^a	97.05±5.55^a
	Bark	37.51±3.90^a	3.81±0.29^{bc}	2.72±0.19^{bc}	90.66±4.86^a
	Fruits	33.27±2.18^{ab}	5.19±0.42^{de}	3.17±0.29^{ca}	78.88±4.41^{ab}
Prunus Africana	Leaves	57.47±3.14^a	7.60±0.42^a	4.16±0.17^a	74.78±1.91^a
	Bark	43.16±2.61^b	5.48±0.52^b	3.73±0.36^a	72.47±2.66^a
Zanthoxylum usambarensis	Leaves	37.82±4.98^a	3.96±0.30^a	1.90±0.13^a	86.09±4.45^a
	Roots	46.03±4.8^a	1.69±0.18^{bc}	2.90±0.22^{bc}	122.33±11.20^b
	Bark	29.46±2.07^{ba}	3.48±0.29^{da}	1.44±0.12^{de}	79.72±5.27^{ca}
Mondia whytei	Roots	55.91±4.78	6.63±0.55	3.03±0.28	53.21±5.45
Maerua edulis	Leaves	57.33±3.03^a	5.67±0.48^a	4.10±0.20^a	94.76±3.57^a
	Roots	42.54±1.54^b	9.00±0.44^{bc}	5.13±0.22^{bc}	111.43±2.04^{bc}
	Fruits	25.94±1.89^c	6.65±0.45^{da}	2.66±0.19^{de}	103.16±6.60^{cd}
Glycyrrhiza glabra.	Roots	54.22±4.75	9.99±0.86	3.85±0.31	83.27±7.10
Trigonella f.-g.	Seeds	29.27±2.82	9.19±0.65	6.94±0.59	66.19±4.37

Table 1; Trace element levels (mg/kg),
***Concentration units in µg/kg*
Concentration values with similar superscript for a given species are not significantly different (P> 0.05, α = 0.05) Those with different superscripts are significantly different (P< 0.05, α = 0.05).

Zinc levels varied from 25.94mg/kg to 70.58mg/kg. *Urtica massaica* leaves had the highest levels at 70.58±4.70 mg/kg with no significance difference between the levels in leaves and roots (P> 0.05, α = 0.05). *trigonella faenum-graecum* seeds had the lowest levels. Zinc is the component of more than 270 enzymes and its deficiency in the organism is accompanied by multisystem dysfunction (Zinpro, 2000). It is responsible for sperm manufacture, fetus development and proper function of the immune response (Serfor *et al*., 2002). The RDI levels of zinc are 2.5-9.4 mg/kg (Giridhar *et al*., 2013).

Chromium levels varied from 1.44mg/kg to 6.94mg/kg. *Trigonella Foenum-graecum* seeds had the highest levels at 6.94±0.59 mg/kg while *zanthoxylum usambarensis bark* had the lowest 1.44±0.30 mg/kg. Chromium is important in the utilization of glucose. The presence of Cr in plants may be correlated with therapeutic properties against diabetic and cardiovascular diseases (Perry, 1972). It has been shown to increase humoral and cell mediated immunity (Khangarot 2002). The RDI levels of chromium are 50-200 µg/kg (Kumplainen *et al*., 1979)

Selenium levels varied from 53.21µg/kg to 124.01µg/kg. The highest levels were found in *urtica massaica* roots at124.01±4.41µg/kg with its leaves having a level of 86.75±7.94 µg/kg. These levels were significantly different ($P< 0.05$, $\alpha = 0.05$). The lowest levels were found in *Mondia whytei* roots at 53.21±5.45µg/kg. Selenium improves sperm mortality and hence human reproduction (Hawkes and Turek, 2001), is essential co-factor of antioxidant enzyme such as glutathione peroxidase (Zhang *et al*., 1999), and its deficiency has been associated with cardiovascular diseases, diabetes, arthritis (Stranges *et al*., 2006; Coppinger and Diamond, 2001). It has also been shown to have protective role against cancers (Bjelakovic *et al*., 2004; Yu *et al.,* 1997) and to improve immune function (Broome *et al*., 2004). RDI levels for selenium are 20-55 µg/kg (Giridhar, 2013)

Vanadium levels varied from 1.69 mg/kg to 9.99 mg/kg. The highest levels were found in *glycyrrhiza glabra* roots at 9.99±0.86 mg/kg and the lowest in *Zanthoxylum usambarensis* roots at 1.69±0.18 mg/kg where the levels were found to be significantly different ($P< 0.05$, $\alpha = 0.05$) between the leaves, roots and bark. Vanadium is used for treating diabetes, high cholesterol, heart disease, tuberculosis, syphilis, a form of anaemia, water retention (oedema) and for improving athletic performance in weight training; and for preventing cancer (Cusi *et al*., 2001;Guo *et al*., 2010 and Samantha, 2008). The RDI requirement for vanadium is 10 µg/kg (NAS, 1998).

4. Conclusion

The herbal plants analysed were found to contain the trace elements Zn. V, Cr and Se which may play part in the therapeutic properties. The herbal plants can therefore be a source for trace elements needed for improving immune system and therapy for many medical conditions. The levels vary between species and within different parts of a given species. These trace elements are significantly high and can readily provide the recommended daily intake value (RDI) The information obtained in this study is useful in standardization of herbal preparations and also in ensuring safety and purity.

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