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# Elemental evaluation of some herbal plants used in Ghana using INAA

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## ABSTRACT

*Instrumental Neutron Activation Analysis was employed to quantitatively study some elemental contents of some medicinal plants used for the treatment of various ailments in Ghana. The accuracy and precision of the method were guaranteed by analyzing certified reference materials under the same conditions as the samples. Various elements of biological importance for human metabolism were found to be present in varying concentrations. Potentially toxic element when exceeding RDI, Al, was also detected in the medicinal plants considered in this study. The concentrations of the various elements in the medicinal plants have been discussed in detail.*

**Keywords:** INAA, Medicinal Plants, Elemental Analysis, Ghana.

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## INTRODUCTION

Worldwide, medicinal plants have been used since time immemorial. [1] They have served as cheaper alternative to orthodox drugs. A great number of research conducted on these medicinal plants often focus on the organic actions of these medicines with little attention going to the elemental contents. [2] Due to their potential impact on human health, the pharmacological properties of these medicines must be studied. The pharmacological properties have been attributed to active chemical contents. Though trace elements have been reported to play an important role in the formation of these active chemical constituents, a direct correlation between elemental composition of the medicinal plants and their remedial properties has not yet been established. [3, 4] However, lack of knowledge of the elemental constituents of these medicinal plants often pose danger to consumers as some may contain toxic elements. Also the dose rates of many of these medicinal plants are not well defined and left to the judgment of the users. This

can sometimes cause problems to users as the probability of taking overdose to speed up healing is highly elevated, ignorant of the dangers in doing so. [5] Thus, screening of the elemental composition of these medicinal plants is highly essential. [6].

Considering the importance of trace elements in various metabolic activities in the human body and also the increasing industrialization and environmental pollution, this present study, elemental analysis of some medicinal plants used in Ghana was carried out using Instrumental Neutron Activation Analysis to study trace elements in some selected medicinal plants and relate the levels of the trace elements to its traditional uses for some time now, several techniques such as AAS, XRF, ICP – MS, PIXE etc have been used for the analysis of trace elements. In this work Instrumental Neutron Activation Analysis (INAA) has been used due to its multielemental characteristics.

## MATERIALS AND METHODS

The plant samples were obtained from local herb shops in Accra, Ghana. The scientific names and traditional uses of the studied medicinal plants are presented in table 1. Samples that were not in powder form were milled into fine powder and homogenized. Aliquots (between 250mg and 300 mg) of the homogenized samples were weighed onto clean polyethylene films wrapped and heat sealed. 3 replicates of each sample and standard reference material Orchard Leaves were prepared. The reference material was analyzed to validate the technique of analysis. The prepared samples were packed into irradiation capsules and heat sealed and sent through the pneumatic Rabbit System, operating at a pressure of 0.6 MPa within the inner channel of a 30 kW Miniature Neutron Source Reactor (MNSR) for 1 hr at a neutron flux of $5x10^{11}$ neutrons/$cm^2$/s. The irradiated samples were left to decay for 24 hours in order to minimize exposure risk and also to eliminate all interferences from short-lived radionuclide medium-lived elements. For short lived element, samples were irradiated for 2 minutes. Each sample was counted for 10 min on a liquid nitrogen cooled High Purity Germanium detector connected to gamma spectroscopy accumulation software, ORTEC MAESTRO – 32.

## RESULTS AND DISCUSSION

Standard reference material SRM 1572 (Citrus Leaves) was also analyzed for method substantiation and quality control purposes. The results obtained for analysis of standard reference material is presented in table 2. From results obtained, it is observed that most of the elemental concentrations are within ±10% of certified values.

Table 3 presents the elemental concentrations in the samples considered in this study. Elements of interest detected are: Al, Br, Ca, Cl, K, Mg, Mn, Na, Si and V. As and Hg were all not present in all the samples examined. The difference in the medicinal plants is mostly ascribed to the differences in the preferential absorption of the plants and also the mineral composition of the soil in which the plants are grown. Other factors that relate to the variations in concentration may include use of fertilizers, irrigation water and the climatic conditions. [8]

**Table 1 Medicinal plant samples selected for the study**

| Common Name | Scientific Name | Traditional Uses |
|---|---|---|
| Astralagus | Astralagus Membranaceus | Cold and Influenza, Fever, Multiple Allegies, Asthma, Anemia, Stomach Ulcers, Hepatitis |
| Cat's Claw | Uncaria Tometosa | Arthritis , Cancer, Promote Kidney Health, Multiple Sclerosis |
| Calendula | Calendula Officinalus | Burns, Cuts and Bruises, Dermatitis, Ear Infection ( Otitis Media) |
| Echinacea | Echinacea Pallida | Common Cold |
| Lady's Bedstraw | Galium Verum | Cancer, Epilepsy, Hysteria, Spasms, Tumors, Loss of appetite |
| Stevia | Stevia Rebaudiana | Diabetes and Strengthens Pancreas |

Examining Table 3, it was found that *Calendula Officinalus* contained the highest concentrations of the elements considered in this study except Br and Ca. The concentration of Al in the medicinal plants ranged from 18.28 - 504.2 ppm which is within previously reported concentration of as high as 5000 ppm in some plant tea [9, 10]. In this study, Bromine is not considered an essential element. It was present in 3 of the samples analyzed. Its highest concentration was 13.95 ppm in *Stevia Rebaudiana*. The Ca content in the various medicinal plants varies from 0.21 % in *Stevia Rebaudiana* to 2.02 % in *Galium Verum*. Ca is known to be an essential element for healthy teeth, bones and blood [11, 12]. Na, K and Cl act as electrolytes in the human body. Na is the principal cation in the extracellular fluids and modulates the maintenance of the intracellular and interstitial volumes. Sodium was present at major levels with its highest concentration found in *Echinacea Pallida* at 216.5 ppm. The least concentration was 36.30 ppm in *Stevia Rebaudiana*. Cl acts as an anion of the extracellular fluid occurring in plasma, lymph, connective tissue, cartilage and bone [13]. Concentrations of Cl ranged from 43 – 6031 ppm. Potassium concentrations varied between 0.08 % and 1.83%. It is the major intercellular cation. The regulation of K is closely involved with that of Na. A comparison of the concentrations in the plants of Cl, K and Na is shown in Figures 1 - 3.

Mg concentrations ranged from 0.1 % to 0. 54%. Mn is also an important element to the human body. Its activities include several enzymic processes and it's also known to help in eliminating tiredness and nervous irritability. [14] A high concentration of Mn was seen in *stevia Rebaudiana* at a concentration of 263.6 ppm. However it was below detection limit in *Echinacea Pallida* and *Uncaria Tometosa*. Vanadium is a transitional element and also the 22$^{nd}$ most frequent element in the outer earth crust. [15] Apart from physiological importance, experimental data have pointed out the pharmacological implication of this element, especially in the prevention and treatment of diabetes mellitus. Vanadium is noted to mimic actions of insulin and produce strong decreases in blood glucose levels in animal models of both types of diabetes [16]. Vanadium was detected in *Astralagus Membranaceus*, *Calendula Officinalus*, *Echinacea Pallida*, *Galium Verum* and *Stevia Rebaudiana* at concentrations of 0.35, 3.45, 1.61, 0.26 and 0.15 respectively units are ppm.

Another essential element that was detected in 3 of the medicinal plants was silicon. Si is a non metallic element. [17] Laboratory experiments on infant rats demonstrate that silicon is essential for normal skeletal growth. [18] This work detected the highest concentration of silicon in *Calendula Offinalus* with a concentration of 15.74 ppm . The lowest concentration was 1.54 ppm which was in *Stevia Rebaudiana*.

**Table 2. Concentrations of Elements in SRM 1572**

| Element | Units | This Work | Reported |
|---|---|---|---|
| **Al** | **µg/g** | 90 ± 5.9 | 92 ± 15 |
| **Mn** | **µg/g** | 24 ± 1.21 | 23 ± 2 |
| **Na** | **µg/g** | 159 ± 22.1 | 160 ± 20 |
| **Mg** | **%** | 0.55 ± 0.04 | 0.58 ± 0.03 |
| **Ca** | **%** | 3.23 ± 0.21 | 3.15 ± 0.10 |
| **K** | **%** | 1.79 ± 0.12 | 1.82 ± 0.06 |

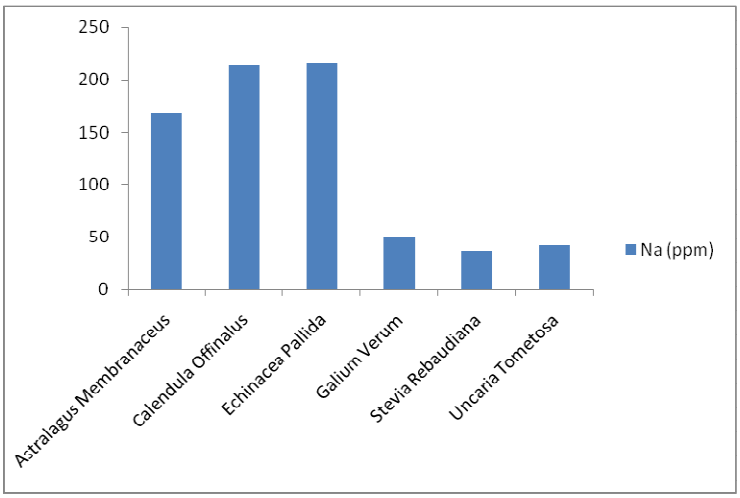


**Fig. 1 Concentration of Na in Samples**

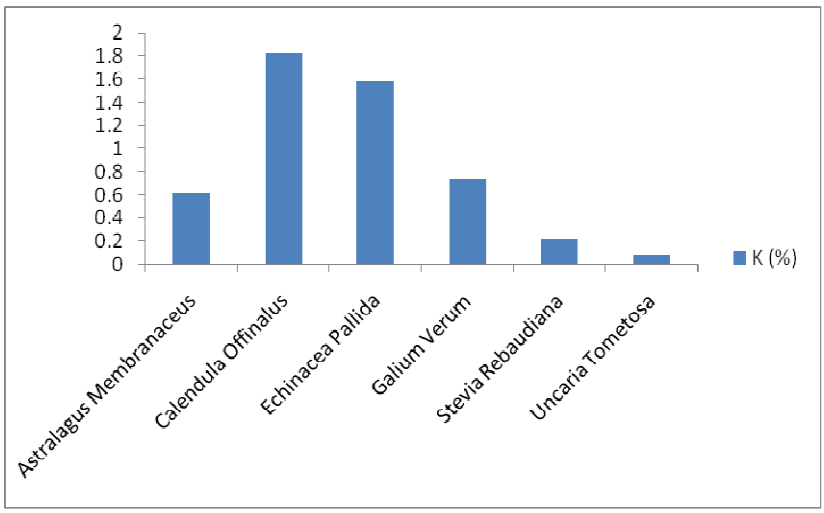


**Fig. 2 Concentration of K in Samples**

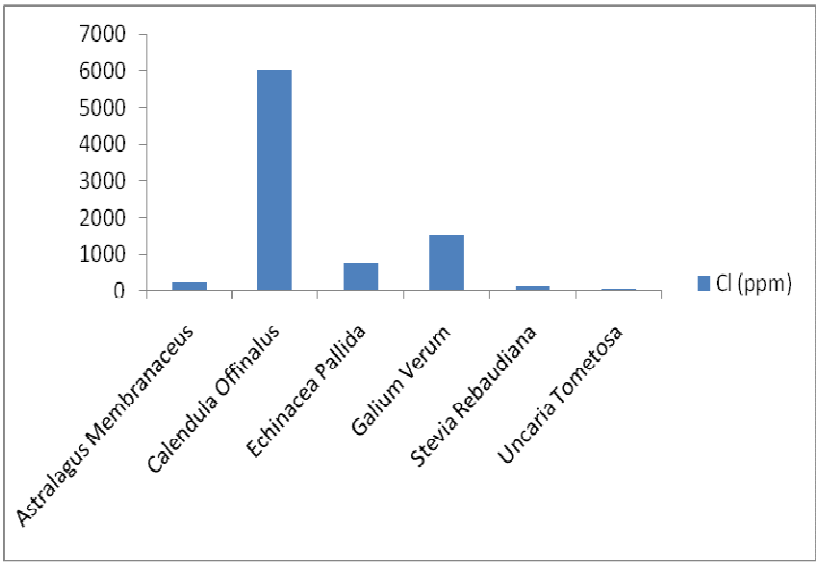


**Fig. 3 Concentration of Cl in samples**

**Table 3 Elemental Concentrations of the medicinal plants considered**

| Element/ Concentration | *Astralagus Membranaceus* | *Calendula Officinalus* | *Echinacea Pallida* | *Galium Verum* | *Stevia Rebaudiana* | *Uncaria Tometosa* |
|---|---|---|---|---|---|---|
| **Al** | 64.99 ± 0.68 | 504.2 ± 2.83 | 109.2 ± 8.40 | 96.09 ± 7.50 | 23.08 ± 0.37 | 18.28 ± 0.32 |
| **Br** | BDL | 4.73 ± 0.45 | BDL | 2.37 ± 0.20 | 13.95 ± 0.86 | BDL |
| **Ca (%)** | 0.38 ± 0.02 | 1.02 ± 0.06 | 0.49 ± 0.03 | 2.02 ± 0.04 | 0.21 ± 0.01 | 0.42 ± 0.02 |
| **Cl** | 225.0 ± 16.54 | 6031 ± 58.08 | 715.6 ± 21.69 | 1498 ± 31.0 | 135.5 ± 9.37 | 43.87 ± 6.05 |
| **K (%)** | 0.61 ± 0.06 | 1.83 ± 0.03 | 1.59 ± 0.02 | 0.74 ± 0.01 | 0.22 ± 0.01 | 0.08 ± 0.005 |
| **Mg (%)** | 0.26 ± 0.02 | 0.54 ± 0.05 | 0.21 ± 0.02 | 0.38 ± 0.03 | 0.10 ± 0.01 | 0.10 ± 0.01 |
| **Mn** | 63.97 ± 5.81 | 20.83 ± 1.69 | BDL | 103.9 ± 3.69 | 263.6 ± 5.11 | BDL |
| **Na** | 168.4 ± 2.08 | 214.9 ± 7.26 | 216.5 ±2.22 | 49.68 ± 1.37 | 36.30 ±1.21 | 42.06 ± 1.0 |
| **Si** | 2.15 ± 0.16 | 15.74 ± 1.33 | BDL | BDL | 1.54 ± 0.20 | BDL |
| **V** | 0.34 ± 0.03 | 3.45 ± 0.25 | 1.61 ± 0.11 | 0.26 ± 0.02 | 0.17 ± 0.01 | BDL |

*[*]BDL : Below detection limit*

*[*]Concentrations are in ppm unless otherwise stated*

## CONCLUSION

While there appears to be diminutive knowledge of precise molecular and elemental mechanisms; medicinal plants have demonstrated significant success in treatment of multifaceted ailments. Trace elements a present in medicinal plants and their influence on the overall pharmacological action cannot be overlooked. Even though a direct link between elemental contents and curative properties of medicinal plants has not been established, it has become necessary to understanding the pharmacological action of medicinal plants. The information obtained in this study will be helpful in the blend of these plants which can be used for the control of various ailments. Nonetheless to better understand the curative properties of these medicinal plants, it will be appropriate to study the effects of soil, climatic and environmental conditions on the elements constituents of these medicinal plants. This work has further demonstrated that Instrumental Neutron Activation Analysis is a useful technique in the multi

elemental analysis over a wide range of concentration since its free of matrix interference hence reduced possibility of contamination due to extensive sample preparation and pre treatment.

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