Evaluation of some minerals and trace elements in Achyranthes aspera Linn.

Aparna Saraf* and Aruna Samant

Department of Botany, The Institute of Science, Mumbai 400032

* Corresponding author: Aparna Saraf; e-mail: draparnasaraf@yahoo.co.in

Received: 20 April 2013 Accepted: 06 May 2013 Online: 09 May 2013

ABSTRACT
Mineral elements have very important functions as they serve as structural components of tissues and also functions in cellular and basal metabolism. The plant Achyranthes aspera Linn. is known for various medicinal properties and used widely for the treatment of different diseases in human. Elemental profile of Achyranthes aspera Linn. (Ten elements to be analyzed - Cu, Na, Ca, Cr, Mn, Fe, Ni, Cd, Zn and Pb) was determined so as to develop a stronger basis for appreciating the curative effects of the plant. Elements were analyzed from root, stem and leaves by ICPES techniques. Various elements of Biological importance for human metabolism were found to be present in varying concentrations. The results were discussed with reference to established role of elements in physiology and pathology of human life. Data obtained would serve as a tool for deciding dosage of Ayurvedic drug prepared from this plant.

Keywords: Achyranthes aspera Linn. Elemental composition, ICPES

INTRODUCTION
Traditional medicine which includes herbal drug therapies has maintained its popularity in all regions of the developing world and its use is rapidly spreading in industrialized countries. Over one-third of the population in developing countries lack access to essential medicines. The provision of safe and effective herbal drug therapies could become a critical tool to increase access to health care [1]. Mixtures of medicinal plants are prescribed by the traditional healers for diseases ranging from common colds to malaria, arthritis, ulcers, etc. [2]. Mineral elements have very important functions and it is believed to be key component of proteins such as haemoprotein and haemoglobin which play role in biochemical functions and essential enzyme system even in low doses.

Bhasma has its unique place in Ayurvedic Therapeutics. Bhasmas are basically made from metals and minerals (Dhatus and Khanij Dravya). The process of Bhasmikaran is used to transform Dhatus and khanij into Bhasmas. Bhasma- an integral part of Ayurveda describes about using metals and minerals for chronic disorders in various combinations, dosages forms & at various levels of purities [3]. Throughout the world, there is increasing interest in the importance of dietary minerals in the prevention of several diseases.

Fortification refers to the addition of mineral nutrients to a commonly eaten food. Both iron fortification of wheat flour and iodine fortification of salt are examples of fortification strategies that have produced excellent results [4]. Minerals are of critical importance in the diet, even though they comprise only 4–6% of the human body.

However, lack of knowledge of the elemental constituents of these medicinal plants often poses danger to consumers as some may contain toxic elements. Also the dose rate of many of these medicinal plants is not well defined and left to the judgement of the users. This can sometimes cause problems to user 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].

Each element has its individual impact in the structural and functional integrity of the living cells and organisms. The present study is undertaken to detect
and determine concentration level of 10 different mineral elements in *Achyranthes aspera* Linn. *A. aspera* is an indigenous medicinal plant of Asia, South America and Africa, it is found throughout India belonging to the family Amaranthaceae. The plant is known for various medicinal properties and used widely for the treatment of different diseases in human. In the recent time, *A. aspera* reported to have array of medicinal compounds and medicinal properties. The plant is astringent, digestive, diuretic, laxative, purgative and stomachic. The juice of the plant is used in the treatment of boil, diarrhoea, dysentery, haemorrhoids, rheumatic pains, itches and skin eruptions. The ash from the burnt plant, often mixed with mustard oil and a pinch of salt, and is used as a tooth powder for cleaning teeth. It is believed to relieve pyorrhoea and tooth ache. The leaf is emetic and a decoction is used in the treatment of diarrhoea and dysentery. A paste of the leaves is applied in the treatment of rabies, nervous disorders, hysteria, insect and snake bite [7]. *A. aspera* reported to possess wound healing activity, immune stimulatory properties, larvicidal activity, antibacterial activity and antifungal activity. Roots of *A. aspera* reported to possess antioxidant activity and anti-inflammatory properties. [8-14]. But no work has been reported on elemental profile of *Achyranthes aspera* Linn. With this background the present work is undertaken.

MATERIALS AND METHODS

Sample collection

Whole plant parts of *Achyranthus aspera* Linn. were collected in the month of August- September from Vasai region of Thane district. The plants were identified at Blatter’s herbarium, St. Xavier’s College, Mumbai. The accession number for *Achyranthes aspera* L. is 62490.

Sample preparation

The plant parts were sorted out and surface contaminants of plant samples were removed by washing with deionised water. It was then dried and then subjected to grinding for powder formation. The powder was stored in air tight glass containers and used for further analysis.

Digestion

Two gram powder of each plant part was dissolved in nitric acid and heated until the reddish brown fumes disappear. Perchloric acid was then added to the above solution and heated for 5 min. This was followed by addition of aqua regia and heated. The volume was then made up to 25ml in a standard flask by adding deionized water.

Estimation of elements was carried out using Inductively Coupled Plasma - Atomic Emission Spectrometer (Model: ARCOS from M/s. Spectro, Germany) [15].

RESULTS AND DISCUSSION

Literature survey revealed that optimal intakes of elements such as sodium, potassium, magnesium, calcium, manganese, copper, zinc and iodine could reduce individual risk factors, including those related to cardiovascular disease for both human beings and animals [16-18].

The various plant parts of *Achyranthes aspera* L. are a good source of trace and major elements. Since these trace elements constitute a minute fraction in different parts of medicinal plants, a sensitive and reliable technique is a prerequisite for obtaining precise and accurate data. In the present investigation we have applied one of the sensitive ICPES analytical techniques.

Copper:

The lowest content of Cu is 0.395 ppm which was seen in stem of *A. aspera* L. and maximum concentration was detected as1.423 ppm in roots of *A. aspera* L. (Table 1 and Figures 1 & 2). In leaves the Cu concentration was found to be 0.437 ppm. The permissible limit set by FAO/WHO for copper in edible plants was 3.00 ppm [19]. However, for medicinal plants the WHO limits not yet been established for Cu. Permissible limits for Cu set by China and Singapore for medicinal plants, were 20 ppm and 150 ppm, respectively [20].

Copper (Cu) is an essential redox-active transition element that play vital role in various metabolic processes. Being toxic, its quantity in plants should be very low. It is essential to the human body since it forms a component in many enzyme systems, such as cytochrome oxidase, lysyl oxidase and an iron-oxidizing enzyme in blood. The observation of anaemia in copper deficiency is probably related to its role in facilitating iron absorption and in the incorporation of iron in haemoglobin. However, copper deficiency in humans is a rare occurrence. Copper could be toxic depending on the dose and duration of exposure [21]. Our results indicate that concentration of Cu was well below permissible limit.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Cu  ppm</th>
<th>Zn  ppm</th>
<th>Mn  ppm</th>
<th>Fe  ppm</th>
<th>Cr  ppm</th>
<th>Na  ppm</th>
<th>Ni  ppm</th>
<th>Pb  ppm</th>
<th>Cd  ppm</th>
<th>Ca  ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Root</td>
<td>1.423</td>
<td>3.523</td>
<td>3.607</td>
<td>194.658</td>
<td>0.526</td>
<td>16.208</td>
<td>0.318</td>
<td>0.342</td>
<td>0.013</td>
<td>949.435</td>
</tr>
<tr>
<td>Stem</td>
<td>0.395</td>
<td>1.34</td>
<td>3.331</td>
<td>33.549</td>
<td>0.373</td>
<td>50.096</td>
<td>0.229</td>
<td>0.033</td>
<td>0.017</td>
<td>588.196</td>
</tr>
<tr>
<td>Leaf</td>
<td>0.437</td>
<td>0.99</td>
<td>1.435</td>
<td>37.494</td>
<td>0.178</td>
<td>157.286</td>
<td>0.107</td>
<td>0.08</td>
<td>0.011</td>
<td>&gt;1363.77</td>
</tr>
</tbody>
</table>

http://ijps.aizonepublishers.net/content/2013/3/ijps229-233.pdf
Figure 1. Concentration of Cu, Zn, Mn, Cr, Ni, Pb in Root, Stem and leaf of Achyranthes aspera Linn.

Sodium:
Concentration of Sodium element was observed to be much higher in leaves 157.286 ppm than the concentration in roots 16.208 ppm and stem 50.096 ppm of Achyranthes aspera Linn.

Sodium is essential to all living organisms. Sodium remains one of the major electrolytes in the blood. Without sodium the body cannot be hydrated, it would dry off. At the point when some vital processes are taking place sodium is not needed, too much of sodium will cause the cell to break down [22]. Na and K are of great importance for many regulation systems in the body. The minimum daily intake of Na and K are 2.4 g and 3.5 g [23].

Calcium:
Calcium is an important trace element because of its role in bones, teeth, muscular system and heart functions [24]. It is required for absorption of dietary Vit. B, for synthesis of neurotransmitter acetylcholine and is also required for activation of enzyme pancreatic lipase [25]. Calcium is necessary for the coagulation of blood, the proper functioning of the heart and nervous system and the normal contraction of muscles. Its most important function is to aid in the formation of bones and teeth.

It is observed that amongst all the elements studied in the analysed sample, calcium accumulation is the highest in all parts of Achyranthes aspera Linn. than the concentration of other metals. Soil could be a factor for accumulation of higher amount of Ca. Similar to Sodium it is found that calcium accumulation is more in leaves than in roots. It is more than 1363.77 ppm in leaves and 849.435 ppm in roots and 588.196 ppm in the stem of Achyranthes aspera Linn.

Ca is the main component of bones and teeth. This element functions on cell membranes and on muscles, by regulating endo-exoenzymes and blood pressure [26].

Chromium:
Chromium is known to regulate carbohydrate, nucleic acid and lipoprotein metabolism and it also potentiates insulin action [27]. Chronic exposure to Cr may result in liver, kidney and lung damage [28]. Chromium also acts as an activator of several enzymes. Deficiency of chromium decreases the efficiency of insulin and increases sugar and cholesterol in the blood. Chromium deficiency can cause an insulin resistance, impair in glucose tolerance and may be a risk factor in atherosclerotic disease.

The chromium concentration in all the parts studied of Achyranthes aspera Linn. was below the permissible limit for chromium as set by FAO/WHO in edible plants which is 2 ppm [19]. Our results indicate that the concentration in roots is 0.526 ppm, in stem it is 0.373 ppm and in leaves it is 0.178 ppm.

Manganese:
The activity of this element is noticed in the metabolism of food which is incorporated into the bone. Manganese is essential element required for various biochemical processes [29]. The kidney and liver are the main storage places for the manganese in the body. Mn is essential for the normal bone structure, reproduction and normal functioning of the central nervous system. Its deficiency causes reproductive failure in both male and female [30]. Apart from physiological importance experimental data have pointed out the pharmacological implication of this element especially in prevention and treatment of diabetes mellitus [31].

High concentration of manganese is found in the root and stem of Achyranthes aspera Linn. Our results indicate that the concentration of Mn in roots is 3.607 ppm, in stem 3.331 ppm, whereas in leaves it is found to be 1.435 ppm. The permissible limit set by FAO/WHO (1984) for Mn was 2 ppm in edible plants [19]. However, the permissible WHO (2005) limits for Mn in medicinal plants have not yet been set [20].

Figure 2. Concentration of Fe, Na and Ca in Root, Stem and leaf of Achyranthes aspera Linn.

Iron:
Iron is important for the formation of haemoglobin and also plays an important role in oxygen and electron transfer in human body. Studies suggest that the intake of Iron in higher concentration is hazardous to health.

In all parts of the sample of Achyranthes aspera Linn. studied, the amount of iron accumulated is much higher than the permissible levels. In roots it is found to be
The present study does not indicate a clear trend. The extent of contamination of Pb depends on the traffic densities and environmental pollution [39-40].

Nickel:
The amount of nickel concentration in all the parts studied of *Achyranthes aspera* Linn. analyzed was below the permissible level. In roots 0.318 ppm, in stem 0.229 ppm, in leaves 0.107 ppm. The permissible limit for nickel set by WHO in edible plants was 1.63 ppm and the permissible limits for medicinal plants have yet not been set.

Nickel is considered to be highly mobile element within a plant. Accumulation of Ni takes place only in the leaves [32]. Ni toxicity in human is not very common occurrence as its absorption by the body is very low [33] but our results show that Nickel has also accumulated in stem and roots.

Cadmium:
The amount of cadmium concentration in the roots of the samples of *Achyranthes aspera* Linn. analyzed is found to be within the permissible limits. In roots 0.013 ppm, in stem 0.017 ppm, and in leaves 0.011 ppm. The permissible level (WHO) for cadmium in edible plants was 0.21 ppm and for medicinal plants is 0.3 ppm [34].

This may be due to low level of cadmium present in the available soil for plant growth. Cadmium is toxic metal having functions neither in human body nor plants [35]. Accumulation of Cd in kidney leads to high blood pressure and renal diseases. Its accumulation also leads in damaging the nerve cells, inhibition of release of acetylcholine and activation of choline esterase enzyme, resulting in a tendency for hyperactivity of the nervous system [36].

Lead:
Lead has no biochemical or physiological importance and is considered as toxic pollutant. It causes a rise in blood pressure, kidney damage, miscarriages and subtle abortion, brain damage, decline fertility of men through sperm damage, diminishing abilities of children and disruption of nervous systems [37].

With reference to WHO (1992), the permissible limit for lead set in edible plants was 0.43 ppm [38]. However, for medicinal plants the limit was 10 ppm set by China, Malaysia, Thailand and WHO [34].

The amount of lead concentration in all the samples analyzed was in minimal amount and well below the permissible level. Our results show that the lead concentration in roots it was 0.342 ppm, in stems 0.033 ppm, in leaves 0.08 ppm. Exposure to increased concentrations of lead is a health hazard. The level of Pb obtained in the present study does not indicate a potential health hazard to users. Reports have shown that leafy plant samples contained higher levels of Pb than the fruit and root sample. However, present study does not indicate this trend. The extent of contamination of Pb depends on the traffic densities and environmental pollution [39-40].

Zinc:
In case of Zinc the highest concentration was found in roots of *Achyranthes aspera* Linn, which was 3.523 ppm where as in stem it was found to be 1.34 ppm and leaves 0.99ppm.

Zinc is essential to all organisms and has an important role in metabolism, growth, development and general well being. It is an essential co-factor for a large number of enzymes in the body. Zinc deficiency leads to coronary heart diseases and various metabolic disorders. Zinc Fortification programmes are being studied, especially for populations that consume predominately plant foods. Fortification of cereal staple foods is potentially attractive interventions which could benefit the whole population as well as target the vulnerable population groups, namely children and pregnant women. Such addition of zinc to the diet would decrease the prevalence of stunting in many developing countries with low-zinc diets, because linear growth is affected by zinc supply in the body [41].

**CONCLUSION**

In view of above facts, the medicinal plant, *Achyranthes aspera* L. studied in this work is a source of biologically important elements, and they may play a part in the observed therapeutic use of this plant. Hence, it could serve as supplement of macro and micro elements in the body. Ayurvedic formulations do demonstrate significant success in treatment of many diseases. The medicinal plants contain trace elements whose activity has an impact on its overall pharmacological action. The variation in elemental concentration is mainly attributed to the differences in botanical structure, as well as in the mineral composition of the soil in which the plants are cultivated. Other factors responsible for a variation in elemental content are preferential absorbability of the plant, use of fertilizers, irrigation and climatological conditions. There is no direct link established between elemental content and curative capability of the plant. But such studies will help us to understand the pharmacological action of the herb and thus provide the vital link between the two. The mode of application of these medicinal plants as a source of mineral supplements in the body has been traced to insufficient data on the mineral accumulation in such plant. The need to screen medicinal plants used in traditional medicine for their elemental composition is highly desirable.

The elucidation of element specification of *Achyranthes aspera* L. done in the present work will be helpful in the designing of new Ayurvedic drugs which can be used for the control and cure of various diseases. However, in order to develop a stronger basis for appreciating the curative effects of medicinal plant, *Achyranthes aspera* L. There is a need to study the effect of soil and climatic
conditions on the elemental contents of this medicinal plant. Medicinal plant *Achyranthes aspera* L. is rich in metals Fe, Cu, Ca and Na and it is expected that plants with high contents of the above-mentioned macro and micronutrients might play an important role in maintenance of human health.

Also, all of the detected values for elements in plant studied here are below the WHO permissible levels for medicinal plants and may not constitute a health hazard for consumers.

REFERENCES

3. Vahalia M.K., et al., Chronic Toxicity Study For Tamra Bhasma (A Generic Ayurvedic Mineral Formulation) in Laboratory Animals, Recent Research in Science and Technology; 2011, 3(11):76-79

22. Gbolahan, D., Lesson note on medical importance of trace elements. Centre for natural health studies. 2001