



Contents lists available at ScienceDirect

Asian Pacific Journal of Tropical Biomedicine

journal homepage: www.elsevier.com/locate/apjtb



Document heading

doi:

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Elemental analysis of some ethnomedicinally important hydrophytes and marsh plants of India used in traditional medicine

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ARTICLE INFO

Article history:

Received 1 October 2012

Received in revised form 5 October 2012

Accepted 7 December 2012

Available online 28 December 2012

Keywords:

Elemental analysis

Ethno-medicinal

Hydrophytes

Atomic Absorption Spectrophotometer

ABSTRACT

Objective: To study the elemental content of some ethnomedicinally important hydrophytes and marsh plant of Tripura, India. **Methods:** With the help of standardized questionnaires, 10 informants were interviewed on the medicinal use of hydrophytes and marsh plants of Tripura, India during 2009–2010. The elemental content of those plants were determined using Atomic Absorption Spectrophotometer. **Results:** A total of 8 plant species belonging to 8 different genera and 8 family were reported with their ethnomedicinal uses. Among the different plant part used leaves and young tender shoots are most frequently used for the treatment of different disease. The hydrophytes and marsh plants are mostly used for the treatment of dysentery and other hepatic disorder. Different elemental constituents at trace levels of plants play an effective role in the medicines prepared. Elemental composition of eight ethno-medicinally important hydrophytes and marsh plants of Tripura, India have been determined using Atomic Absorption Spectrophotometer (AAS). A total of 11 elements K^+ , Mg^{+2} , Ca^{+2} , Na^+ , Fe^{+2} , Mn^{+2} , Cu^{+3} , Mn^{+2} , Cu^{+3} , Cr^{+3} , Zn^{+2} , Pb^{+4} and Cd^{+2} have been measured. Their concentrations were found to vary in different samples. Toxic elements Cd and Pb were also found but at very low concentration. Medicinal properties of these plant samples and their elemental distribution have been correlated. These results can be used to set new standards for prescribing the dosage of the herbal drugs prepared from these plant materials in herbal remedies and in pharmaceutical companies. **Conclusions:** The data obtained in the present work will be useful in synthesis of new herbal drugs with various combinations of plants, which can be used in the treatment of different diseases at global level.

1. Introduction

Medicinal plants and herbs are of great importance to the health of individual and communities [1]. Although the efficacy of medicinal plants for curative purposes is often accounted for in terms of their organic constituents like essential oils, vitamins, glycosides, etc. [2]. Now, it has been established fact that over dose or prolonged ingestion of medicinal plants leads to the chronic accumulation of different elements which causes various health problems [3]. In this context, elemental content of the medicinal plants are very important and need to be screened for their quality control [4–7]. Relatively high levels of essential elements, such as Fe, Mn, Zn, and Ca, have been demonstrated to influence the retention of toxic elements in human

beings [8,9]. Only scanty reports are available on the role of micronutrients, [10,11] which play an important role in the formation of active constituents responsible for their curative properties [12]. Direct correlation between elemental content of medicinal plants and their curative ability is not yet understood in terms of modern pharmacological concepts. So, the quantitative estimation of various trace element concentrations is important for determining the effectiveness of the medicinal plants in treating various diseases and also to understand their pharmacological action [13]. The imbalance in human health has been linked with the excess or deficiency of trace elements in soils, water, plants and animals.

Hydrophytes grow profusely in lakes and waterways all over the world and have in recent decades their negative effects magnified by man's intensive use of natural water bodies. Eradication of this water plants are has proved almost impossible and even reasonable control is difficult. The potential of aquatic plants as food and feed has been emphasized by several authors [14,15]. Large growths of hydrophytes in lakes and waterways of tropical countries, although a menace, represent a natural resource of green

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Foundation Project: Supported by Tripura University, India (Grant No: TU/REG/ph/D/02/2007 dated 23rd July, 2008).

leaves [16]. With increasing interest in finding new drugs, the wild or unutilized plants receive more attention which offers a good scope to meet the increasing demand for novel drug discovery.

The present study was carried out in *Tripura*, India. Several ethno–botanical studies [17–21] in the state have documented various healing plants with folk recipes. However literature related to the ethno–medicinal importance of hydrophytes and marsh plants are scarce. Rapid industrialization and urbanization in the state are threat to the local medicinal aquatic flora in the context of heavy metal pollution. Therefore, it is important to have a look on good quality control of medicinal herbs in order to consumers from contamination. The primary aim of this study is to establish the trace (Zn, Cu, Cr, Cd, Pb, Mn and Fe) and major (K, Na, Ca and Mg) elemental levels in 8 ethnomedicinally important aquatic herbs of *Tripura*, India. Secondly, whether, the use of these plants is safe for consumers according to the World Health Standards.

2. Materials and methods

2.1. Study area

Tripura is India's third smallest hilly state in the North–eastern part of the country (Figure 1). *Tripura* state lies between 22° 56' to 24° 32'N latitude and between 90° 09' to 92° 20'E longitudes covering an area of 10,491 sq.km. In *Tripura*, 19 different tribal communities are found to dwell, viz. *Tripura*, *Mog*, *Riang*, *Shantal*, *koki*, *Noatia*, *Lusai*, *Halam*, *Jamatia*, *Chakma* and others. The climate of *Tripura* is characterized by intermediate temperature and highly humid atmosphere. During summer (April–May), maximum temperature reaches 38 °C. Humidity remains high throughout the year. In summer relative humidity ranges 50–75% while during monsoon it remains over 85%. There are many lakes and ponds in the state, which favours the occurrence of a rich hydrophytic flora in this state.

2.2. Sample preparation

Certain ethno–medicinally important hydrophyte and marsh plant species [8 species viz., *Alternanthera philoxeroides* (Martius) Grisebach, *Bacopa monnerii* (L.) Pennell, *Centella asiatica* (L.) Urban, *Enhydra fluctuans* Loureiro, *Hygrophila auriculata* (Schumacher) Heine, *Ipomoea aquatica* Forster; *Ludwigia adscendens* (L.) Hara and *Neptunia prostrata* (Lamarck) Baillon] used by different local tribal community of state *Tripura* collected from local market (Figure 2) . The sample collected were air dried at room temperature (25°C ± 1) and ground into fine powder in a mortar and pestle to avoid chromium contamination from stainless steel utensils. The powder was placed temporarily in air tight polythene pouches until further analysis. The identity of plant materials was confirmed with assistance from local practitioners and botanists.

2.3. Chemical analysis.

The minerals [calcium (Ca), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), lead (Pb), magnesium (Mg), manganese (Mn), potassium (K), sodium (Na), and zinc (Zn)] contents of the powdered samples was determined. The minerals and heavy metal content of the powdered samples were determined through AAS Perkin Elmer 3110 at Sophisticated Analytical Instrumental Facility Centre, North Eastern Hill University, Shillong following standard method [22]. Briefly, a known amount of the sample was digested with a mixture of concentrated nitric acid, sulphuric acid, and perchloric acid (10:0.5:2, v/v), and the analysis was conducted using the All the glassware was cleaned by soaking overnight in a 10% nitric acid solution and then rinsing three times with deionised water. The Total Carbon and Hydrogen content was determined using CHNO Perkin Elmer 2400 Series II Analyzer.

3. Results

3.1. Enumeration of ethnomedicinally important hydrophytes and marsh plants

The present study focused mainly on the plant species used by differ rent tribal and non– tribal's community of *Tripura* for primary healthcare needs as reported by the informants/ traditional healers. The reported plants were arranged according to their scientific name, voucher specimen number, family, vernacular names (as recorded during the field work), parts used, therapeutic uses and method of usage of herbal preparations.

Alternanthera philoxeroides (Martius) Grisebach, Bhowmik & Datta 421; Amaranthaceae; Jol Daroga; Young tender shoots. The decoction of the young shoot is taken in empty stomach twice a day to treat dysentery.

Bacopa monnerii (L.) Pennell, Bhowmik & Datta 363; Scrophulariaceae; Brahmi. Leaves; The decoction of the leaves is mixed with honey and taken orally to enhance memory power and to strengthen nervous s system.

Centella asiatica (L.) Urban, Bhowmik & Datta 483; Apiaceae; Thankuni; Leaves; The paste of the leaves are taken with rice to treat dysentery. Leaf juice is taken orally to treat gastritis and as liver stimulant.

Enhydra fluctuans Loureiro. Bhowmik & Datta 473; Asteraceae; Helencha; Young twigs; The juice of the young twigs are taken orally to treat blood dysentery.

Hygrophila auriculata (Schumacher) Heine, Bhowmik & Datta 413; Acanthaceae; Kule khara; Leaves; The decoction of the young leaves are taken orally for two consecutive weeks in empty stomach to treat anaemia.

Ipomoea aquatica Forster, Bhowmik & Datta 417; Convolvulaceae; Kalmi; Young twigs; Special type of curry is pre pared with young twigs and taken with rice during blood dysentery and also treat indigestion.

Ludwigia adscendens (L.) Hara. Bhowmik & Datta 495 ; Onagraceae ; Gaura sag; Whole plant; Leaf decoction with black pepper is taken orally for stomach pain and for the treatment of intestinal worms.

Neptunia prostrata (Lamarck) Baillon, Bhowmik & Datta 482; Mimosaceae; Khorai Sag; Leaves, Young tender shoots; Half glass of leaf decoction is taken orally about a fortnight to treat dysuria (burning sensation during urine pass) ; The decoction of the young twigs are taken with common salt to treat white discharge.

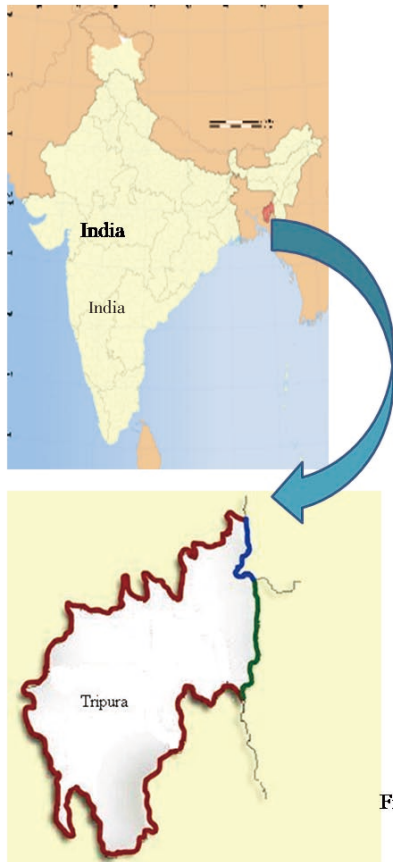


Figure 1

Tripura

Figure 1. Showing geographical position of Tripura.

3.2. Elemental content of ethnomedicinally important hydrophytes and marsh plants

The elemental content of the ethno-medicinally important hydrophytes and marsh plant species was presented in (Table 1).The mineral contents in these 8 vegetables showed that calcium was the most abundant secondary macro element present, ranging from 34.6 ppm (*Neptunia prostrata*) to 10.5 ppm (*Ipomea aquatica*) High concentrations of Ca

are important because of its role in bones, teeth, muscles system and heart functions [23].This is followed by K, which was present in amount ranging from 8.77 ppm (*Ipomea aquatica*) to 3.36 ppm (*Hygrophila auriculata*). K is important in for its diuretic nature and Na plays an important role in the transport of metabolites. The ration of K/Na in any food is an important factor in prevention of hypertension arteriosclerosis, with K depresses and Na enhances blood pressure. The ration of K/Na is significant in *Neptunia prostrata* (27), *Centella asiatica* (6.8), *Ipomea aquatica* (5.51), and compared with leafy vegetables (Cabbage 17.5, beet 3.9). The Mg content of the studied plant taxa varied from 2.14 ppm (*Bacopa monnerii*) to 3.77 ppm (*Alternanthera philoxeroides*). In humans, Mg is required in the plasma and extracellular fluid, where it helps in maintaining osmotic equilibrium. It is required in many enzyme –catalysed reactions, especially those in which nucleotide participate where the reactive species is the magnesium salt, e.g., MgATP²⁻.Lack of Mg is associated with abnormal irritability of muscle and convulsions and excess Mg with depression of the central nervous system.



Figure 2. Selling different ethnomedicinally important hydrophytes by local tribal community.

A: *Bacopa monnerii*; B: *centella asiatica*; C: *enhydra fluctuans* and *Ipomea aquatica*; D: *Hygrophila auriculata*; E: *Ludwigia adscendens*; F: *Neptunia prostrata*

The lowest concentration of Cu that is 0.015 ppm (*Centella asiatica*) and maximum concentration was estimated at 0.151 ppm (*Enhydra fluctuans*). The permissible limit set by FAO/WHO (1984) in edible plants was 3.00 ppm. After comparison, metal limit in the studied medicinal plants with those proposed by FAO/WHO [24] it is found that all plants accumulate Cu below this limit. The range of Fe in the studied plant varies from 0.505 ppm to 6.427 ppm. The permissible limit set by FAO/WHO [24] in edible plants was 20

Table 1.

Concentration of mineral contents (ppm) of some ethnomedicinally important hydrophytes and marsh plants used in Traditional medicine.

| SL No | Scientific Name | Cu | Fe | Cr | Pb | Mn | Cd | Ca | Mg | Na | K | Zn |
|-------|--|-------|-------|-------|------|-------|-------|------|------|------|------|------|
| 1. | <i>Alternanthera philoxeroides</i> (Martius) Grisebach | 0.030 | 1.682 | ND | 0.05 | 0.692 | 0.030 | 21.1 | 3.77 | 1.62 | 7.23 | 3.63 |
| 2. | <i>Bacopa monnerii</i> (L.) Pennell | 0.032 | 1.427 | 0.005 | 0.07 | 0.622 | 0.034 | 29.2 | 2.14 | 2.54 | 6.39 | 2.24 |
| 3. | <i>Centella asiatica</i> (L.) Urban | 0.015 | 5.470 | 0.007 | 0.06 | 1.245 | 0.021 | 34.3 | 2.85 | 1.11 | 7.55 | 4.13 |
| 4. | <i>Enhydra fluctuans</i> Lour. | 0.151 | 2.595 | 0.001 | 0.38 | 2.510 | 0.026 | 13.2 | 2.44 | 2.57 | 6.47 | 5.8 |
| 5. | <i>Hygrophila auriculata</i> (Schumacher) Heine | 0.020 | 5.281 | 0.002 | 0.10 | 0.253 | 0.030 | 33.9 | 3.31 | 0.83 | 3.36 | 1.56 |
| 6. | <i>Ipomoea aquatica</i> Forster | 0.016 | 6.427 | ND | 0.16 | 1.053 | 0.016 | 10.5 | 2.69 | 1.59 | 8.77 | 1.63 |
| 7. | <i>Ludwigia adscendens</i> (L.) Hara. | 0.019 | 2.633 | 0.001 | 0.11 | 3.618 | 0.017 | 22.4 | 2.28 | 2.12 | 5.82 | 2.39 |
| 8. | <i>Neptunia prostrata</i> (Lamarck) | 0.016 | 0.505 | ND | 0.07 | 1.912 | 0.028 | 34.6 | 2.17 | 0.2 | 5.4 | 4.87 |

ppm. Fe is necessary for the formation of haemoglobin and also plays an important role in oxygen and electron transfer in human body [25] and normal functioning of the central nervous system and in the oxidation of carbohydrates, proteins and fats [26]. The observation of anaemia in Fe deficiency may probably be related to its role in facilitating iron absorption and in the incorporation of iron into haemoglobin [24]

The range of Cr varies from 0.001 ppm in *Enhydra fluctuans* and *Ludwigia adscendens* to 0.007 ppm in *Centella asiatica*. Chronic exposure to Cr may result in liver, kidney and lung damage [27]. Among the investigated edible plants *Enhydra fluctuans* exhibits higher concentration of Pb 0.38 ppm while *Neptunia prostrate* contains minimum amount of Pb 0.07 ppm. Pb causes both acute and chronic poisoning, and also poses adverse effects on kidney, liver, vascular and immune system [28]. The range of Mn varied with values between 0.253 ppm in *Hygrophila auriculata* to 3.618 ppm in *Ludwigia adscendens*. It is found that except *Centella asiatica* and *Ludwigia adscendens* all other investigated taxa accumulate Mn below this limit. Cd causes both acute and chronic poisoning, adverse effect on kidney, liver, vascular and immune system [28]. In the studied plant Cd concentration ranged from 0.016 ppm in *Ipomea aquatica* to 0.034 ppm in *Bacopa monnerii*. The positive impact of zinc supplementation on the growth of some stunted children, and on the prevalence of selected childhood diseases such as diarrhoea, suggests that zinc deficiency is likely to be a significant public health problem, especially in developing countries [29–32]. According to FAO's food balance data, it has been calculated that about 20% of the world's population could be at risk of zinc deficiency.

4. Discussion

Hydrophytes and marsh plant species have economic and environmental uses depending on their natural characteristic. Some are consumed in human diet while other species have medicinal value and still other species are good resource of mineral and vitamin [33]. The medicinal use of hydrophytes and marsh plants are documented for the first time from *Tripura* in this paper. Cultivation of those species by the local people needs to be encouraged to prevent their extinction and also to maintain the natural vegetation. The elements Fe⁺², K⁺, Mg⁺², Na⁺, Ca⁺², Mn⁺², Zn⁺² and Cu⁺³ have been classified as essential elements, Cr⁺³ are possibly essential while Cd⁺², Pb⁺⁴ are non essential

elements for the human body. The researchers are trying to link the contents of the trace elements and medicinal values of the plants. Most of the studied species contains the trace below the permissible limit [24]. The study revealed that investigated edible plants are good source of Na, K, Ca, Mg and Fe. However, in some cases they carry very high content of toxic metal whose main reason is the industrial pollution and irrigation by polluted water waste [34,35]. The mineral and heavy metal concentration reported herein might not be on par with some of the earlier reports on medicinal plants. The differences observed might be due to different growth conditions, genetic factors, geographical variations in the level of soil fertility, efficiency of mineral uptake, and the analytical procedure employed [36]. Though much is known about the functional role of a number of elements, the best foreseeable benefit for human health, by mineral nutrition, lies in obtaining the correct amount of supplementation in the right form at the right time. The data obtained in the present work will be useful in synthesis of new herbal drugs with various combinations of plants, which can be used in the treatment of different diseases at global level generally and in *Tripura*, India particularly.

Conflict of interest statement

We declare that we have no conflict of interest.

Acknowledgements

The first author is thankful *Tripura* University, India, for providing RET Fellowship in order to carry out the research work.

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