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Determination of Mineral Composition of Some Wild Edible Plants Consumed by Bodos of Assam, North-East India

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ABSTRACT

In the present study, the macro and micro elements present in eleven wild edible plants consumed by Bodos of Assam from North-East India were assessed. The study showed variable amounts of minerals content among the plant species which are presented herein and discussed. The heavy metals like cadmium and arsenic were not detected in the plant species. The investigation showed that these non-conventional food sources are good sources of minerals and consumption of such vegetables can replace the malnutrition problems.

Keywords: Minerals; Heavy metals; Wild edible plants; Bodos

INTRODUCTION

The minerals are important elements for living organisms which help in the normal functioning of life. The traditional wild edible vegetables contain good quantity of nutrients and phytochemicals that have been directly correlated to the growth of good health as well as the prevention of various diseases. The food crisis and malnutrition are the major problems for many developing countries and one example is the iron deficiency which causes anaemia that affects 33% of the world population [1]. Green leafy vegetables hold an important position in well-balanced diets that are believed to occupy good sources of minerals due to their high moisture content [2,3]. The optimal intake of minerals such as sodium, potassium, calcium, magnesium, etc. reduces the risk factors for many diseases including cardiovascular diseases [4]. The macro elements are those which are required in amounts greater than 100 mg per day and those required less than 100 mg per day are the micronutrients. The macro elements serve as structural and functional components of cellular and basal metabolism, and maintain acid-base balance in the organisms [5]. Calcium is well known for its function in maintaining bone and teeth in human beings [5]. Minerals are usually found in vegetables which constitute the formation of stable bioactive molecules, and perform all the metabolic functions in the human body as components of structural proteins, cofactors and activators of enzymes, regulators of nerve transmission, muscle contraction and osmotic pressure [3,6]. Zinc acts as a cofactor and is a part of several enzymes like carbonic anhydrase, alkaline phosphatase and other enzymes for nucleic acid synthesis [5,6]. Iron is an essential element and a vital component of proteins involved in oxygen transport and metabolism. It is also an essential cofactor for the synthesis of neurotransmitters such as dopamine, or epinephrine, and serotonin [7]. Likewise the magnesium, phosphorus, copper, molybdenum etc. also take part in many metabolic activities and controlling many metabolic and physiological disorders [3,5]. On the other hand, many industrialized processes give rise to environmental problems with increased levels of metals such as cadmium, chromium, and lead which can have profoundly deleterious effects on human health including kidney problems, neurobehavioral and developmental disorders, high blood pressure and potentially even lung cancer [8].
Bodoland Territorial Area Districts (BTAD) is the part of Assam, North-East India where Bodos are the indigenous tribal groups that constitute the major segment of the population of these regions. The rich biological diversity of this area is utilized by these indigenous communities in a variety of ways and the wild edible plants

are the common food resources among them. The works on proximate composition and antioxidant properties of some wild edible plants and fruits in different localities were reported by some researchers [9-14]. Still there is no systematic study and reports on the mineral composition of many indigenous plant foods. Therefore, the aim of present study was to evaluate the macro and micro elements in some selected wild edible plants consumed by Bodos of Assam.

MATERIALS AND METHODS

Collection of plants and identification

The eleven wild edible plants selected for this study are *Blumea lanceolaria* (Roxb.) Druce, *Oenanthe javanica* (Blume) DC., *Tetrastigma angustifolium* (Roxb.), *Drymaria cordata* (L.) Willd.ex Schult., *Stellaria media* (L.), *Cryptolepis sinensis* (Lour) Merr., *Antidesma acidum* Retz., *Polygonum perfoliatum* L., *Eryngium foetidum* L., *Lippia javanica* (Burm.f.) Spreng., and *Enhydra fluctuans* Lour, and these were obtained in the year 2014 from Kokrajhar District of Assam. The plants were authenticated by Botanical Survey of India, Shillong (Meghalaya).

Sample preparation

The collected plant samples were cleaned using tap water, dried in a hot-air oven at 55^{o}C and then powdered using a grinder. The sample (0.5 g) was taken in silica crucible and it was heated to ash in a Muffle furnace at 500^{o}C for 2 h. It was then digested repetitively with concentrated HNO_3 by evaporating in a hot plate till it becomes colorless. Thereafter, it was dissolved in distilled water, filtered with Whatman no. 1 filter paper, the volume was made upto 50 mL with distilled water in a volumetric flask and was taken for metal analyses.

Analyses of metals

Metals like calcium (Ca), magnesium (Mg), iron (Fe), copper (Cu), zinc (Zn), manganese (Mn) and nickel (Ni) were determined using Graphite Furnace-Atomic Absorption Spectrometer (GF-AAS, Analytik Jena Vario-6) at Sophisticated Analytical Instrumentation Facility (SAIF), North Eastern Hill University, Shillong (Meghalaya) and metals like sodium (Na), potassium (K), chromium (Cr), cobalt (Co), selenium (Se), cadmium (Cd) and arsenic (As) were determined using Atomic Absorption Spectrometer (AAS-ICE 3500, Thermo Scientific, UK) at Sophisticated Analytical Instrumentation Centre (SAIC), Tezpur University (Assam). The results were converted to mg/100 g dry weight of sample.

Statistical analysis

The data of the experiments were presented as mean of triplicate readings ± standard deviation. Standard deviations were calculated using Microsoft Excel. Relative significant differences among the means were studied by one-way ANOVA *t*-test at $p<0.05$ using OriginPro 8.5 software (OriginLab Corporation, MA 01060 USA).

RESULTS AND DISCUSSION

Macro elements analysis of the eleven wild edible plants in mg/100 g of dry weight is presented in Table 1. The sodium content present in the sample ranged from 18.88 ± 0.01 mg (*C. sinensis*) to 290.54 ± 0.03 mg (*E. fluctuans*). The higher amount of sodium was also found in *E. foetidum* (139.44 ± 0.02 mg). A similar value of sodium content was also reported in the underutilised green leafy vegetables [15]. In this study, higher value of sodium was reported in comparison to some Mediterranean spontaneous edible herbs [16], wild edible fruits, berries, nuts, roots and spices consumed by the Khasi tribes [17] and some wild leafy vegetable of North East India [18]. The concentration of potassium was found to be higher in all the selected plants, the highest being in *D. cordata* (11784.13 ± 0.11 mg/100 g) and the lowest being in *S. media* (6376.16 ± 0.15 mg/100 g). High amount of potassium was also found in *P. perfoliatum* (9566.23 ± 0.13 mg), *E. fluctuans* (9166.26 ± 0.10 mg), *L. javanica* (8828.24 ± 0.10 mg) and *O. javanica* (8528.41 ± 0.10 mg). Similarly, close value of potassium content was also reported in leafy vegetable [9], edible herbs, wild fruits and flowers [16] and some plants used as condiments in Turkey [19]. Foods rich in nutrients are essential for proper growth and balanced diet in children and adults. Fresh green leafy vegetables are considered to contain rich sources of minerals which can solve nutrient requirements of human health and generally, potassium rich food sources are used for the treatment of rheumatoid arthritis [9]. In this study, lower levels of calcium was obtained that varied from 4.00 ± 0.06 mg in *E. fluctuans* to 7.41 ± 0.01 mg in *B. lanceolaria* and similar value was also reported in some Mediterranean spontaneous edible herbs [16]. Magnesium deficiency can affect a wide range of medical disorders including high blood pressure, asthma, and all types of musculoskeletal disorders, epilepsy, and many other diseases [8]. The lower levels of magnesium ranging from 4.40 ± 0.03 mg to 9.00 ± 0.01 mg was detected in this study in comparison to other reports of green leafy vegetable, edible herbs, wild flowers and fruits [9,15,17,19], but similar value was also reported in some Mediterranean edible herbs [16].

Table 1: Macro element contents of wild edible plants (mg/100 g dry weight)

Plants	Na	K	Ca	Mg
B. lanceolaria	33.91 ± 0.02^{a}	7468.14 ± 0.10^{a}	7.41 ± 0.01^{a}	8.10 ± 0.06^{a}
T. angustifolium	34.00 ± 0.01^{b}	7698.19 ± 0.12^{b}	4.51 ± 0.02^{b,c}	8.06 ± 0.05^{a}
O. javanica	45.54 ± 0.01^{c}	8528.41 ± 0.10^{c}	4.20 ± 0.05^{b}	5.60 ± 0.07^{b}
D. cordata	59.45 ± 0.02^{d}	11784.13 ± 0.11^{d}	5.52 ± 0.02^{d}	8.02 ± 0.02^{a}
C. sinensis	18.88 ± 0.01^{e}	7262.16 ± 0.04^{e}	5.73 ± 0.04^{d}	4.40 ± 0.03^{c}
S. media	72.91 ± 0.03^{f}	6376.16 ± 0.15^{f}	4.20 ± 0.05^{b}	7.40 ± 0.04^{d}
A. acidum	23.48 ± 0.02^{g}	6786.16 ± 0.10^{g}	6.70 ± 0.02^{e}	9.00 ± 0.01^{e}
E. foetidum	139.44 ± 0.02^{h}	6822.11 ± 0.10^{h}	4.70 ± 0.05^{b}	6.80 ± 0.06^{f}
L. javanica	52.99 ± 0.02^{i}	8828.24 ± 0.10^{i}	5.60 ± 0.06^{d}	7.00 ± 0.02^{d}
P. perfoliatum	37.02 ± 0.02^{j}	9566.23 ± 0.13^{j}	4.92 ± 0.02^{c}	7.10 ± 0.02^{d}
E. fluctuans	290.54 ± 0.03^{k}	9166.26 ± 0.10^{k}	4.00 ± 0.06^{b}	6.50 ± 0.03^{f}

Results are expressed as mean of 3 replicates ± standard deviation. The values with different letters in a column are significantly different from each other at $p<0.05$.

Table 2: Micro element contents of wild edible plants (mg/100 g dry weight)

Sample	Fe	Cu	Zn	Mn	Co	Cr	Se	Ni	Cd and As
B. lanceolaria	13.90 ± 0.02^{a}	1.62 ± 0.02^{a}	1.11 ± 0.03^{a}	4.80 ± 0.02^{a}	0.43 ± 0.04^{a}	1.68 ± 0.09^{a}	1.01 ± 0.06^{a}	0.17 ± 0.09^{a}	Nd
T. angustifolium	0.90 ± 0.005^{b}	1.81 ± 0.01^{a}	1.70 ± 0.02^{a,b}	3.40 ± 0.02^{b}	0.54 ± 0.01^{a}	1.65 ± 0.04^{a}	0.18 ± 0.06^{b}	0.25 ± 0.07^{a}	Nd
O. javanica	12.60 ± 0.06^{c}	2.14 ± 0.05^{b}	1.20 ± 0.03^{a}	5.00 ± 0.06^{c,d}	0.51 ± 0.01^{a}	7.53 ± 0.13^{b}	0.84 ± 0.03^{a}	0.25 ± 0.03^{a}	Nd
D. cordata	10.80 ± 0.01^{d}	1.90 ± 0.07^{a}	1.40 ± 0.03^{a,b}	5.20 ± 0.04^{d}	0.71 ± 0.01^{a}	1.61 ± 0.15^{a}	1.79 ± 0.02^{c}	0.43 ± 0.02^{a}	Nd
C. sinensis	0.60 ± 0.03^{b}	3.21 ± 0.01^{c}	1.00 ± 0.01^{a}	5.60 ± 0.02^{d}	0.61 ± 0.09^{a}	1.74 ± 0.05^{a}	0.51 ± 0.01^{a}	0.23 ± 0.01^{a}	Nd
S. media	13.42 ± 0.02^{a}	1.50 ± 0.02^{a}	0.90 ± 0.02^{a}	4.50 ± 0.06^{a}	0.64 ± 0.01^{a}	2.61 ± 0.11^{c}	0.74 ± 0.02^{a}	0.35 ± 0.02^{a}	Nd
A. acidum	0.90 ± 0.061^{b}	1.70 ± 0.05^{a}	1.20 ± 0.02^{a}	3.90 ± 0.03^{b}	0.45 ± 0.01^{a}	2.34 ± 0.13^{c}	0.72 ± 0.07^{a}	0.13 ± 0.04^{a}	Nd
E. foetidum	12.50 ± 0.01^{c}	2.60 ± 0.07^{b}	1.00 ± 0.06^{a}	5.13 ± 0.03^{c}	0.56 ± 0.01^{a}	1.19 ± 0.09^{a}	1.15 ± 0.04^{a}	0.28 ± 0.09^{a}	Nd
L. javanica	10.70 ± 0.01^{d}	2.40 ± 0.03^{b}	0.40 ± 0.01^{c}	5.61 ± 0.01^{d}	0.31 ± 0.09^{a}	2.37 ± 0.08^{c}	0.98 ± 0.01^{a}	0.15 ± 0.04^{a}	Nd
P. perfoliatum	12.50 ± 0.01^{c}	1.40 ± 0.06^{a}	1.60 ± 0.04^{b}	4.80 ± 0.01^{a}	0.46 ± 0.07^{a}	2.27 ± 0.09^{c}	0.94 ± 0.05^{a}	0.21 ± 0.01^{a}	Nd
E. fluctuans	15.10 ± 0.02^{e}	1.70 ± 0.04^{a}	1.70 ± 0.04^{b}	3.30 ± 0.06^{b}	0.67 ± 0.01^{a}	2.46 ± 0.09^{c}	0.24 ± 0.01^{b}	0.16 ± 0.01^{a}	Nd

Nd, not detected. Results are expressed as mean of 3 replicates ± standard deviation. The values with different letters in a column are significantly different from each other at $p<0.05$.

The results of micro elements analyses of eleven wild edible plants in mg/100 g of dry weight are presented in Table 2. The highest iron content was found in *E. fluctuans* (15.10 ± 0.02 mg/100 g) and the lowest was in *C. sinensis* (0.60 ± 0.03 mg/100 g). A good amount of iron was also found in *B. lanceolaria, S. media, O. javanica, P. perfoliatum* and *E. foetidum* (Table 2). By consuming these wild vegetables, one can fulfil the daily requirement of iron and can prevent the iron deficiency disease like anaemia. Close value of iron content was also reported in some underutilized green leafy vegetables [15], Mediterranean edible herbs [16] and plants used as condiments in Turkey [19]. A higher amount of iron was detected in cabbage, *Amaranthus spinosus, Portulaca oleracea, Solanum nigrum* and in some condiments [19-21]. Copper content was found to be highest in *C. sinensis* (3.21 ± 0.01 mg) and the lowest was detected in *P. perfoliatum* (1.40 ± 0.06 mg). Similarly, Volpe et al. [16] and Ozcan [19] also reported comparable amount of copper in their study. The copper contents in this study were found to be higher than some other leafy vegetables [15,18], tropical fruits and unconventional foods [22]. This variation may be due to the mineral contents of soil, age of sample, genotype of plants and also may be due to geographical variations. Copper is essential for the biological electron transport and production of enzyme in the body and its deficiency causes abnormal glucose and cholesterol metabolism, reduced energy production, and increased oxidative damage [23]. The amount of zinc present in the plants ranged from 0.40 ± 0.01 mg/100 g in *L. javanica* to 1.70 ± 0.04 mg/100 g in *E. fluctuans*. The similar results were also reported in leafy vegetable such as *Bidens pilosa, Brassica sp., Amaranthus sp.* etc. and some condiments like cumin, minth, fennel, coriander etc. [19,24]. In comparison to this study, some researchers reported lower levels of zinc in some wild green leafy vegetables such as *Lasia spinosa, Ipomea aquatic, Centella asiatica* and some other domestic vegetables such as cabbage, spinach, chicory etc. [15,25]. Zinc is important for the growth of human body and increases infection resistance, but excess of its level becomes toxic [23]. The manganese content was found ranging from 3.30 ± 0.06 mg (*E. fluctuans*) to 5.61 ± 0.01 mg (*L. javanica*) which is similar to the works of Volpe et al. [16] and Ozcan [19]. The concentration of cobalt in the plants of this study varied from 0.31 ± 0.09 mg (*L. javanica*) to 0.71 ± 0.01 mg (*D. cordata*) which is comparable to that of the tropical fruits and unconventional food as well as edible plants [20,25,26]. Cobalt is an element which has therapeutic property in pharmacological doses and improves the effect of insulin [23]. The chromium was found to be highest in *O. javanica* (7.53 ± 0.13 mg) and the lowest was observed in *E. foetidum* (1.19 ± 0.09 mg). Chromium is essential for the activities of enzyme and hormone [18]. Selenium content varied from 0.18 ± 0.06 mg in *T. angustifolium* to 1.79 ± 0.02 mg in *D. cordata*. Similar results were also reported in some condiments [20] and lower value of selenium was reported in some wild fruits, edible plants, and Korean foods [20,22,27]. Selenium is incorporated into proteins to make seleno-proteins which defend oxidative stress and deficiency of this element causes heart diseases, hypothyroidism and weak immune system [28]. Low amount of nickel was detected in the plants ranging from 0.13 ± 0.04 mg (*A. acidum*) to 0.43 ± 0.02 mg (*D. cordata*) which is similar with the results of unconventional food of Colombia [22], edible plants of the Republic of Niger [20] and some wild edible plants of North East India [18].

The heavy metals like cadmium, lead, arsenic and mercury are toxic elements and they are the pollutants of environment. They are not biodegradable, have longer half-life and cause serious adverse effects on human health as they have the ability to get stored in the different organs of the body [29]. The heavy metal contamination in plants arises from a number of anthropogenic activities like industry, agriculture and urban life, and the uptake of heavy metals in vegetables take place from the soil as well as from the surface deposits on the parts of plants and vegetables exposed to polluted air [30]. In this study, the heavy metals *viz*. cadmium and arsenic were not detected as these elements were found below the detection level (Table 2). The study showed that the eleven wild edible plants collected from Kokrajhar District of Assam are still not contaminated by the heavy metals. Hence, the consumption of these wild plants is considered to be free from health hazards and could provide nutrients to those who are suffering from a serious nutrient deficiency.

CONCLUSION

The present study on wild edible plants revealed the variation of metals content among the plant species. The study showed that the plants have good sources of minerals and free from heavy metal contamination. These non-conventional food sources are easily available at negligible cost and consumption of such vegetables can replace the malnutrition problems among the rural populations. This investigation will be useful for supply of basic nutritional composition among the general consumer for improving the diet list. Such type of study is important as the consumption of vegetables have a direct effect on human health.

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