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Om Prakash Arya
G.B. Pant National Institute of Himalayan Environment and Sustainable Development North East Unit, Itanagar, Arunachal Pradesh, India

Anita Pandey
G.B. Pant National Institute of Himalayan Environment and Sustainable Development, HQ, Kosi-Katarmal, Almora, Uttarakhand, India

Prasanna K Samal
A) G.B. Pant National Institute of Himalayan Environment and Sustainable Development North East Unit, Itanagar, Arunachal Pradesh, India
B) Department of tribal studies, Indira Gandhi National Tribal University, Amarkantak, Madhya Pradesh, India

Correspondence
Om Prakash Arya
G.B. Pant National Institute of Himalayan Environment and Sustainable Development North East Unit, Itanagar, Arunachal Pradesh, India

Ethnobotany and nutritional importance of four selected medicinal plants from Eastern Himalaya, Arunachal Pradesh

Om Prakash Arya, Anita Pandey and Prasanna K Samal

Abstract
The medicinal plants have traditionally played an important role in the socio-cultural, spiritual and medicinal arena of the peoples of Eastern Himalaya. The Eastern Himalaya region is inhabited by a large number of ethnic communities and tribes. The indigenous people use various medicinal plants traditionally either in the form of extract or decoction for treating various ailments. Four plants species viz. *Drymaria cordata, Solanum spirale, Solanum torvum and Spilanthes paniculata,* widely used in folk medicine and food in this region were selected to assess their nutritional values. The investigation revealed that *S. paniculata* contains Fibre (27.82 % in leaves), Na (50.05 mg/100g in flowers), and Ca (78.49 mg/100g and 77.53 mg/100g in flowers and leaves respectively) while *S. torvum* contains Protein (15.71%), Total Carbohydrate (28.14%) and *D. cordata* contains Ash (17.11%), K (317.51 mg/100g) highest amongst all. Present manuscript focuses on ethnobotanical information as well as nutritional importance of four selected plants

Keywords: Nutrients, ethnobotanical, Himalayan, North-East India, biochemical

1. Introduction
The Indian Himalayan Region supports about 18,000 species of plants, including a large repository of medicinal plants including many rare and valuable species. Medicinal plants are an integral part of the culture of the local communities of the Himalayas [1]. Being the part of north east Himalayan region, Arunachal Pradesh is regarded as one of the mega biodiversity hotspot areas of the world. The distinct geographical location and climatic condition makes it an ideal repository of a rich biodiversity including medicinal plants [2, 3]. The original inhabitant of Arunachal Pradesh belong to 26 major tribes and 110 sub-tribes. The tribes have their own culture, tradition and medicinal system of treatment and knowledge acquired through close observation of nature [4].
In recent times, focus on plant research has increased all over the world and a large body of evidence has been collected to show immense potential of medicinal plants used in various traditional systems. The therapeutic effect of these plants for the treatment of various diseases is based on the chemical constituent present in them [5]. As various medicinal plant species are also used as food along with their medicinal benefits, evaluating their nutrient content can help to understand the nutritional significance of these plant species [6]. Several nutrients constitute a small fraction of our diet and play an important role in metabolic processes. Their excess or deficiency may disturb normal biochemical functions of the body [7]. The principle of biochemical individuality states that the optimal dose of any nutrient will normally vary between individuals. This is well supported by the science and considered in statistical considerations of biomarkers [8]. In present study, four plants from Eastern Himalaya, particularly from Arunachal Pradesh were selected to study their ethnobotany and Nutritional importance.

2. Materials and methods
2.1 Field survey
The study area falls in Lower Subansiri, Lower Dibang Valley and Papumpare districts of Arunachal Pradesh (Fig. 1). Field survey were conducted in various parts (Table 1) of selected districts of Arunachal Pradesh, India. Informal interviews and discussions were held with the local people particularly with traditional healers in the selected areas to collect the data on

ethno-botanical information like local names and traditional uses of medicinal plants. Information on availability status and place of occurrence of the selected plants was obtained with the help of local people. On the basis of availability and uses, four plants *Drymaria cordata, Solanum spirale, Solanum torvum* and *Spilanthes paniculata* (Fig. 2) were selected for the investigation.

Table 1: Description of the study sites

Plant species	Location	Geographical position
Solanum torvum	Ziro, Lower Subansiri district, Arunachal Pradesh	27°37'13.8"N to 27°37'36.5"N and 93°51'58.6"E to 93°51'28.4"E Altitude range: 1680-1700
Spilanthes paniculata	Ziro, Lower Subansiri district, Arunachal Pradesh	27°37'35.3"N to 27°38'08.7"N and 93°50'40.7"E to 93°50'52.8"E Altitude range: 1600-1612
Solanum spirale	Roing Circle, Lower Dibang Valley district, Arunachal Pradesh	28°11'26.5"N to 28°11'35.3" N and 95°48'17.7"E to 95°48'05.3" E Altitude range: 683-686
Drymaria cordata	Itanagar area, Papumpare district, Arunachal Pradesh	27°2'58.2"N to 27°3'15.3"N and 93°29'41.9"E to 93°29'34.09"E Altitude range: 210-222m

2.2 Plant collection and sample preparation

Plant samples were collected from selected area of Arunachal Pradesh, India. Plants were identified with the help of locals, photographs and consulting scientist & herbarium at Botanical survey of India, Arunachal Pradesh Regional center, Itanagar. The leaves and flowers of collected plant species were washed, dried in hot air oven at 55°C and powdered using a grinder mill (*SECOR Sci. Engg.*). Powdered samples were stored in airtight container and placed in the dark at room temperature prior to further analysis.

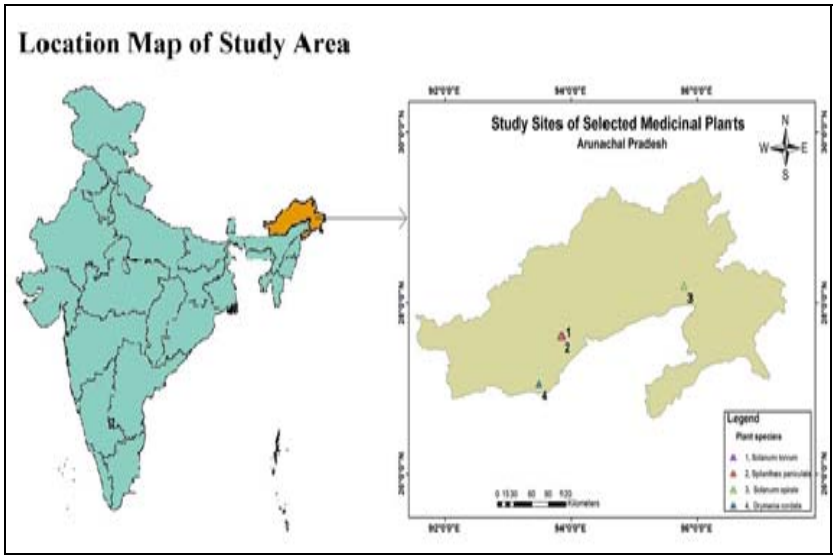

Fig 1: Location map of the plant collection sites

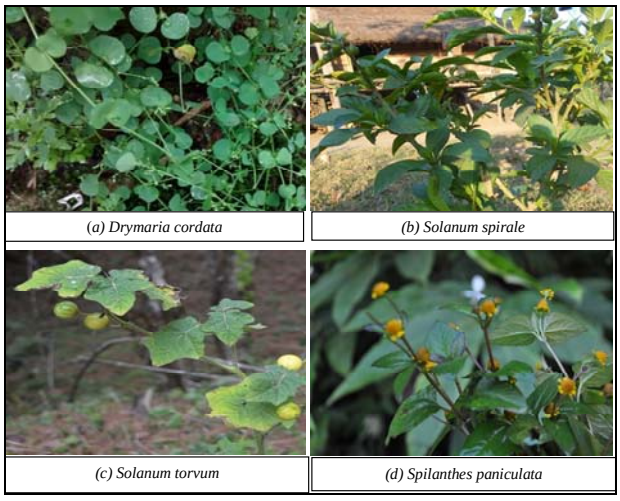

Fig 2: The medicinal plants under study

2.3 Proximate Analysis

The moisture content during the drying of the samples were determined using a standard vacuum oven until constant weight is obtained [9]. For ash content, samples were weighed in a silica crucible. The crucible was heated in muffle furnace (*Narang Scientific works)* for 5-6 hours at 600°C followed by cooling and weighing the sample till the weight became constant; weight of ash gave the ash content [10]. For Crude fat, samples were extracted with solvent petroleum ether (60-80°C) in Soxhlet extractor (*Model: SCS-6, Pelican equipment*) for about 6-8 h followed by evaporating the solvent [10]. Crude protein was determined by digesting the samples followed by cooling and transferring it to micro Kjeldahl distillation assembly to trap ammonia. The quantity of ammonia distilled was estimated by titration; the percentage of Nitrogen (N) in the sample was accordingly calculated. The crude protein content was determined by factor Nx6.25 to convert nitrogen into crude protein [10]. Crude fiber was determined on defatted samples by Fibra-plus *(FES-2, pelican equipment)* system

with repeated treatment of 1.25% H_2SO_4 followed by 1.25% NaOH. The washed residue was then dried in an oven at 120°C until constant weight obtained followed by incineration at 600°C for 30 min. Crude fiber content was expressed as percentage loss in weight on ignition [10]. Total carbohydrate was estimated by Anthrone method. Carbohydrate are first hydrolyzed and then dehydrated using a digestion chamber with sulfuric acid addition and heat treatment. The digested compound reacts with anthrone to give green colored compound. The amount of total carbohydrate in the sample was then estimated using UV-Visible Spectrophotometer (*UV-2700, Thermofisher*) via reading the absorbance of resulting solution against a glucose standard curve [11].

2.4 Mineral Analysis

Mineral elements were determined using wet digestion method, particularly for macro minerals determination. For determination of macro minerals, the plant samples were digested in a di-acid mixture. The di-acid digestion is used for determination of P, K, Ca and Na. The samples were taken into a volumetric flask and genteelly mixed with acid mixture. The solution was then digested at higher temperature followed by cooling and filtrating the solution through Whatman no. 1 filter paper. Aliquots of this solution was then used for determination of P, K, Ca and Na. Potassium (K), Sodium (Na) and Calcium (Ca) were determined by flame Photometry method. Standard solutions of Potassium (K), Sodium (Na) and Calcium (Ca) were prepared following the proper methods [12]. The standard solution was tested in Flame Photometer (*Systronic, Model-128),* the atomizer of the instrument was dipped into the sample solution and values were recorded; the blanks were used for zeroing the instrument before each analysis to avoid matrix interference. The concentration of the each element was determined by comparison with their standard solution values. Double Beam UV-Visible Spectrophotometer (*UV-2700, Thermo Fisher*) was used for phosphorus determination in plant samples. The aliquots of digested samples were diluted to prepare standards for phosphorus estimation against a phosphorus standard curve following the procedure [12]

2.5 Statistical Analysis

For each species, three replicate samples were taken for analysis of proximate and mineral composition. The data obtained was subjected to one way analysis of variance (ANOVA) to determine the significant difference in proximate and mineral composition among, the species. Tukey HSD Test in ANOVA was also performed for pair-wise comparison between the species. The result presented in table are mean ± standard deviation (SD). Statistical analysis was performed using STATISTICA 6.0 (StatSoft. Inc., USA).

3. Results and Discussion

3.1 Interview with Villagers

During the various field survey in villages and adjoining forest areas, villagers were interviewed for their knowledge on plants. Interview & discussion with villagers revealed that the locals have rich knowledge about the uses of plants as medicine for curing various diseases. Elderly people were the main knowledge holders of usages of medicinal plants. Most of the knowledge holders kept their medicinal plant knowledge secret or pass through the family line and mainly through sons. Different parts of the selected plant species were used by them as medicine for curing various ailments. The aboveground parts were more commonly used than the underground parts. Leaf were used in the majority of the cases, followed by fruits and flowers. The ethno botanical information of selected plant species is given in Table 2.

Table 2: Ethno-botanical information of the selected medicinal plant species

Plant Name (Family)	Local name(s)	Habit	Plant parts used	Medicinal uses
1	2	3	4	5
Solanum torvum (Solanaceae)	Byako (Adi), Byakta (Nyishi), Sathi Byako (Apatani)	Shrub	Fruit, root, seed	Headache, fever and cough, toothache, tooth decay, reducing blood sugar, colic, asthma
Spilanthes paniculata (Asteraceae)	Marsang (Adi), Byadhi or Marcha (Nyishi), Yakhohama (Apatani)	Herb	Flowers, leaf, young stem	Toothache, body ache, cough, fever, deworming, liver trouble, constipation
Solanum spirale (Solanaceae)	Bangko or Okobang (Adi& Adi Minyong)	Shrub	Root, leaf, fruit	Jaundice, Oral contraceptive, indigestion, itching, Skin disorder, teeth worms, toothache
Drymaria cordata (Caryophyllaceae)	Ropsik romnik (Nyishi), Kaira (Adi)	Herb	Whole plant, leaf	Burns, skin diseases, snakebite, ringworm, cough, fever, diarrhea, pneumonia, jaundice, muscular sprain,

3.2 Proximate composition

Protein, ash, crude fibre, and crude fat were analyzed on dry weight basis except moisture content (analyzed on fresh weight basis). The proximate composition (Table 3) of four selected plants, namely *Spilanthes paniculata* (leaves and flower), *Solanum spirale* (leaves), *Drymaria cordata* (whole plant) and *Solanum torvum* (leaves) on dry weight basis is shown graphically in *Fig. 3*. Significant variation in proximate composition was observed among the selected species. Moisture content was significantly higher in leaves of *Spilanthes paniculata (88.74%)* and *Drymaria cordata (87.85%)* than *Solanum torvum (81.56%*) (p<0.01). Protein content was significantly higher in *Solanum torvum (15.71%)* than *Drymaria cordata (12.51%), Solanum spirale (13.02%) and Spilanthes paniculata leaves* (6.54%) (p<0.001). *Solanum torvum* had a significant fat content (5.92%) than other selected plants (1.73-2.24%) (p<0.01). Fibre content was highest in the leaves of *Spilanthes paniculata* (27.82%) and lowest in *Drymaria cordata* (16.53%) (p<0.001). Drymaria *cordata (17.11%)* and leaves of *Spilanthes paniculata (17.05%)* had significantly higher Ash content than *Solanum torvum (12.08%), Solanum spirale (13.13%)* and flowers of *Spilanthes paniculata (11.12%)* (p<0.01). Total Carbohydrate content was significantly higher in *Solanum torvum* (28.14%) than flowers of *Spilanthes paniculata* flowers (15.79%) and leaves of *Solanum spirale* (p<0.001).

3.3 Mineral composition

The study shows that the selected species have emerged as good source of macro minerals. Potassium and Calcium were the most abundant of the macro minerals, followed by Phosphorus and Sodium as shown in Fig. 4. The flowers of

Spilanthes paniculata contains significantly higher Sodium (Na) content (50.05 mg/100g on dry weight basis) than *Solanum spirale* (18.75 mg/100g, DW basis) ($p<0.01$). Potassium content was significantly higher in *Drymaria cordata* (317.51 mg/100g) and *Solanum spirale* (309.90 mg/100g) than other plants ($p<0.01$). *Spilanthes paniculata* had significant Calcium content (78.49mg/100g and 77.53 mg/100g in flowers and leaves, DW basis), ($p<0.001$). Phosphorus content was significantly higher in the flower of *Spilanthes paniculata* (79.66 mg/100g), than *Solanum spirale* (50.2 mg/100g) *and Drymaria cordata* (50.5mg/100g) (Table 4).

Table 3: Proximate composition of the selected medicinal plants on 100g dry weight basis

Plant species	Moisture (g)	Protein (g)	Fat (g)	Total Carbo- Hydrate (g)	Fibre (g)	Ash (g)
Solanum torvum (Leaves)	81.56±0.19^{c}	15.71±0.19^{a}	5.92±0.48^{a}	28.14±0.07^{a}	23.08±0.03^{c}	12.08±0.05^{c}
Spilanthes paniculata (Leaves)	88.74±0.11^{a}	6.54±0.29^{c}	2.22±0.03^{b}	19.62±0.03^{c}	27.82±0.06^{a}	17.05±0.03^{a}
Spilanthes paniculata (Flowers)	82.12±0.24^{c}	13.33±0.46^{b}	2.24±0.03^{b}	15.79±0.04^{e}	26.80±0.28^{d}	11.12±0.14^{d}
Solanum spirale (Leaves)	84.66±0.81^{b}	13.02±0.63^{b}	1.93±0.17^{b}	16.56±0.23^{d}	21.32±0.21^{d}	13.13±0.04^{b}
Drymaria cordata (whole plant)	87.85±0.07^{a}	12.51±0.39^{b}	1.73±0.02^{b}	23.21±0.01^{b}	16.53±0.05^{e}	17.11±0.03^{a}

Values are mean ± Standard deviation (SD) of three replicates, different superscripts within the column are significantly different (Tukey HSD test, $p<0.05$)

Table 4: Mineral composition of the selected medicinal plants on 100g dry weight basis

Plant species	Na (mg)	K (mg)	Ca (mg)	P (mg)
Solanum torvum (Leaves)	22.65±0.44^{c}	245.31±0.97^{b}	63.71±0.38^{d}	52.34±0.58^{b}
Spilanthes paniculata (Leaves)	40.09±0.10^{b}	218.80±0.56^{c}	77.53±0.29^{a}	48.92±0.29^{d}
Spilanthes paniculata (Flower)	50.05±0.18^{a}	187.63±0.50^{d}	78.49±0.18^{a}	79.66±0.11^{a}
Solanum spirale (Leaves)	18.75±0.10^{e}	309.90±5.41^{a}	73.69±0.09^{b}	50.22±0.06^{c}
Drymaria cordata (whole plant)	20.10±0.32^{d}	317.51±0.10^{a}	67.53±0.05^{c}	50.56±0.20^{c}

Values are mean ± standard deviation (SD) of three replicates, different superscripts within the column are significantly different (Tukey HSD test, $p<0.05$);

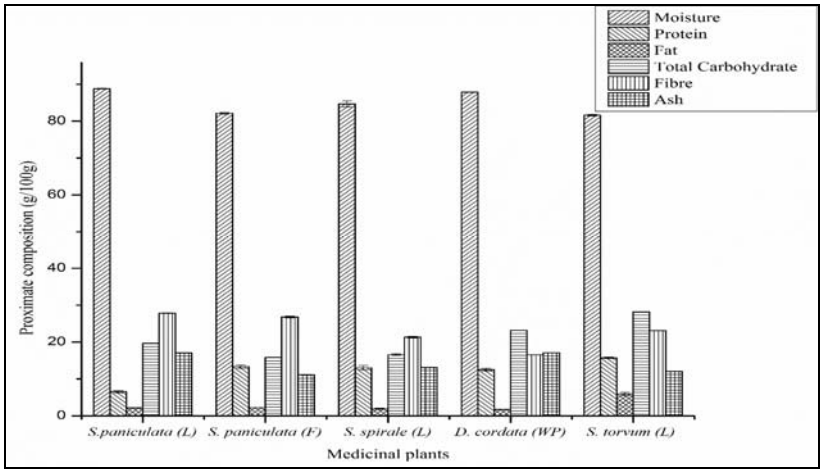

Fig 3: Proximate composition of selected medicinal plants

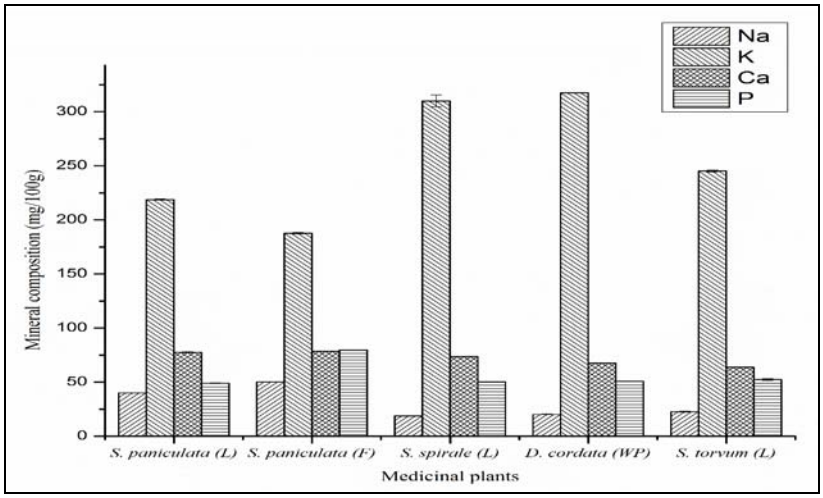

Fig 4: Mineral composition of selected medicinal plants

Protein is complex biomolecule in the body, required to provide the nitrogenous materials for synthesis of the nonessential amino acids [13, 14]. Carbohydrates play key role in the energy metabolism [15]. The fat in the diet allows a physiological response to various environmental stimuli [16]. Dietary fibre is important for our digestive health and regular bowel movements. Calcium is essential for the structure and function of bone metabolism, muscle functions, blood pressure, bone density, coagulation process, and releasing neurotransmitters [17]. Potassium and sodium are the major determinants of osmotic pressure and electrolyte balance, higher intake of Potassium reduce blood pressure and bone resorption [18]. Approximately 80–90% of the mineral content of bone is made up of calcium and phosphorus, adequate phosphorus intake is essential for many biologic processes, including skeletal mineralization [19].

Therefore, realizing that minerals are necessary for the normal biochemical processes in human system, the plant studied have emerged as good source of nutrients and minerals both. The presence of necessary nutrients makes these medicinal plants more effective in the folk medicinal uses as well as in consumption and good health of human being.

4. Conclusion

The study showed that these medicinal plants, i.e. *Drymaria cordata, Solanum spirale, Solanum torvum* and *Spilanthes paniculata*, possess a fairly good amount of nutrients and minerals content. Medicinal plants are of great importance to the tribal and indigenous people of NE India. Most of the plant species are being used by local people for curing various diseases and also as food supplement. Elderly people were the main knowledge holders of usages of medicinal plants, while younger generations were lacking in traditional practices and ethno medicinal knowledge. Assessment of nutritional values of the four selected medicinal plants will be helpful in improving the database of nutritive values of medicinal plants of NE region and it will also draw in younger generation's attention about nutritional importance of the selected plants. These results also suggest that these plants can be used for the well-being of mankind due to their nutritional importance.

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