



Biochemical Evaluation of Socio-culturally Important Wild Plants in Eastern Himalayas of Arunachal Pradesh

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ABSTRACT The current study intended to evaluate and validate the correlation between nutritional and antioxidant properties with their ethnomedicinal uses of four commonly used wild plants namely *Clerodendrum colebrookianum* (Oyin), *Pouzolzia bennettianum* (Oyik), *Zanthoxylum rhetsa* (Onyor), *Mussaenda glabra* (Taksap) among the Gulo community of Arunachal Pradesh. Results revealed that carbohydrate and starch content were highest in *M. glabra* (169.5 ± 0.2 µg/ml) and *Z. rhetsa* (13.6 ± 0.2 µg/ml) respectively. Protein, phenol and ascorbic acid were recorded highest in *C. colebrookianum* (367.0 ± 0.3 µg/ml), (250.0 ± 0.3 µg/ml) and (66.6 ± 0.3 mg/100g) respectively. Whereas percent DPPH activity was maximum in *P. bennettiana* (91.4 ± 0.6%). The rich nutritional and antioxidant properties of these wild plants and its ethnomedicinal uses by indigenous communities were found to be correlated.

INTRODUCTION

Arunachal Pradesh, the 25th world mega biodiversity hotspot and biogeographically one of the largest province of North-Eastern hilly regions of the Himalayan zone is a natural repository of prized medicinal plants and valuable wild plant species. The state is home of 26 major tribes and 110 sub-tribes which practices mostly *Jhum* cultivation with mixed cropping (Singh et al. 2010a). With the remoteness, inaccessibility, and dominance of *Jhum* farming in difficult terrains with a meager income, it has necessitated the local tribes in the region to depend on some edible wild plants and explored the ethnomedicinal uses to enlarge their meager food basket for sustaining life since time immemorial. These wild plants are closely associated with their socio-cultural, spiritual, dietary supplements and medicinal arena for the people of Eastern Himalaya (Arya et al. 2017). For centuries, these wild plants have been used for food, fiber, fodder and medicinal purposes which may play

a vital role in the improvement of food security and reduce the risk of over-reliance on major food crops (Mayes et al. 2011). The ethnomedicinal use of these wild plant species among different tribes have been reported by several authors (Sarmah et al. 2008; Namsa et al. 2011; Yumnang et al. 2011; Gibji et al. 2012; Tangjang et al. 2014; Perme et al. 2015; Bharali et al. 2016; Sharma et al. 2016; Arya et al. 2017). Such traditional knowledge on the ethnobiological value of wild plants leads to the promotion of biodiversity conservation in the Eastern Himalayas (O'Neil et al. 2017).

The epidemiological studies have consistently demonstrated the positive correlation between the intake of natural food products and reduced risks of several degenerative diseases which have been attributed to the presence of several antioxidants. The antioxidant activities including 2, 2-diphenyl-1-picrylhydrazyl (DPPH), 2, 2-azino-bis (3-ethylbenzothiazoline-6-sulfonic acid) (ABTS), total phenolic substances, phytochemical constituents, carbohydrate, protein were determined in different part of these wild plants with different extraction solvents (Vidyalakshmi et al. 2006; Majaw and Moirangthem 2009; Payum et al. 2013; Lalitharani et al. 2013; Prabhash et al. 2014; Ali et al. 2015; Azad et al. 2015; Payum et al. 2015). Concentration of the compound depends on the type of extractant

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along with plant part used (Thangi et al. 2016) and the ethnomedicinal uses of particular four plants under study are given in Table 1 (Singh et al. 2010a; Shankar et al. 2012; Payum et al. 2013; Payum et al. 2014).

However, the information regarding the validation of the medicinal properties of these wild plants is fragmented and meager. Amongst this vast array of wide plant species deserving attention which has been used by indigenous tribes of Arunachal Pradesh, the following four plants *Clerodendrum colebrookianum* (Family: Verbenaceae), *Pouzolzia bennettianum* (Family: Urticaceae), *Zanthoxylum rhetsa* (Family: Rutaceae) and *Mussaenda glabra* (Family: Rubiaceae) have been selected under the present investigation based on their frequency of consumption, year-round availability, and ethnomedicinal value of *Galo* tribe of West Siang district of Arunachal Pradesh (Fig. 1). Hence, the study was conducted to evaluate and correlate between nutritional and antioxidant properties of four wild plants with their ethnomedicinal uses in Eastern Himalaya of Arunachal Pradesh.

METHODOLOGY

Plants were collected from farmer's field or its natural habitats and maintained at ICAR Research farm (N27°59.537' and E 94°41.269'), Basar, West Siang District of Arunachal Pradesh for standardizing package of practices. Young leaves were collected from the plant and 0.5 g sample was homogenized with 5 ml of extraction buffer

containing 50 mM NaPO₄ buffer (pH 7.8), 1 mM EDTA, 0.1 percent Triton X-100, 1 mM ascorbate and ten percent sorbitan. Homogenate was centrifuged at 15,000 rpm at 4°C for 20 min and the supernatant was used for further studies (Sahoo et al. 2015). Total carbohydrate, starch, total protein, total phenol, ascorbic acid were analyzed as per the protocols described by Sadasivam and Manickam (2015) while percent DPPH activity was determined according to (Brand-William et al. 1995) from the extract. During the present investigation, fresh leaf materials were preferred to dry ones based on the preferential use by the local people.

RESULTS

Nutritional Evaluation

Present investigation revealed that total carbohydrate was highest in *M. glabra* (183.4 ± 0.4 µg/ml) followed by *C. colebrookianum* (169.5 ± 0.2 µg/ml), *Z. rhetsa* (166.8 ± 0.4 µg/ml) and *P. bennettiana* (159.9 ± 0.9 µg/ml) respectively (Table 2). However, no significant difference was observed among them. Similarly, starch was found to be highest in *Z. rhetsa* (13.6 µg/ml) followed by 9.3 µg/ml in *C. colebrookianum*, 6.2 µg/ml in *P. bennettiana* and 5.9 µg/ml in *M. glabra* respectively. While total protein was found highest in *C. colebrookianum* (367.0 ± 0.3 µg/ml) followed by *Z. rhetsa* (190.2 ± 0.3 µg/ml), *P. bennettiana* (161.1 ± 0.8 µg/ml) and 89.5 ± 0.3 µg/ml in *M. glabra* respectively.

Table1: Ethnomedicinal uses of indigenous wild plant consumed among *Galo* people

Plant name	Local name (Galo dialect)	Plant part use	Uses	Mode of preparation
<i>Clerodendrum colebrookianum</i>	Oyin	Tender leaves	Diabetes, high blood pressure, malaria	Boiled leaves and infusion
<i>Pouzolzia bennettiana</i>	Oyik	Leaves	Increases secretion in lactating mothers, stomach disorder	Boiled leaves/Blended with rice and dishes prepared from local fishes
<i>Zanthoxylum rhetsa</i>	Onyor	Shoot and roots	Pain killer, toothache, cold and cough, nerve dislocation, stress, and strain relieve, dysentery, diarrhea	Steam cooked or boiled with other vegetables or added with pork to reduce helminths/tapeworm problems
		Seeds/leaves	Eco-friendly harvesting of fishes	Green leaves paste/crush seed
<i>Mussaenda glabra</i>	Takshap	Leaves Leaves and Shoots	Biopesticides in the rice field Jaundice and constipation	Green leaves paste Fresh juice

Source: Singh et al. (2010a); Shankar et al. (2012); Payum et al. (2013); Payum et al. (2014)

Table 2: Biochemical evaluation of indigenous wild plant

	Carbohydrate ($\mu\text{g/ml}$)	Starch ($\mu\text{g/ml}$)	Protein ($\mu\text{g/ml}$)	Phenol ($\mu\text{g/ml}$)	Ascorbic acid (mg/100 mg)	% DPPH activity
<i>Pouzolzia bennettiana</i>	159.9 $\pm$ 0.9	6.26 $\pm$ 0.1	161.1 $\pm$ 0.8	134.8 $\pm$ 0.6	50.0 $\pm$ 0.1	91.4 $\pm$ 0.6
<i>Clerodendrum colebrookianum</i>	169.5 $\pm$ 0.2	9.3 $\pm$ 0.27	367.0 $\pm$ 0.3	250.0 $\pm$ 0.3	66.6 $\pm$ 0.3	89.9 $\pm$ 0.4
<i>Zanthoxylum rhetsa</i>	166.8 $\pm$ 0.4	13.6 $\pm$ 0.2	190.2 $\pm$ 0.3	169.6 $\pm$ 0.2	33.5 $\pm$ 0.1	89.6 $\pm$ 0.4
<i>Mussaenda glabra</i>	183.4 $\pm$ 0.4	5.9 $\pm$ 0.1	89.5 $\pm$ 0.3	165.6 $\pm$ 0.3	53.9 $\pm$ 0.4	86.3 $\pm$ 0.2
CV (%)	5.8	40.8	58.3	26.7	27.3	2.4

Note: Result are given with $\pm$ standard error

Antioxidant Evaluation

Total phenol was recorded maximum in *C. colebrookianum* (250.0 $\pm$ 0.3 $\mu\text{g/ml}$) followed by *Z. rhetsa* (169.6 $\pm$ 0.2 $\mu\text{g/ml}$), *M. glabra* (165.6 $\pm$ 0.3 $\mu\text{g/ml}$) and *P. bennettiana* (134.8 $\pm$ 0.6 $\mu\text{g/ml}$) respectively. While ascorbic acid content was found to be highest in *C. colebrookianum* (66.6 $\pm$ 0.3 mg/100mg) followed by *M. glabra* (53.0 $\pm$ 0.4 mg/100mg), *P. bennettiana* (50.0 $\pm$ 0.1 mg/100mg) and *Z. rhetsa* (33.5 $\pm$ 0.1 mg/100mg) respectively. The highest percent of DPPH scavenging activity was recorded in *P. bennettiana* (91.4 $\pm$ 0.6%) followed by *C. colebrookianum* (89.9 $\pm$ 0.4%), *Z. rhetsa* (89.6 $\pm$ 0.4%) and *M. glabra* (86.3 $\pm$ 0.2%) respectively. Although no significant variation was observed, results revealed that all the plants in the present study have good antioxidant potential.

DISCUSSION

Diet and nutritional behaviors of people are influenced by cultural and environment (Powell et al. 2017). It is inevitable to the indigenous tribes residing in remote hilly terrains of Arunachal Pradesh with meager modern amenities to depend on wild plant species for food, nutritional supplements and medicinal purposes for livelihood. Accumulation of rich ethnomedicinal knowledge and its oral transferring to successive generations has become a tradition since time immemorial. This reflects the rich ethnomedicinal knowledge of indigenous people of Arunachal Pradesh on wild edible plants. Although these edible wild plants are seldom cultivated in the agricultural system, they are widely collected and consumed in the daily diet for

sustenance and source of income (Thongam et al. 2016). Therefore, it is necessary to investigate and document the traditional herbal medicines for the welfare of rural communities (Sharma et al. 2016).

Nutritional Content and Ethnomedicinal Uses

Traditionally, *Mussaenda glabra* and *Zanthoxylum rhetsa* were used against jaundice. The sugar-containing foodstuffs (juice, sweets, etc.) were recommended in dietary by clinical studies (Gibji et al. 2012; Shankar et al. 2012). Earlier studies by Singh et al. (2010b) revealed that a high concentration of total carbohydrate and starch found in the plants may be associated with their ethnomedicinal use against jaundice as the starch was broken down completely into glucose in the small intestine. This also led to enhanced urination which helps in the elimination of excess bile pigments in the blood (Sharma et al. 2016). Therefore, a high concentration of total carbohydrate in *Mussaenda glabra* which is known as *Takshap* may be associated with its ethnomedicinal uses against jaundice. Sharma et al. (2016) also reported that plants from the Rutaceae and Rubiaceae family were frequently used against the Jaundice.

While the most important ethnomedicinal uses of *C. colebrookianum* known as *Oyin* in local dialect is to control high blood pressure. Hypertension or high blood pressure, cardiovascular disease has become a worldwide problem. Although the primary function of protein is for growth and tissue maintenance, it may also play a role in the regulation of glucose metabolism (Rosett 1988). The correlation between metabolic disorders with diabetes and hypertension

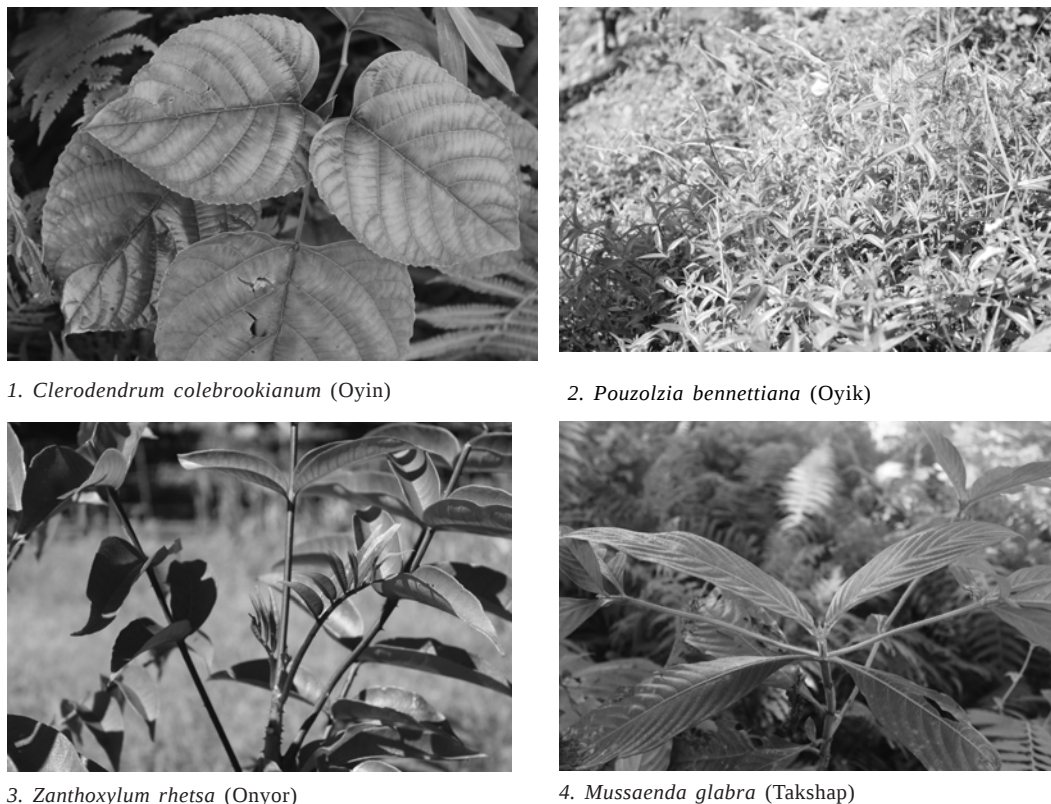


Fig. 1. Four indigenous wild plants consumed among the local community of Arunachal Pradesh

were revealed by George (2001). As there is an inverse relationship between vegetable protein intake and blood pressure, its ethnomedicinal uses to control high blood pressure by indigenous people were found to be correlated. The comparatively higher value of protein content found in *C. colebrookianum* signifies its ethnomedicinal uses as an important ingredient in the diet for a protein source to regulate the metabolic activity for controlling diabetes and high blood pressure (Rosett 1988; Altorf-Van der Kuil et al. 2010).

Antioxidant Potential and Ethnomedicinal Uses

Phenol

Total phenol was found to be highest in *C. colebrookianum* ($250.0 \pm 0.3 \mu\text{g/ml}$). Phenols act as a primary antioxidant and are known for their

protective activities for health (Ozcan et al. 2014). Lokesh and Amitsankar (2012) revealed the anti-hypertensive activity of n-butanol, ethyl acetate and chloroform fractions of aqueous leave extract of this plant which is mediated by cholinergic action and through the inhibition of ROCK-II, PDE-5 enzymes of *C. colebrookianum*. Similarly, the hypolipidemic and cardioprotective activity of this prized plant has been revealed by Devi and Sharma (2004) and Devi et al. (2011). The anti-stress activity of this plant was also reported by Majaw et al. (2008). The inhibitory effects of the plant phenolic extract on angiotensin-I converting enzyme could be the biochemical rationale behind the use of traditional medicine for the prevention and management of hypertension (Adefegha and Oboh 2016). Therefore, there is a high correlation between comparative higher phenol content recorded in *C. colebrookianum* and its ethnomedicinal used in controlling high blood pressure.

Ascorbic Acid

Ascorbic acid content was recorded highest in *C. colebrookianum* (66.6 ± 0.3 mg/100mg). The higher content of ascorbic acid also known as vitamin C in *C. colebrookianum* revealed its potentiality in reducing blood pressure. Adequate dietary of vitamin C has a lowering effect on blood pressure especially on systolic pressure and reduction in cancer, common cold, increase in immunity and drug metabolism (Walingo 2005). Thus the nutritional and antioxidant properties observed in *C. colebrookianum* and its ethnomedicinal use as a remedy for high blood pressure were highly correlated and justifiable.

DPPH

DPPH acts as a source of free radical to measure the antioxidant capacity of a plant which gets neutralized by test sample via donating hydrogen or an electron. In the present study, the highest percent of DPPH scavenging activity was recorded in *P. bennettiana* locally known as *Oyik* ($91.4 \pm 0.6\%$). Although no significant variation was observed, results revealed that all the plants in the present study have good antioxidant potential. *P. bennettiana* is given to the lactating mother to increase the quality of milk and a quick source of energy (Singh et al. 2010a). Besides, *P. bennettiana* is generally consumed as an important supplementary diet by the indigenous people of Arunachal Pradesh. This revealed that the high antioxidant capacity of this plant may or likely associated with enhancing the immunity in the milk.

Among the different types of phytochemicals, some are considered under the category of secondary metabolites which are linked with the different activities. In this connection, Sukumar and Anandhi (2014) reported the antimicrobial activity of quercetin 3-O-rutinoside (glycoside) isolated from *Mussaenda glabra* against the *E. coli* and *B. subtilis*. Similarly, Mahesh et al. (2015) also reported the antimicrobial activity of *C. colebrookianum* against *E. coli*, *Serratia marcescens* and *Staphylococcus aureus*.

Zanthoxylum rhetsa (Onyor) is traditionally used against insects possessing the chewing cutting type of mouthparts (Singh et al. 2010a). The insecticidal activity of the plant-derived oil

was validated by Priya et al. (2016) against *Drosophila melanogaster* and its ethnomedicinal uses against anticancer activity were reported by Payum et al. (2013). Scientifically, the anticancer activity of the alkaloids (6-acetonyldihydrochelerythrin 1) and arnottianamide 2 isolated from the stem bark of the plant was found against seven cancer cell lines (Sreelekha et al. 2014). Other activities reported for the plant include thrombolytic activity (Azad et al. 2015) and photo protective activity used for preparing sunscreen lotion (Santhanam et al. 2013). All these previous findings relate the ethnomedicinal use of this plant for the protection of the stomach against tapeworm/helminths since time immemorial by the indigenous people of Arunachal Pradesh.

CONCLUSION

It is concluded from the study that, the rich nutritional and antioxidant properties of these wild plants and their ethnomedicinal uses by indigenous communities were highly correlated. Among the various edible wild plant species, *C. colebrookianum* (Oyin), *Zanthoxylum rhetsa* (Onyor), *P. bennettiana* (Oyik) and *Mussaenda glabra* (Takshap) constitute the most preferable dietary supplements, socio-culturally important and serves as important ethnomedicinal purposes among the various communities of Eastern Himalaya of the state Arunachal Pradesh, India.

RECOMMENDATIONS

Since the collection and consumption of these valuable underutilized wild plants as a vegetable are highly perishable, further study standardization of agro-techniques with value additions, its conservation and commercialization will be rewarding to enhance food and nutritional security and converting the huge potentiality of rich ecological and floristic diversity into economic prosperity.

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