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Ethnomedicinal plants with anti-diabetic property used by tribes of Nagaland, India: A review

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Abstract
Nagaland is a state of North Eastern region of India and a part of Indo-Myanmar biodiversity hotspot. The state is very rich in flora and fauna due to favorable agro-climatic condition. Tribes of Nagaland have been using various plants to treat different kind of diseases including diabetes. Since herbal drugs have lesser or no side effect, plant based herbal drugs are very popular in the state. This communication intended to review of the past researches in the state on use of different plant and plant parts for treating/controlling diabetes. Systematic review of literatures reveals that till date a total of 47 plants belonging to 29 families are used as anti-diabetic by different tribes in the state. Though, these plants/parts are being used for anti-diabetic ethnomedicinal purpose, there is no or very limited information available on characterization of anti-diabetic potential active molecules/compounds from these plants, thus warrants isolation and identification of anti-diabetic compounds from these plants.

Keywords: Ethnomedicinal plants, tribes, diabetes, Nagaland

1. Introduction
Diabetes is a chronic, complex metabolic disorder with numerous acute and chronic consequences [1]. The body cells cannot metabolize carbohydrate properly and there is abnormal increase in blood sugar level resulting from insulin deficiency. The pathogenic process of development of diabetes includes autoimmune destruction of beta cells of pancreas and abnormalities in metabolism [2]. Failure of organ systems such as heart, blood vessels, eyes, kidney and nerves are the long-term effect of diabetes which can ultimately leads to death [3]. Sign and symptoms of diabetes include weight loss, polyuria, hypertension, blurred vision, polydipsia, polyphagia, tachycardia [4]. Here are two type of diabetes: Type 1 is absolute deficiency of insulin. Here, Islets of Langerhans in pancreas that produce β cell are destructed autoimmune. Type 2 is relative deficiency resulting from impaired insulin secretion and resistance its action [5]. By 2020, 34.2 million have been diagnosed with Diabetes [6]. The severe complicacy as a result of diabetes includes cardiovascular diseases, retinopathy, nephropathy, peripheral vascular disease, neuropathy, stroke etc. Out of 14166 patient, a total of 356 death occurred every year [7]. According Centers for Disease Control and Prevention, the cause for Type 1 diabetes is unclear but a having them in family history is a risk factor and there are no preventive measures for Type 1 diabetes. For type 2 diabetes, risk factors include overweight, older than 45 year, physically inactive for less than 3times a week or have a history of diabetes in the family. Type 2 diabetes can be prevented with losing weight, eating healthier and getting regular physical exercise. By the year 2000, India has the highest record in diabetes with 31.7 million diabetes patients [8].
The underlying goal of all diabetes treatment and management is to maintain an adequate blood glucose concentration. Type 1 is usually treated with exogenous insulin and Type 2 with oral hypoglycaemic agents [9]. Plants based diet are rich in fiber, antioxidants and they reduce insulin resistance, inhibit glucose absorption, enhance glucose uptake and also promote weight loss. Limiting the intake of red meat and increasing plant in diet reduce the risk of cardiovascular disease leading from diabetes and since they are low in saturated fat, accumulation of toxic fat in hepatic and muscle cells that cause impairment in insulin signaling is also reduced [10]. Herbal drugs have lesser or no side effects and are less expensive as compared to synthetic drugs. Herbal medicinal plants with antidiabetic properties can induce release of insulin in Islets of Langerhans in pancreas and also act as insulin sensitizer [11]. Therefore, identification and isolation of anti- hyperglycemic compounds from the plants has become more and more important these days. The ethno-botanical information reports about 800 plants that may possess anti-diabetic potential [12]. Several anti-diabetic plants has been confirm for its hypoglycemic effect and mechanism of hypoglycemic effect are being studied [13]. Glycosides, alkaloids, terpenoids, flavonoid, carotenoids etc. are frequently implicated to

be the reason of anti-diabetic in medicinal plants [14]. Treatments of diabetes with oral hypoglycaemic drugs has many side effects and treatment`s expenditure is also very costly. So utilizing herbal drugs with significant potency can decrease the side effects to negligible amount.

Nagaland, home to a rich variety of flora and fauna is a state in Northeastern India. It is bordered by Assam to its west, Arunachal Pradesh to the north, Sagaing region of Myanmar to the east and Manipur to the south. Its area is cover by tropical, sub-tropical forest and temperate hills. There are 12 districts in Nagaland *viz:* Dimapur, Kiphire, Kohima, Longleng, Mokokchung, Mon, Peren, Phek, Tuensang, Wokha, Zunheboto, Noklak. The state is inhibited by 16 major tribes: Angami, Ao, Chakhesang, Chang, Kachari, Khiamniungan, Konyak, Kuki, Lotha, Phom, Pochury, Rengma, Sangtam, Sumi, Yimchunger, Zeliang. Some other minor tribes include Garo, Mikir, Chirr, Makury, Rongmei and Tilchir. Forests of Nagaland receive abundant rainfall (1,800mm to 2,500 mm annually) which makes the state suitable for a vast variety of flora and fauna [15]. Over 80% of the population lives in remote rural areas and depends on plant based drugs for ailments of different diseases including diabetes. In the past many researchers have published numerous papers on the use of different plants and parts for treatment of this deadly disease. The aim of research was to make a comprehensive review on the use of different plants and their part, mode of uses for treatment of diabetes by the 'Local Healers/ Rural Medicine Persons' which are being used and knowledge has been passed from generation to generation.

2. Materials and methods

This review article is compiled on the anti-diabetic plants through literature survey and compilation of data on ethnobotanical work reported in various scientific journals, books on Nagaland. This survey was conducted during the period from March to October, 2021. The published literatures were collected from papers available online from www.sciencedirect.com; www.plantsjournal.com, www.researchgate.net; www.phytojournal.com; www.elsevier.com; www.academicjournal.org; www.scholarsresearchlibrary.com, etc. The collected data is presented in table 1 and tables contains the relevant ethno medicinal information with name of the plant family and species arranged in alphabetical orders along with its local name, part used and method of using it. Only the accepted names of the plant species were used to avoid repetition of species name of same plant.

3. Results

From various journals on the use of ethnomedicinal plants by various tribes of Nagaland, 47 plants belonging to 29 families are reported to use specially as anti-diabetic. *Albizia lebbeck* Linn. Benth., *Catharanthus roseus* (Linn.) G. Don, *Cissampelos pareira* Linn., *Clerodendron colebrookianum* D. Don, *Debregeasia longifolia* (Burm. f.) Wedd., *Eucalyptus globulus* Labill., *Gynura crepidioides* Benth. *Tithonia diversifolia* (Hemsl.) A. Gray, *Urtica dioica* L., *Zanthoxylum rhetsa* (Roxb.) DC. are 10 medicinal plants used by the Chungtia tribe for the treatment of diabetes [16]. *Kalanchoe pinnata* is used by Phom tribe as anti-diabetic [17]. Chang tribe use *Discentra scandens*, *Momordica balsamina*as anti-diabetic [18]. *Asparagus racemosus* Willdenow, *Catharanthus roseus* Linnaeus is used as anti-diabetic by Phom tribe [19]. Angami tribe uses *Passiflora edulis* Sims., *Potentilla fulgens* Wall. Medicinal plants as anti-diabetic [20]. *Panax ginseng* C.A. Meyer is also reported to used as anti-diabetic in Folk Medicinal Plants of the Nagas in India by Changkija [21]. Shankar *et al*. [22] reported *Catharanthus roseus* (L.) G. Don., *Azadirachta indica* A. Juss., *Coccinia indica* W. & A., *Ecliptap rostrata* Roxb., *Momordica dioica* Roxb. Will., *Momordica charantia* L., *Ocimum sanctum* L., *Scoparia dulcis* L., *Syzygium cumini* (L.) Skeels., *Tamarindus indica* L. as anti-diabetic medicinal plants in conservation of some pharmaceutically important medicinal plants from Dimapur district of Nagaland. Local traditional healers and collectors for trading widely used these medicinal plants. Some of the cultivars are also practicing cultivation for some of the medicinal plants [22]. While species like *Abroma augusta* (L.) L.f., *Bauhinia variegata* L., *Cajanas cajan* (L.) Millsp., *Cinnamomum tamala* (Buch-Ham.) T. Nees & C.H. Eberm., *Juniperus racemosa* Risso., *Melothria heterophylla* (Lour.) Cogn., *Ocimum tenuiflorum* L., *Tinspora cordifolia* are the antidiabetic medicinal plants found in Kohima, Mokokchung, Tuensang and Zunheboto districts of Nagaland [15]. Sumi Naga tribe are using *Bauhinia variegata* Linn., *Dioscorea alata* Linn., *Passiflora edulis* Sims., as remedy for by diabetes patient [23]. *Solanum nigrum* and *Emblica officinalis* are anti-diabetic medicinal plants used by Chakhesang tribe of Nagaland [24]. Fruits extract of *Emblica officinalis* Gaertn. is used to treat diabetes by Lotha tribe [25]. *Paederia foetida* L., *Phlogacanthus thtyrsi* Florus Nees., *Perilla jrutescens* (L.) Britt., *Punica granatum* L. are anti-diabetic plants used by Ao Naga tribe [26].

4. Discussion

In the present review paper, total of 47 plants belonging to 29 families are reported as antidiabetic plants used by the tribes of Nagaland. This plants list is not completely comprehensive as more information and plants could be added through more detail investigation of the region. Since, there is cultural diversity and there are rich ethnobotanically important plants in Nagaland, ethnobotanical field exploration is still necessary. Sharing methods of used of folklore medicinal plants from older generation to younger generation are endangered nowadays [15]. Therefore, compilation and documentation of ethnomedicinal used is very important before the complete loss of this valuable information.

It is evident that there are various reports on ethnomedicinal importance and phytochemical analysis on various antidiabetic plants species has been done in different part of the world. However, there are very limited information on the molecular characterization and phytochemical analysis of the native genus with antidiabetic values occurring in Nagaland. Thus, this review article will be the based platform to analyses the biochemical properties and establishing possible mode of anti-diabetic action withhold by the above mentioned native plants of Nagaland.

Table 1: List of anti-diabetic potential ethnomedicinal plants used by the local healers and various ethnic tribes of Nagaland, India

Sl. No.	Scientific Name	Family	Local Name	Habit	Parts used	Method of use
1.	*Abroma augusta* (L.) L. f.	Malvaceae	Ulatkambal	Shrub	Fresh leaf	Decoction of fresh leaf
2.	*Albizia lebbeck* Linn.	Fabaceae	Moang (Ao tribe)	Tree	Stem and its bark	Dried powder of stem and bark are boiled

	Benth					and extract are drink
3.	*Asparagus racemosus* Willd	Asparagaceae	Pongijo (Phom tribe)	Climber	Roots	Decoction of roots
4.	*Azadirachta indica* A. Juss	Meliaceae	Neem	Tree	Leaf	Extract of leaf
5.	*Bauhinia variegate* L.	Caesalpiaceae	Alphabo(Sumi tribe)	Tree	Roots and bark	Extract of root and bark
6.	*Cajanus cajan* (L.) Millsp.	Fabaceae	Chiopi (Zeliang tribe)	Herb	Leaf	Boiled leaf is drink as tea
7.	*Catharanthus roseus* (Linn.) G. Don	Apocynaceae	Ampoknaro (Phom tribe), Supienaro (Ao tribe)	Herb	Leaves and flower	Decoction of leaves and flower
8.	*Cassia alata* L.	Fabaceae	Dadmari	Shrub	Leaf	Decoction of leaf
9.	*Cinnamomum tamala* (Buch-Ham) T.	Lauraceae	Tejpat	Tree	Leaves	Boiled leaves
10.	*Cissampelos pareira* Linn.	Menispermaceae	Likhazung(Ao tribe)	Climber	Roots and leaves	Boiled extract of roots and leaves
11.	*Clarodendron colebrookianum* D. Don	Verbenaceae	Oremwa (Ao tribe)	shrub	Leaves	Leaves are taken by simple boiling
12.	*Coccinia indica* W. & A.	Cucurbitaceae	Kundru	Climber	Leaf and fruit	Leaf and fruit is consumed as vegetables
13.	*Debregeasia longifolia* (Burm. f.) Wedd	Urticaceae	Natsulawa (Ao tribe)	Shrub	Leaf	Leaf decoction is taken orally
14.	*Dicentra scandens*	Fumariaceae	Phubai (Ao tribe)	Climber	Tubers	Extract of tubers
15.	*Dioscorea alata* Linn.	Dioscoreaceae	Achuchu (Sumi tribe)	Climber	Tubers	Extract of tubers
16.	*Eclipta prostrate* Roxb.	Asteraceae	Bringaraja	Herb	Leaf	Leaf extract
17.	*Emblica officinalis* Gaertn.	Euphorbiaceae	Jakhethi (Lotha tribe), Aonla (Chakhesang tribe)	Tree	Fruit	Fruit extract
18.	*Eucalyptus globules* Labill.	Myrtaceae	Eucalyptus (Ao tribe)	Tree	Leaves and flowers	Leaves and flowers extracts
19.	*Euphorbia hirta* L.	Euphorbiaceae	Laghudugdhika	Herb	Leaves and flower	Leaves and flower decoction
20.	*Gynura crepidioides* Benth.	Asteraceae	Monglibaza (Ao tribe)	Herb	Leaf	Leaf decoction is taken orally
21.	*Juniperus racemosa* Risso.	Cupressaceae	Vapusa	Tree	Berries	Decoction of berries
22.	*Kalanchoe pinnata* (Lam.) Pers.	Crassulaceae	Hohlongkak (Phom)	Herb	Leaves	Leaves decoction
23.	*Melothria heterophylla* (Lour.) Cogn.	Cucurbitaceae	Hangkhapaitarere (tangkhul – naga tribe)	Climber	Fruits	Fruits is taken as vegetables
24.	*Momordica balsamina* L.	Cucurbitaceae	Kora (Chang tribe)	Climber	Leaves and seed, fruits	Leaves as decoction, fruits and seeds as vegetables
25.	*Momordica charantia* L.	Cucurbitaceae	Karela	Herb	Fruits	Fruits are taken by frying
26.	*Momordica dioica* Roxb. Will	Cucurbitaceae	Bhat karela	Herb	Fruits	Fruits is taken as vegetables
27.	*Morus alba* L.	Moraceae	Yong metiong	Tree	Leaf	Leaf is used as tea
28.	*Mucuna pruriens* (L.) DC	Fabaceae	Mesener (Ao tribe)	Climbing shrub	Seeds	Seeds are used
29.	*Ocimum basilicum* L.	Lamiaceae	Nangparangtong	Shrub	Leaf	Leaf decoction
30.	*Ocimum tenuiflorum* L.	Lamiaceae	Tulasi	Shrub	Leaf	Leaf decoction
31.	*Oroxylum indicum* (Linn.) Benth. ex Kurz.	Bignoniaceae	Kakidziihe (Mao tribe)	Tree	Bark	Decoction of freshly peeled bark, dried peels of bark grounded and mixed with water
32.	*Paederia foetida* L.	Rubiaceae	Ajungzu or sunemli (Ao tribe)	climbers	Whole plant	Whole plant is pounded into paste and the paste is taken orally
33.	*Panax ginseng* C.A. Meyer.	Araliaceae	Tsudirmozu	Herb	Roots	Dried roots powder is taken orally
34.	*Passiflora edulis* Sims.	Passifloraceae	Bel (Angami tribe)	Vine	Leaf	Decoction of leaf
35.	*Perilla frutescens* (L.) Britt.	Lamiaceae	Napa –tong (Ao tribe)	Herb	Leaves and inflorescence	Powder of dried leaves and inflorescence are drank with water
36.	*Phylogacanthus thytyrsiflorus* Nees.	Acanthaceae	Tuo-mozu (Ao tribe)	Shrub	Leaves	Tea of powdered dried leaves.
37.	*Potentilla fulgens* Wall.	Rosaceae	Kijiichiini (Angami tribe)	Herb	Roots	Roots is tap and then eaten raw or decoction taken
38.	*Punica granatum* L.	Puniaceae	Pomegranate, Jarem (Ao tribe)	Shrub	Fruits and seeds	Decoction of fruits and seeds mixed with pure honey is taken orally
39.	*Scoparia dulcis* L.	Plantaginaceae	Mithipatta	Herb	Whole plant	Whole plant extract
40.	*Solanum nigrum* L.	Solanaceae	Tiitsishe (Chakhesang tribe)	Herb	Leaves	Leaves is boiled and taken along with extract
41.	*Solanum trilobatum* L.	Solanaceae	Longkok or likok (Ao tribe)	Herb	Leaf	Leaf extracts
42.	*Solena heterophylla* Lour.	Cucurbitaceae	Bankundri	Climber	Roots	Roots decoction
43.	*Syzygium cumini* (L.) Skeels	Myrtaceae	Jamun	Tree	Bark	Bark decoction
44.	*Tamarinduss indica* L.	Fabaceae	Imli	Tree	Seeds and leaf	Extract of seeds and leaf
45.	*Terminalia chebula* Retz.	Combretaceae	Haritaki	Tree	Seeds	Extract of seeds
46.	*Tinospora cordifolia* (Thunb.) Miers	Menispermaceae	Guduchii	Herbaceous vine	Stem	Extract of stem
47.	*Zanthoxylum armatum*	Rutaceae	Mongmang (Ao tribe), Ganya (Angami)	shrub	Leaves and fruits	Leaves and fruits are chewed

5. Conclusion

The study shows that herbs (specially the leaf part of the plant) are mainly used by tribe of Nagaland. Cucurbitaceae, Fabaceae and Lamiaceae are some of the most common occurring families with anti-diabetic properties. Many bioactive drugs have been isolated from the plants which have hypoglycemic effect and have shown effective for the treatment of diabetes. However many other bioactive agents obtained from the plant is still yet to be characterized. To establish the safety and effectiveness of reported plant species, phytochemical analysis of the mentioned plant needs to be done. It will also increase the awareness among the younger generation about the need of preserving these important floras which otherwise will be lost because of deforestation. Therefore there is urgent need for the management of these anti-diabetic plants with the establishment of its chemical profiling and their anti-diabetic mode of action. The toxicity effect of these plants also needs to be elucidated.

6. Conflict of Interest: Authors declare that there is no conflict of interest.

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