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An ethnobotanical survey of antidiabetic medicinal plants used by the Bodo tribe of Kokrajhar district, Assam

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Diabetes mellitus (DM) belongs to the group of diseases causing major health problems in India and world at large. Natural products including medicinal plants are known to treat various diseases worldwide since ancient times. It is well known that plants are a great source of bioactive compounds having tremendous medicinal properties and can be used to discover plant-based drugs with lesser side effects. A survey was carried out among the Bodo community of Kokrajhar district of Assam to explore the traditional knowledge on medicinal plants against diabetes using semi-structured interviews among the local healers and elderly people. A total of 54 informants were interviewed in a face-to-face manner following readymade questionnaire, of which 15 healers were known to have knowledge regarding antidiabetic medicinal plants. A total of 37 medicinal plants, belonging to 24 families and 33 genera were found to be used by traditional healers of Kokrajhar district to cure diabetes. The mostly cited plant was found to be *Hodgsonia heteroclita* (Roxb.) followed by *Andrographis paniculata* (Burm. f.) Nees. Out of the 24 families, Apocynaceae was found to be the most popular plant family with four numbers of plants.

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The world is fertile with natural and medicinal plants. Medicinal plants continue to be an important therapeutic aid for alleviating ailments of mankind[1]. Approximately 80% of the people in the developing countries rely on traditionally used medicinal plants for their primary health care needs[2]. Plants have always been an exemplary source of drugs since ancient times. Many of the currently available drugs have been derived directly or indirectly from plant source[3]. Plants are a rich source of bioactive compounds (secondary metabolites) and are of great value for developing novel therapeutic agents[4]. Since ancient times, plants and its derivatives have been traditionally used as medicine for the treatment of various diseases. Many plants such as *Tylophora indica*, *Dioscorea bulbifera* etc. are used for the treatment of common health problem such as asthma, piles, dysentery, etc[5].

DM is a metabolic disorder characterized by hyperglycemia resulting from defects in either insulin secretion or insulin resistance or both[1]. There are two major forms of diabetes- Type-1 (insulin-dependent DM) and Type-2 (noninsulin-dependent DM). Type-I DM occurs when the human immune system destroys pancreatic β-cells, which are responsible for secreting insulin. Insulin concentration can efficiently be managed through continuous injection in timely dosages. Elevated post-prandial blood glucose levels are widely recognized as one of the earliest disease markers in the prediction of subsequent microvascular and macrovascular complications that can progress to full symptomatic Type-2 Diabetes (T2DM). Type-2 DM accounts for about 90% of the diabetic cases and typically begins as insulin resistance until the pancreas slowly loses its ability to produce insulin[6]. Globally, an estimated of 422 million adults were living with diabetes in 2014, rising from 4.7% to 8.5% in adult population[7]. It is the most common and very prevalent disease affecting the citizens of both developed and developing countries all around the world. It is estimated 25% of the world's population is currently being affected by this disease[8]. Currently available therapy for diabetes and the use of orthodox drugs in the management of DM

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has not improved the situation but are reported to produce serious adverse side effects such as liver problems, lactic acidosis and diarrhoea. Plants are well known in traditional medicine for their hypoglycaemic activities. Available literature indicates that there are more than 800 plants species showing hypoglycaemic activity[9]. There has been increasing demand for the use of plant products with antidiabetic activity due to low cost, easy availability and lesser side effects[1]. Currently medicinal plants continue to play an important role in the management of diabetes milletus. Recently, the World Health Organization (WHO) recommended the use of medicinal plants for the management of DM and further encouraged the expansion of the frontiers of scientific evaluation of the hypoglycaemic properties of diverse plant species[10].

North east India is blessed with rich flora and fauna. The favourable climate condition in this part of India, provide various endemic plants and animals to sustain their lives, making it the biodiversity hot spot area. It comprises of eight states viz; Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura. Bodoland Territorial Council (BTC) consist of areas located in extreme north of north bank of river Brahmaputra in the state of Assam, at the foothills of Bhutan and Arunachal Pradesh. It is the gateway to the north eastern region of India, which was created in February, 2003 by curving eight districts out of Assam namely Kokrajhar, Dhubri, Bongaigaon, Barpeta, Nalbari, Kamrup, Darrang and Sonitpur within the state of Assam. Geographically, it covers an area of 8,795 sq. km (provisional) that includes Bodoland Territorial Area Districts administered by the BTC, an autonomous administrative unit constituted under the sixth schedule of constitution[11]. This part of India is full of medicinal plants. Several medicinal plants are traditionally being used as medicines against many diseases. Although a large number of plants are used as medicine, no scientific work has been carried out comprehensively in this part of India. Keeping this view in mind, the present study has been designed to study the medicinal plants traditionally being used as antihyperglycemic agent by the Bodo people of Kokrajhar district of Assam.

Materials and methods

A survey was carried out in Kokrajhar district which is predominantly inhabited by the Bodo tribe, and covers an area of 3169.22 km^2, geographical location of 89˚46' East to 90˚38' East and 26˚19' North to 26˚54'North. It is located in the extreme north of the river Brahmaputra, and is rich in various flora and fauna. For administrative purpose, the district is divided into 11 Community Development Blocks (CDBs) and has a total of 1068 villages, of which 15 is uninhabited forest villages. The names of CDBs are: (1) Kachugaon, (2) Gossaigaon, (3) Hatidhura, (4) Dotma, (5) Kokrajhar, (6) Golakganj, (7) Rupsi, (8) Debitola, (9) Mahamaya, (10) Bilasipara and (11) Chappar-Salkocha.

The survey was done from the month of April to October 2018. The demographic data and information about the medicinal plants was collected with the help of local healers and elderly people having knowledge about medicinal plants. Within every CDB, approximately 20 adjacent villages were taken as single cluster and one sample is collected from a cluster. The information was collected via the administration of semi-structured interviews with the help of ready-made questionnaire. The information collected from informants included informer's bio-data, name of the plant, parts used, traditional formulation processes and mode of administration. A total of 54 traditional healers were interviewed from different villages of Kokrajhar district but only 15 informants were found to have knowledge regarding medicinal plants used for the treatment of diabetes. The medicinal plants mentioned by the herbalist were photograph and collected for identification. Herbarium sheets were prepared and submitted to the Department of Botany, Bodoland University, the identification numbers were collected and the voucher specimen were preserved.

Data analysis

All the statistical calculations, graphs etc. were carried out in Microsoft excel and Origin software. The documented data was analysed by comparing a number of parameters such as number of plant species, families, plant part used, modes of utilization, habit and habitat of the plant species.

Results and discussion

In the present study 54 local healers were interviewed from 54 different villages of 11 CDBs under Kokrajhar district. However, only 15 informants were found to possess ethnomedicinal knowledge regarding the antidiabetic medicinal plants

as well as other common diseases. Out of the 15 informants, 11 were male and 4 were female. The names of the CDBs, Informant's villages and their geographical locations are given below in Table 1. Out of the 15 informants, the highest numbers of informants were recorded from Kokrajhar CDB followed by Dotma and Gossaigaon. Fig. 1 represents the different locations of information collection sites. Regarding literacy, it is found that most of the informants (40%) were having school level education, while 33.3% have college level education, and 20% has no formal education at all (Table 2). Similarly, many such ethnomedicinal survey reports have revealed that traditional knowledge bearers are always illiterate, poor and rural based livelihood[63,64]. Regarding the ethnomedicinal knowledge literate

Table 1 — List of villages where antidiabetic medicinal plants were collected along with the geographical location

Sl no	C.D. Block	List of villages	Geographical location
1.	Chapar- Salkocha	Borghola	26°17'04.23″N 90°18'20.32″E
2.	Dotma	Baoraguri	26°27'07.21″N90°08'36.27″E
3.		Dotma Bazar	26°28'06.81″N 90°09'02.61″E
4.		Narenguri	26°29'19.30″N 90°05'23.74″E
5.	Kachugaon	Karikhar FV	26°32'47.01″N 90°03'35.05″E
6.		Kumtola FV	26°33'06.04″N 90°02'55.13″E
7.	Kokrajhar	Chilaguri	26°28'35.26″N 90°12'04.06″E
8.		Mahendrapur	26°36'09.86″N 90°14'24.07″E
9.		Mawriagaon-II	26°27'04.83″N 90°08'40.14″E
10.		Pakhriguri	26°31'00.58″N 90°14'32.44″E
11.		Sutharpara	26°29'36.69″N 90°20'38.95″E
12.	Gossaigaon	Banglabari	26°39'90.55″N 90°03'27.32″E
13.		Gossaigaon-I	26°42'84.87″N 89°99'98.33″E
14		Singimari-II	26°36'04.09″N 89°99'01.02″E
15	Debitola	Kazigaon Pt.-I	26°19'21.79″N 89°99'46.81″E

*Part (Pt.) means some villages of Debitola CDB comes under Dhubri district and some under Kokrajhar district and the villages that come under Kokrajhar district is written as 'Part'. FV - forest village.

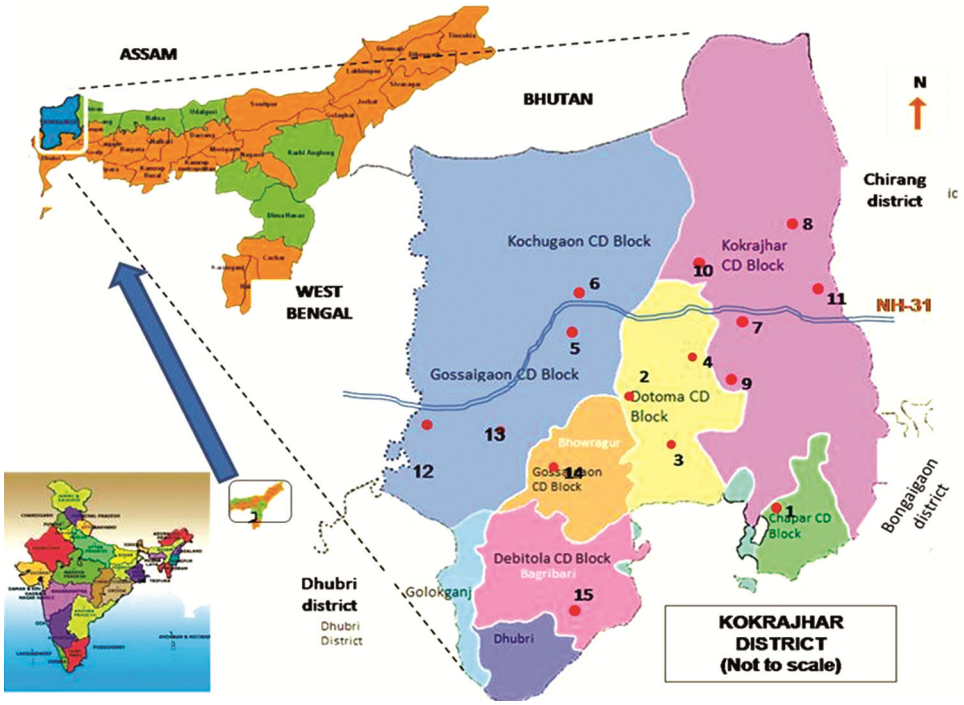

Fig. 1 — Map showing geographical locations of informants of 11 CDB of Kokrajhar district

traditional healers were found to possess move information (4.8 plant citations/informants) than illiterates (2.3 plant citations/informants). All the informants were local healers, who had been practicing traditional medicine system since long times. It has also been found that most of the knowledge about the medicinal plants has been passed onto them by their parents or grandparents or some relatives who had a vast knowledge about the diseases and its cure. The names of the plant species, its local names as well as the traditional formulation methods is shown in Table 3. Our survey revealed that 37 species of medicinal plants belonging to 24 families and 33 genera are found to be used for the treatment of diabetes. Our survey also found that, most of the plants cited by the local healers are locally available,

Table 2 — Demographic characteristics of informants of Kokrajhar district CDBs

Block	School	College	Illiterate
Chapar-Salkhocha	1	-	-
Dotma	2	1	-
Debitola	1	-	1
Gossaigaon	1	1	1
Kokrajhar	1	3	-
Kachugaon	1	-	1
Total	**7**	**5**	**3**

Table 3 — Name of the plants, parts used, traditional formulation and habit of plants

Sl. No.	Scientific Name & Voucher Number	Family	Local Name (Bodo)	Parts Used	Preparation	Habit	References
1.	*Tinospora cordifolia* (Willd.) Meirs [BUBH2018024]	Menispermaceae	amar lotha	stem, leaves	decoction	climber	Yes[12-14]
2.	*Phyllanthus emblica* L. [BUBH2018023]	Euphorbiaceae	amla	fruit	raw	tree	Yes[15,16]
3.	*Terminalia arjuna* (Roxb. Ex DC.) Wigt & Arn [BUBH2018066]	Combretaceae	arjun	bark	infusion	tree	Yes[17,18]
4.	*Musa balbisiana* Colla [BUBH2018067]	Musaceae	athia thalir	aerial stem	decoction	shrub	No
5.	*Phlogacanthus tubiflorus* Nees [BUBH2018028]	Acanthaceae	basikhor	flower	decoction	shrub	NO
6.	*Aegle marmelos* (L.) Corrêa [BUBH2018068]	Rutaceae	bell	leaves	decoction	tree	Yes[19-21]
7.	*Terminalia bellirica* (Gaertn.) Roxb. [BUBH2018069]	Combretaceae	bhaora	fruit	raw	tree	Yes[15,22]
8.	*Paspalum fimbriatum* Kunth [BUBH2018070]	Poaceae	dapsa	whole plant	decoction	herb	No
9.	*Syzygium jambos* (L.) Alston [BUBH2018071]	Myrtaceae	godjaam	tender leaves	raw	tree	Yes[23]
10.	*Calotropis gigantea* (L.) R. Br. ex Schult. [BUBH2018072]	Apocynaceae	gogondo	leaves	decoction	shrub	Yes[24,25]
11.	*Rosa alba* L. [BUBH2018073]	Rosaceae	golabgufur	flower	infusion	shrub	No
12.	*Syzygium cumini* (L.) Skeels BUBH2018074]	Myrtaceae	gwswm jamboo	seed	infusion	tree	Yes[26-28]
13.	*Hodgsonia heteroclita* (Roxb.) Hook.f. & Thomson [BUBH2018075]	Cucurbitaceae	hagrani jwgwnar	fruit	decoction	climber	Yes[29]
14.	*Artocarpus heterophyllus* Lam. [BUBH2018076]	Moraceae	khanthal	leaves	infusion	tree	Yes[30-32]
15.	*Ficus racemosa* L. [BUBH2018077]	Moraceae	dumburu	fruit	decoction	tree	No
16.	*Alpinia galanga* (L.) Willd. [BUBH2018078]	Zingiberaceae	jermao	tuber	raw	herb	Yes[33]
17.	*Andrographis paniculata* (Burm.f.) Nees [BUBH2018009]	Acanthaceae	kalmith	leaves	decoction	herb	No
18.	*Oroxylum indicum* (L.) Kurz [BUBH2018012]	Bignoniaceae	Kharong khandai	leaves	decoction	tree	No

(*Contd.*)

Table 3 — Name of the plants, parts used, traditional formulation and habit of plants (*Contd*.)

Sl. No.	Scientific Name & Voucher Number	Family	Local Name (Bodo)	Parts Used	Preparation	Habit	References
19.	*Rauvolfia tetraphylla* L. [BUBH2018013]	Apocynaceae	kharwkha	root	decoction	shrub	No
20.	*Syzygium aromaticum* (L.) Merr. &L.M.Perry [BUBH20180079]	Myrtaceae	long	flower bud	decoction	tree	Yes[34-36]
21.	*Centella asiatica* (L.) Urb. [BUBH2018020]	Apiaceae	manimuni gidir	leaf	decoction	herb	Yes[37-39]
22.	*Hydrocotyle sibthorpioides* Lam. [BUBH2018019]	Apiaceae	manimuni fisa	whole plant	decoction	herb	No
23.	*Trigonella foenum-graecum* L. [BUBH2018080]	Fabaceae	methi	seed	infusion	herb	Yes[40-42]
24.	*Clerodendrum infortunatum* L. [BUBH2018047]	Lamiaceae	mwkhwna	tender leaf	decoction	shrub	No
25.	*Lindernia crustacea* (L.) F. Muell. [BUBH2018048]	Linderniaceae	na bikhi	whole plant	decoction	herb	No
26.	*Azadirachta indica* A. Juss. [BUBH2018051]	Meliaceae	neem	leaf	raw	tree	Yes[43-45]
27.	*Asparagus racemosus* Willd. [BUBH2018063]	Asparagaceae	nilikhor	roots	decoction	climber	Yes[46,47]
28.	*Catharanthus roseus* var. *albus* G. Don [BUBH2018081]	Apocynaceae	parboti	flower, leaves	decoction	herb	Yes[48]
29.	*Bryophyllum pinnatum* (Lam.) Oken [BUBH2018057]	Crassulaceae	path gaja	leaf	infusion	herb	Yes[49]
30.	*Ficus religiosa* L. [BUBH2018082]	Moraceae	phakhri	leaves	decoction	tree	Yes[50-52]
31.	*Nelumbo nucifera* Gaertn. [BUBH2018083]	Nelumbonaceae	podophul	stem	infusion	herb	Yes[53,54]
32.	*Terminalia chebula* Retz. **[BUBH2018062]**	Combretaceae	selekha	fruit	raw	tree	Yes[55-57]
33.	*Nyctanthes arbor-tristis* L. **[BUBH2018084]**	Oleaceae	sewali	flower	decoction	tree	Yes[58]
34.	*Piper longum* L. [BUBH2018085]	Piperaceae	simfri	fruit	raw	climber	Yes[59]
35.	*Alstonia scholaris* (L.) R. Br. **[BUBH2018040]**	Apocynaceae	sithona	bark	infusion	tree	No
36.	*Ocimum tenuiflorum* L. **[BUBH2018045]**	Lamiaceae	tulsi	roots	decoction	herb	No
37.	*Momordica charantia* L. [BUBH2018086]	Cucurbitaceae	udasi	tender leaf, fruit	decoction	climber	Yes[60-62]

some are wild, and some plants had been grown by them for easy availability as well as to conserve the valuable medicinal plants. Furthermore, on being asked about the plant availability, they also added that most of the plants which were available several years ago are now found to be decreased in their numbers. This shows the decrease of valuable medicinal plants.

The most cited plant families was seen to be Apocynaceae (16.6%), followed by Moraceae, Combretaceae and Myrtaceae (12.5%), Cucurbitaceae, Acanthaceae, Apiaceae and Lamiaceae (8.3%). The most highly cited plant life forms are found to be a big tree (40.54%) followed by herbs (29.72%), shrubs (16.21%) and climbers (13.51%). *H. heteroclita* was found to be the most popular plant with 6 numbers of citations followed by *A. paniculata* (5 citations) and *R. tetraphylla* (3 citations). Out of the 37 reported plant species, 26 numbers of plant species have been mentioned once by the informers (Fig. 2). The most common plant part used in the preparation of traditional medicine was found to be leaves (51.35%), followed by fruit (16.21%), flowers (13.50%), roots

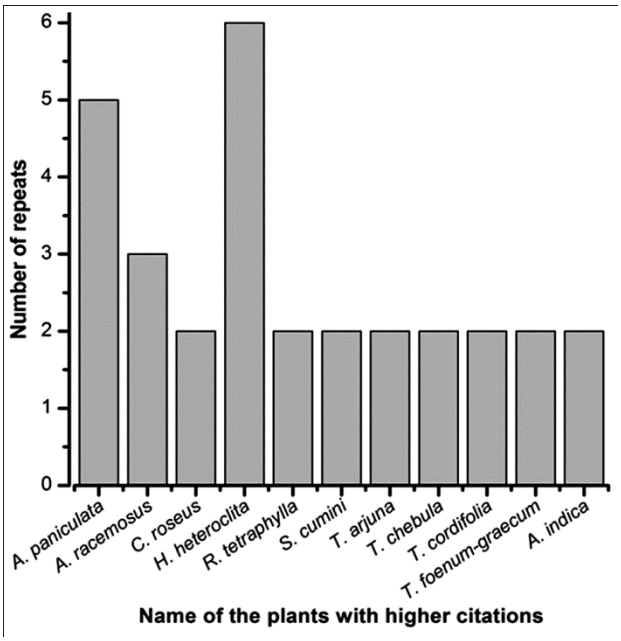

Fig. 2 — List of plants and citations by traditional healers

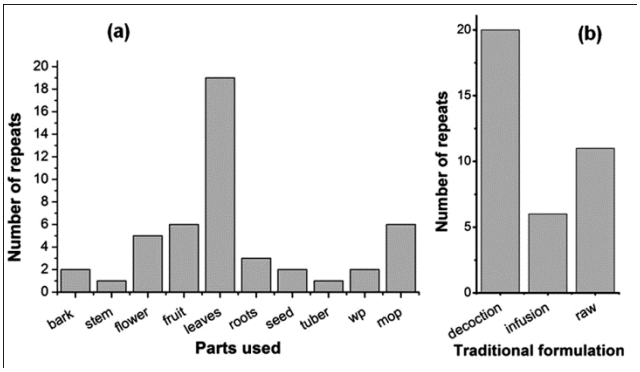

Fig. 3 a) — frequency of plant parts used during preparation of herbal medicines and b) traditional formulations adopted by the traditional healers in the preparation of herbal remedies. mop-more than one part, wp-whole plant

(8.10%), bark (5.40%), seed (5.40%), stem (2.70%) and tuber (2.70%) (Fig. 3a). In two plants, namely *H. sibthorpioides,* and *L. crustacea,* the whole plant was found to be used. Similar to our finding, leaves has been found to be the mostly used parts for preparation of herbal remedies in many other studies[65,66]. It has come into our observation that out of 37 plant species, in 6% of the plants more than one part is used for the preparation of traditional medicine. *Nelumbo nucifera* is the most common plant where leaves, rhizome and stem are used.

Decoction, infusion and raw preparations were found to be the common traditional herbal formulation practices among the traditional healers of Kokrajhar district of Assam. Based on the method of preparation, our survey found that decoction (54.05%) is the mostly used method adopted by the traditional healers. Similar to our study, many ethnomedicinal survey reports also reported decoction being the mostly used method for preparation of herbal medicines[67]. Fig. 3b showed the various ethnomedicine preparations practiced by traditional healers. We have also performed a literature survey for all the plants cited by the traditional healers and found that 62.16% of the plants have one or more literature regarding antidiabetic property. However, 37.83% of the plants and the parts cited by the traditional healers were found to have no scientific literature on antidiabetic property. Similar to our study, an ethnobotanical survey was carried out in Nalbari district of Assam which revealed 35 species of plants belonging to 28 families which are used to cure diabetes and most of them are consumed in the form of raw juice[68]. In another study, Tarak *et al.*[69] surveyed and collected the ethnomedicinal information on antidiabetic medicinal plants of Dhemaji district showing the use of 21 plant species belonging to 20 families to cure diabetes. The traditional healers of Unakoti district of Tripura were also found to use 39 medicinal plant species belonging to 37 genera and 28 families for diabetes treatment[70].

Conclusion

The medicinal plant plays an important role in the treatment of Diabetes among the Bodo community of Kokrajhar district, Assam. Out of total 37 reported plants, 13 plants were found to have no scientific literature regarding the antidiabetic activity. *Andrographis paniculata* and *Rauvolfia tetraphylla*, although popularly used for diabetes cure in Kokrajhar district, there is no report of any experimental validation from India in favor of their antidiabetic activity. However, few literatures are available from outside of India. Most of the plants cited the traditional healers possesses scientific validation about antidiabetic property and therefore, the importance and significance of ethnomedicinal knowledge practiced since time immemorial cannot be ruled out. Traditional healers although do not have any scientific experimental methodology, but they do have some kind of experimentation by which diseases are cured. With the increase in urbanisation and mass deforestation, there is a rapid loss of many important medicinal plants. In addition to it, the blooming modern healthcare facilities have overshadowed the ethnomedicinal practice leading to the deterioration of

traditional knowledge. The present study will be helpful, to protect the ancient and traditional ethnomedicinal knowledge of Bodo community and also to preserve and transfer the knowledge to the next generations for the development of effective herbal remedies in the near future.

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