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Ethnomedicinal Plants and their Traditional Use for Treatment of Diabetes in Kokrajhar District of Assam, India

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ABSTRACT

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The present study was aimed at investigating the traditional utilization of medicinal plants located in Kokrajhar district of Assam. The local inhabitants of the district have a long history of traditional plant usage for medicinal purposes. Different herbs are used by different tribes to treat various diseases. The knowledge of traditional formulation of medicinal plants is inherited from one generation to other. Medicinal herbs to treat different ailments by the tribal folks are already getting scientific evidence based research and many are found effective. Different parts of plants like roots, leaf, seed, flower, bark etc are also used in preparation of different Ayurvedic medicines to treat various human ailments including diabetes. Research findings support that many ethnomedicinal herbs are effectively used to treat Diabetes mellitus.

Introduction

Medicinal plants have important contributions in the healthcare system of local communities across the world for almost all types of ailments. Out of the total 422,000 flowering plants reported from the world, more than 50,000 are used for medicinal purposes (Hamilton, 2004). The healing power of traditional herbal medicines has been realized and documented since *Rigveda* and *Atharvaveda*, most of which involve the use of plant extracts. In last few decades, traditional knowledge on primary healthcare has been widely acknowledged across the world. It is estimated that 60% of the world

population and 80% of the population of developing countries rely on traditional medicine, mostly plant drugs, for their primary health care needs (Shrestha and Dhillon, 2003).

The highest popularity of medicinal plant in rural areas is due to high cost of allopathic drugs and side effects. Traditionally used medicinal plants have been a source of relief in controlling different types of diseases throughout the globe.

Among many other different ailments, Diabetes Mellitus is considered to be a metabolic disorder and 2.8% of the world's

population suffers from this disease and it is expected to increase to more than 5.4% by 2025. Various research and reviews have demonstrated the benefits of medicinal plants containing hypoglycemic properties in diabetes management. The most common herbal active ingredients used in treating diabetes are flavonoids, tannins, phenolic, and alkaloids.

Further, the mechanisms of actions for hypoglycemic plants includes increasing of insulin secretion, increasing of glucoses absorption by muscle and fat tissues, prevention of glucose absorption from the intestine, and prevention of glucose production from liver cells. (Kooti *et al.*, 2016).

These factors are mostly responsible for the reduction or elimination of diabetes complications through enthome medicinal plants abundantly available in nature.

Therefore, there is an urgent need to document the medicinal and aromatic plants associated traditional knowledge, because this knowledge orally passes on from one generation to the next; thus, have vulnerability to wiped out (Kala, 2005).

Most of the medicinal plants used by local people and tribes of the state of Assam are indigenous and are not known to the vast world of phytochemical science and research. The active ingredients and potent phytochemicals with promising pharmacological properties present in those plants are yet to be explored and some are in the pipeline (Sarmah and Das, 2018).

Traditional use of plants and plant-parts has been a deep rooted practical knowledge in the culture and livelihood of the people living in the remote district like Kokrajhar in the state of Assam. They have been using different

medicinal plants in their daily health care practices. Plant parts used more frequently are in form of bark, leaf, tuber, fruits, roots etc. The present study was aimed at investigating the traditional utilization of medicinal plants located in Kokrajhar district of Assam in order to identify and explore plant species that are used locally for treatment of human ailments particularly diabetes and also to document traditional formulation from these medicinal plants

Materials and Methods

The present study was carried out in four (4) health blocks or 11 development block of Kokrajhar district of Assam. A total of 100 respondents were selected on the basis of information provided by the local administrator and elder people of the study areas. Prior to survey, a semi structured interview schedule was designed and pre tested with five respondents to find out its suitability for the present study and later on it was modified according to response of respondents.

The revised schedule was used for collecting data from individual respondent about medicinal plants of the study area. Indigenous technological knowledge (ITK) on medicinal properties of edible species was also collected in the same manner from the respondents. Their scientific names, vernacular names and family were identified consulting literatures. Traditional uses of the plant species were supported with relevant literatures.

Results and Discussion

Data collected from 100 respondents reveals that 23 plant species were in use for medicinal purposes, specifically for diabetes management. Traditional uses of the plant species were discussed with reference to the relevant literatures (Fig. 1 and Table 1).

Table.1 Ethnomedicinal plants and their traditional use for treating diabetes in Kokrajhar district of Assam

Sl. No.	Plant species	Traditional use	Reported phytochemical/pharmacological activities
1	<i>Annona squamosa</i> L Family: Annonaceae Common name: Custard apple Vernacular names: Assamese: <i>Attaphol</i> , <i>Atlas</i> , <i>Ata kothal</i> , <i>Sita phol</i> Bodo: <i>Aithaphol</i>	Raw bark or/and leaves of custard apple are grinded and the extracts are obtained by squishing. The extract is then filtered and used 2 to 3 tea spoonfull of extract every morning.	The plant is reported to contain glycosides, flavonoids, phenolic compounds, proteins, tannins, bio active compounds like Anonaine, aporphine, norcorydine, glaucine, geraniol, etc. It acts as anti-diabetic, anti-microbial having pesticide effect. Flavonoids are reported to possess antidiabetic activity. Phytochemical analysis of leaves of <i>A. squamosa</i> Linn. revealed the presence of flavonoids. which can be used as potential antidiabetic drug (Tomar and Sisidia, 2014).
2	<i>Azadirachta indica</i> A.Juss Family: Meliaceae Common Name: Neem Vernacular names: Assamese: <i>Neem</i> Bodo: <i>Neem</i>	Raw leaf extracts of Neem is mixed with little water and 2-3 tea spoonful is taken daily in empty stomach	Neem extract which have Nimbinin, nimbandiol as active constituents, alcoholic extract of the leaves is found to possess a significant blood sugar lowering effect, which are very useful against diabetes. (Uddin <i>et al.</i> , 2018) Bio active compounds are Azadirachtin, meliacin, salanin, nimbin and valassin etc. Various biological and pharmacological activity of the plant includes- anthelmintic, antibacterial, antiulcer, anti-fertility, anti-diabetic, anti-inflammatory, antiviral, anti-malarial, diuretic, insecticidal, anti-spermatogenic, antitumor, hypo-glycaemic, etc (Giri <i>et al.</i> , 2019)
3	<i>Cateranthus roseus</i> (L.) G.Don Family: Apocynaceae Common Name: Bright eye Vernacular names: Assamese: <i>Nayantara phul</i> Bodo: <i>Daodwi bibar</i>	Fresh leaf extracts or fresh leaf of bright eye may be chewed in empty stomach	The plant has immense medicinal importance for its alkaloids. All parts of the plant including leaf, root, shoot and stem contains more than 200 alkaloids, which are used for therapeutic purposes against several diseases. The most important alkaloids vinblastine and vincristine are derived from leaves and they exhibits anti-cancer and anti-diabetic property and alkaloid rubacine derived from roots is used as hypotensive and anti-arrhythmic agent. (Gupta <i>et al.</i> ,2017) . The leaf and flower are extensively used to treat diabetes and it promotes insulin production in human body. (Gomaa <i>et al.</i> , 2019)
4	<i>Centella asiatica</i> (L. Urban) Family: Mackinlayaceae Common Name:	<i>Centella asiatica</i> is a traditionally important plant with wide range of therapeutic potential Two to three (2-3) tea spoonful of fresh	Madecassic acid, asiatic acid, α -terpinene, α -copaene, β -caryophyllene are some of the important bioactive compounds responsible for its antioxidant, antimicrobial, antiulcer, antifilarial, antiviral and anti diabetic activies etc. The Methanolic and ethanolic extract of <i>C.asiatica</i> revealed considerable protection and reduce the blood sugar level to normal. (Zahara <i>et</i>

	<p>Indian Pennywort</p> <p>Vernacular names: Assamese: <i>Manimuni</i> Bodo: <i>Manimoni</i></p>	<p>leaf extracts of Indian Pennywort are taken in empty stomach nearly for 21 days in the early diabetic conditions.</p>	<p><i>al.</i>, 2015).</p>
5	<p><i>Citrullus colocynthis</i> (L.) Schrad</p> <p>Family: Cucurbitaceae.</p> <p>Common Name: Bitter apple fruit</p> <p><u>Vernacular names:</u> Assamese: <i>Kuwa baturi</i> Bodo: <i>khuwa bhaturi</i></p>	<p>The bark of the red ripens fruit of bitter apple is dried and powdered. Five to ten(5-10) gm powder is taken with water in empty stomach.</p>	<p>All the part of plant (root, stem, leaf, fruit and Seed) are utilized in traditional system of medicine and different parts of the plant are believed to have anti-diabetic, anti-hyper-lipidemic, laxative, anti-inflammatory, analgesic, vermifuge, hair-growth-promoting, antibacterial, antifungal and antioxidant properties.(Dhakad, <i>et al.</i>, 2017).</p> <p>The bio active compounds found are Quercetin, isovitexin, colocynthoside A & B, cucurbitacin E 2-O-beta-D-glucoside etc. <i>Citrullus colocynthis</i> plant was traditionally used for the treatment of diabetes. Application of 125 mg C. colocynthis once per day for 2 months can lead to considerable decrease in the mean levels of HbA1c and FBS among the patients with type II diabetes without any side effects. (Asadollahi <i>et al.</i>, 2015).</p> <p>Moreover, Meena <i>et al.</i>, (2014) documented that pulp of ripe fruit trembled in naked feet for 15 days was used to treat diabetes by tribes of Rajasthan.</p>
6	<p><i>Kalanchoe pinnata</i> (Lam.) Pers.</p> <p>Family: Crassulaceae.</p> <p>Common Name: Air plant/ life plant/ miracle leaf</p> <p>Vernacular names: Assamese: <i>Pataygoja</i> Bodo: <i>Patgaza</i></p>	<p>1 g of raw leaves of air plant is grinded with 100 ml of water. 2-3 tea spoonful of the leaf extract are taken early in the morning.</p>	<p>The plant has biological property like antimicrobial, anti-inflammatory, anti-allergic, anti-anaphylactic, anti-leishmanial, immunosuppressive, insecticidal etc. Sunayana <i>et al.</i>, (2016) in his study reported that extracts of K. pinnata proved to be the potential antidiabetic drug.</p>
7	<p><i>Momordica charantia</i> L.</p> <p>Family: Cucurbitaceae</p> <p>Common Name: Bitter gourd.</p> <p>Vernacular names: Assamese: <i>Tita kerela</i></p>	<p><i>Bitter gourd</i> is a tropical plant which bears intensely bitter fruits usually used in cooking as well as used as a natural remedy to treat various ailment 20-30 ml of fresh extracts of bitter gourd are taken in empty stomach</p>	<p>It is a nutrient dense plant composed of complex bio active compounds such as Charantin, polypeptide-p, vicine, 5β,19-epoxy-3β,25-dihydroxycucurbita-6,23(E)-diene, and 3β,7β,25-trihydroxycucurbita-5,23(E)-dien-19-al etc; vitamins, minerals and antioxidant in the body. The extract from its fruits, vines, roots and leaves have been used as folk medicine for the remedy of toothache, diarrhea, antiviral, hypoglycemic, immune-modulation, anti tumor, anti diabetic etc (Desai <i>et al.</i>, 2019).</p>

	Bodo: <i>Tita kerela</i>		
8	<p><i>Solanum xanthocarpum</i> Schrad and Wendl.</p> <p>Family: Solanaceae.</p> <p>Common Name: Yellow fruit night shade.</p> <p>Vernacular names: Assamese: <i>Tita bekhuri</i> Bodo: <i>Ambu fanthao</i></p>	<p><i>Solanum xanthocarpum</i> is a prickly herb is immensely important (one of the members of Dasamula of the Ayurveda) in traditional system of medicine The juice extract of the fresh fruits (1-3 no.) is taken as a remedy to the high blood glucose in the body</p>	<p><i>Solanum xanthocarpum</i> is an important medicinal herb in ayurvedic medicine. Fruit juice is useful in sour throat, rheumatism and decoction of fruit of the plant is used by tribes of Orissa to treat Diabetes.(Parmar <i>et al.</i>, 2010).</p> <p>The Bio active compounds found are Campesterol, daucosterol and triterpenes like cycloartanol and cycloartenol. The fruits are known for several medicinal uses like anthelmintic, antipyretic, laxative, anti-inflammatory, anti-asthmatic and aphrodisiac activities, anti-hyperglycemic property. Leaf extract of <i>Solanum xanthocarpum</i> is effectively lower the blood glucose level and increase the production of insulin. (Tekuri <i>et al.</i>,2019)</p>
9	<p><i>Stellaria media</i> (L.)Vill</p> <p>Family: Caryophyllaceae.</p> <p>Common Name: Chick weed.</p> <p>Vernacular names: Assamese: <i>Morolya</i> Bodo: <i>Morolya</i></p>	<p><i>Stellaria media</i>(L.) Vill plant is widely dispersed all over the world.Intake of two to three tea spoonfull of aqueous extracts of the whole plant of chick weed in empty stomach is beneficial to help reduce the glucose concentration in blood</p>	<p>Chick weed has been used as therapeutic substance since time immemorial and revealed important secondary metabolites such as flavonoid, oligosaccharide stellariose, anthraquinone derivatives, fatty acid, steroid saponins and phenolic compounds. Different parts of the plant have been used to treat various gastrointestinal disorders, asthma, diarrhoea, measles, jaundice, renal, digestive, reproductive and respiratory tracts inflammations and also lessen swelling and used as plasters for broken bones. Flavonoids undergo metabolic processes to combat diabetic complications and enhance insulin secretion, proliferation of pancreatic β-cells and it also reduces oxidative stress, insulin resistance, apoptosis and inflammation in muscles (Oladeji <i>et al.</i>, 2020).</p> <p>Bhuyan (2015) also reported that the whole plant extract of chick weed was used to treat Diabetes traditionally by the tribes of Bongaigoan district.</p>
10	<p><i>Murraya koenigii</i> L. Spreng</p> <p>Family: Rutaceae.</p> <p>Common Name: Curry leaves.</p> <p>Vernacular names: Assamese: <i>Narasingha</i> Bodo: <i>Nwrshing</i>.</p>	<p>Curry leaf is a potential medicinal plant highly valued for its characteristic aroma and bioactive compound.</p> <p>Two to three(2-3) tea spoonful of Leaf extract of Curry leaf is taken early in the morning</p>	<p><i>Murraya koenigii</i> has diverse role in traditional medicine and is known for its stomachic properties. The plant is rich source of carbazole alkaloids. In addition, it also contains Phyto compounds like koenimbine, koenine, mahanimbine, murrayazolidine, murrayazoline, murrayacine, girinimbine, mukoeic acid etc. These bioactive compounds possess antioxidant, antimicrobial, anthelmintic, anticancer, analgesic, antidiabetic, anti-inflammatory, antidiarrheal, hepato protective and antitumor properties. (Gahlawat <i>et al.</i>, 2014). Bhuyan, (2015) documented that the leaf extract of curry is beneficial to treat Diabetes mellitus to a great extent.</p>
11	<i>Phlogocanthus</i>	<i>Phlogacanthus</i>	This plant has been known to possess antibacterial,








	<p><i>thyrsiflorus</i> (Nees)</p> <p>Family: Acanthaceae.</p> <p>Common Name: Nongmangkha.</p> <p>Vernacular names: Assamese: Ronga <i>Titaphul/ranga bahak/banhaka</i> Bodo: <i>Basikar bibar</i></p>	<p><i>thyrsiflorus</i> is a gregarious evergreen shrub which is used in several traditional medicines to cure various diseases. Two to three tea spoonful of fresh leaf extract of Nongmangkha is taken early in the morning</p>	<p>antifungal, anti diabetic, anti-inflammatory, anti cancerous, hypolipidaemic and hepatoprotective activity. Phytochemical constituents isolated from the plant are flavonoids, tannins, phytosterols, phenol, glycosides, fatty acids, galacto-glycero lipid and volatile oil etc. Gogoi <i>et al.</i>, (2013) also reported the anti diabetic properties of leaf extract of Nongmangkha.</p>
12	<p><i>Hodgsonia heteroclita</i> (Roxb.)</p> <p>Family: Cucurbitacea.</p> <p>Common Name: Chinese Lard Plant.</p> <p>Vernacular names: Assamese: <i>Thebau lata/ Khaum.</i> Bodo: <i>Hagrani jwgwnar</i></p>	<p>Two to three (2-3)tea spoonful of fresh or dry extracts of the fruit juice is taken in empty stomach</p>	<p><i>Hodgsonia heteroclita</i>(Roxb.) is one of the high oil yielding traditional food as well as medicines used by tribal communities inhabiting North east hills of India. (Bhatt <i>et al.</i>,2014)</p> <p>Phytochemicals like phenolics, flavonoids, alkaloids, saponins and steroids are also present in Chinese lard plant. The plant possess good antioxidant activity and less quantity of toxic metals, which therefore can be used as a source of natural free radical scavenger. Further, fruit pulp of <i>H. heteroclita</i> is traditionally used as antidiabetic medicine. (Swargiary and Brahma, 2017; Basumatary <i>et al.</i>, 2015) .</p>
13	<p><i>Spinacia oleracea</i></p> <p>Family: Amaranthaceae.</p> <p>Common Name: Spinach.</p> <p>Vernacular names: Assamese: <i>Paleng saak.</i> Bodo: <i>Paleng shaak.</i></p>	<p>About 200 g of <i>S. oleracea</i> are mixed with an equal amount of fresh carrot and ground to obtain juice which is taken every day in empty stomach</p>	<p>Spinach is packed with vitamins such as vitamin C, vitamin A and vitamin E and minerals like magnesium, manganese, iron, calcium and folic acid. It is a good source of the bioflavonoid quercetin with many other flavonoids. Moreover, it is also used to prevent the bone loss associated with osteoporosis and for its anti-inflammatory properties in easing the pain of arthritis. Spinach is good for the heart and circulatory system and has energy-boosting properties. Spinach is truly one of nature's most perfect foods (Mehta and Balemkar, 2014).</p> <p><u>Azad and Islam</u>(2018) states that Spinach leaf extract have very good anti diabetic properties and also compound like Saponin, tannin and alkaloid are found in Spinach leaf.</p>
14	<p><i>Erythrina variegata</i> L</p> <p>Family: Fabaceae.</p> <p>Common Name: Tiger's claw/ Indian</p>	<p>The <i>Erythrina variegata</i> L plant is commonly known as Tiger's Claw and exhibit medicinal properties. Fresh</p>	<p>Devaki <i>et al.</i>, (2016) found that the aqueous extract of <i>E. variegata</i> exerted a hypoglycemic effect. In addition, the extract positively functions on pancreas and provide evidence for its traditional usage in the control of diabetes.</p> <p>Hemalakhmi and Devaki (2017) mentioned that the</p>

	<p>coral tree.</p> <p>Vernacular names: Assamese: <i>Modar Ghos</i> Bodo: <i>Mandar</i></p>	<p>roots are ground for obtaining juice. About 25 ml of juice are taken for 1 week without water.</p>	<p>antidiabetic activity of ethanolic extract of <i>Erythrina variegata</i> L flowers have more number of secondary metabolites (phenols, alkaloids, flavonoids etc.) followed by bark extract and is effective to treat diabetes patients.-Nagar and Chauhan (2015) reported that the extract of <i>Erythrina variegata</i> L have potential to decrease Blood glucose level as well as improving hyper lipidermia and thus reduce complications associate with Diabetes mellitus.</p>
15	<p><i>Phyllanthus emblica</i></p> <p>Family: Phyllanthaceae.</p> <p>Common Name: Amla.</p> <p>Vernacular names: Assamese: <i>Amlokhi</i> Bodo: <i>Amlai</i></p>	<p><i>Phyllanthus emblica</i> L. is commonly known as Indian gooseberry and used for both as edible (tonic) plants and therapeutic potentials. About 10 numbers of fruits are ground and juice are mixed with honey and taken every day</p>	<p><i>P. emblica</i> is highly nutritious and is reported as an important dietary source of vitamin C, minerals and amino acids. Moreover, all parts of the plant are used for medicinal purposes, especially the fruit, which has been used in Ayurveda as a potent Rasayana (rejuvenator). In addition, <i>P. emblica</i> contains phytochemicals including fixed oils, phosphatides, essential oils, tannins, minerals, vitamins, amino acids, fatty acids, glycosides, etc. Various pharmaceutical potential of <i>P. emblica</i> has been reported previously including antimicrobial, antioxidant, anti-inflammatory, analgesic and antipyretic, adaptogenic, hepatoprotective, antitumor and antiulcerogenic activities either in combined formulation or <i>P. emblica</i> alone. Further, the leaf extract of <i>E. officinalis</i> exerted rapid protective effect against lipid per oxidation by scavenging free radicals and reducing the risk of diabetes complications. (Gaire and Subedi, 2015).</p>
16	<p><i>Rubus fruticosus</i> L.</p> <p>Family: Rosaceae.</p> <p>Common Name: Mulberry/ black berry.</p> <p>Vernacular names: Assamese: <i>Nuni phol</i> Bodo: <i>Thaishree/ Gwswm bwigri.</i></p>	<p><i>Rubus fruticosus</i> L. is a shrub famous for its fruit called blackberry fruit which has medicinal, cosmetic and nutritive value. Dried barks of the plant is soaked into water for 12 hours and filtered. The filtrate (approximately 30 ml) is taken every day in empty stomach for 1 month.</p>	<p><i>Rubus fruticosus</i> L is a concentrated source of valuable nutrients, as well as bioactive constituents of therapeutic interest highlighting its importance as a functional food. Moreover, it also contains vitamins, steroids and lipids in seed oil and minerals, flavonoids, glycosides, terpenes, acids and tannins in aerial parts that possess diverse pharmacological activities such as antioxidant, anti-carcinogenic, anti-inflammatory, antimicrobial anti-diabetic, anti-diarrheal, and antiviral.(Haq <i>et al.</i>,2014). Motevalian and Javadpour (2017) in his study found that oral administration of aqueous extract of black berry leaves can have the blood sugar lowering effect and reduce serum lipid in liver.</p>
17	<p><i>Vigna mungo</i> L</p> <p>Family: Fabaceae.</p> <p>Common Name: Black gram</p>	<p>Black gram is one of the most nutritious beans and is commonly used for its wide health benefits and consumed by</p>	<p>Blackgram helps in improve our digestion as it is filled with fibers that help with the bulking up and movement of stool therefore combat both constipation as well as diarrhea. It is very good for patients with diabetes as it regulates the glucose levels in the blood. In addition it is good for skin and can help fight dark spots, acne, and marks. It is also</p>

	<p>Vernacular names: Assamese: <i>Matimah</i> Bodo: <i>Hani sobai</i></p>	<p>cooking and also used in Ayurvedic medicine. About 50 g of raw blackgram seeds ground and soaked in 1 cup of milk overnight and taken for 20 days.</p>	<p>helpful with joint pain, is extremely good for the heart, and is also a diuretic that helps keeps body clean. Firdous and Marwah, 2020; Girish <i>et al.</i>, 2019; Nitin <i>et al.</i>, 2012) <i>Vigna Mungo</i> L is nutritionally rich and consumed for the purpose of lowering the blood glucose level of Diabetic patient in rural areas. (Ayenewu, 2017) The extract of <i>V. mungo</i> having low glycemic index and high fibre content is helpful in the treatment of obesity and type 2 diabetes (Kaur <i>et al.</i>, 2015.</p>
18	<p><i>Curcuma longa</i> L Family: Zingiberaceae. Common Name: Turmeric. Vernacular names: Assamese: <i>Halodhi</i>. Bodo: <i>Haldw</i></p>	<p>About 8g of raw turmeric were grinded, mixed with water and ½ tea spoonfull of honey and taken for one(1) month after meal</p>	<p>Curcumin present in turmeric is actively involved in treatment of diabetes and diabetic disorders, which included liver disorders, adipocyte dysfunction, neuropathy, nephropathy, vascular diseases, pancreatic β cell dysfunction, and other complications. Curcumin favorably affect most of the leading aspects of diabetes, including insulin resistance, hyperglycemia, hyperlipidemia, and islet apoptosis and necrosis. (Zhang <i>et al.</i>, 2013). In a study conducted by Hodaei <i>et al.</i>, (2019) found that daily administration of 1500 mg curcumin has positive effects in reducing fasting blood glucose and weight in patients with type 2 diabetes. Rivera <i>et al.</i>, (2019) found that <u>curcumin</u> (or curcuminoids) is a hypoglycemic agent or act as an adjuvant to improve the metabolic profile and also to ameliorate the associated complications of diabetes mellitus, such as diabetic nephropathy and cardiopathy.</p>
19	<p><i>Ficus hispida</i>(L.f) Family: Moraceae Common Name: Hairy fig. Vernacular names: Assamese: <i>Jagya dumabru</i>. Bodo: <i>adumbra</i></p>	<p>Ripe fruits are eaten as remedy for diabetes. It is used as a supportive medicine for the diabetic treatment.</p>	<p>Deepa <i>et al.</i>, (2018) found that <i>Ficus benghalensis</i>, <i>F. carica</i>, <i>F. glomerata</i>, <i>F. glumosa</i>, <i>F. racemosa</i>, and <i>F. religiosa</i> exhibited remarkable antidiabetic properties with various mechanisms of action. Moreover, <i>Ficus</i> species are versatile sources of bioactive metabolites such as flavonoids, phenolic acids, tannins, alkaloids, glycosides, coumarins, triterpenoids, sterols and vitamin E. These extracts and isolated compounds significantly have enhanced insulin secretion and subsequently reduced blood glucose level.</p>
20	<p><i>Leucas aspera</i> Family: Lamiaceae. Common Name: Thunbe./ Gumma Vernacular names: Assamese: <i>Durun</i> <i>saak</i>. Bodo:</p>	<p>The plant is believed to be a liver corrective herb. It is used as a potherb during diabetic treatment.</p>	<p>Decoction of whole plant is used to alleviate the symptoms of psoriasis, Chronic skin eruption, painful swelling and diabetes in folk medicines (Atchutkumar <i>et. al</i>, 2013) Annapandian and Sundaram (2017) also stated that the crude extract of <i>Leucas aspera</i> have exhibited antidiabetic activity.</p>

	<i>Khangsisa.</i>		
21	<p><i>Andrographis paniculata.</i> (Burm.f) wall</p> <p>Family: Acanthaceae.</p> <p>Common Name: Creat/green Chireta.</p> <p>Vernacular names: Assamese: <i>Sirotha teeta/ Kalmegh.</i> Bodo: <i>Chirota.</i></p>	<p>Whole plant extract is used for diabetic cure. The crude extract is taken at a dose of 1 tea spoonful in empty stomach in the morning hours before meal</p>	<p><i>Andrographis paniculata</i> is highly used potential medicinal plants and is traditionally used for the treatment of common cold, diarrhoea, fever due to several infective cause, jaundice, as a health tonic for the liver and cardiovascular health, and as an antioxidant. Nugroho <i>et al.</i>, (2012) found that purified extract and <i>andrographolide</i> significantly ($P<0.05$) decreased the levels of blood glucose, triglyceride, and LDL without effecting serum cholesterol and body weight. In addition, <i>Andrographis paniculata</i> (Burm. f.) Nees has shown an antidiabetic effect in type 1 Diabetes Mellitus and the purified extract of the plant and its active compound andrographolide for antidiabetic and antihyperlipidemic effects in Type 2 Diabetes Mellitus (high-fructose-fat).</p>
22	<p><i>Syzygium cumini</i> (L.) Skeels</p> <p>Family: Myrtaceae. Common Name: Malabar Plum/ Black plum.</p> <p>Vernacular names: Assamese: <i>Kola jamu</i> Bodo: <i>Gwswm jamu.</i></p>	<p><i>Syzygium cumini</i> (L.) Skeels is one of the widely used medicinal plants in the treatment of various diseases in particular diabetes. Seed powder about 1 teaspoonful is taken with water in the morning in empty stomach and also in the evening before meals.</p>	<p>The plant is rich in compounds containing anthocyanins, glucoside, ellagic acid, isoquercetin, kaemferol and myrecetin. The seeds are claimed to contain alkaloid, jambosine, and glycoside jambolin or antimellin, which halts the diastatic conversion of starch into sugar. (Ayyanar and Subashbabu, 2012). Antidiabetic effect of Jamun has been indicated in Ayurvedic pharmacopeia, which states that the seed powder of Jamun is effective in controlling high blood sugar levels (Jagetia and Magri (2018).</p>
23	<p><i>Scoparia dulcis</i> L..</p> <p>Family: Plantaginaceae.</p> <p>Common Name: Licorice weed/ sweet broom.</p> <p>Vernacular names: Assamese: <i>Bon-dhonia/ Bon chini/ Modhumehari.</i> Bodo: <i>Bonsini.</i></p>	<p><i>Scoparia dulcis</i> is known as sweet broom weed and is a perennial herb. Fresh leaves 5-6 in number are eaten or chewed for three times a day before meals</p>	<p><i>Scoparia dulcis</i> has been used in many traditional medicinal systems as an antidiabetic herb and for a variety of ailments. This herb can be used as an antioxidant and also having antidiabetic activity. (Mishra, 2013).</p>

Fig.1 Medicinal Plants used for Treating Diabetes in Kokrajhar District of Assam

			
Sugar apple (<i>Annona squamosa</i> L.)	Neem (<i>Azadirachta indica</i> A.Juss)	Bright eyes (<i>Cateranthus roseus</i> (L.) G.Don	Indian pennywort (<i>Centella asiatica</i> (L. Urban)
			
Musk melon (<i>Citrullus colocynthis</i> (L.) Schrad)	Air plant (<i>Kalanchoe pinnata</i> Lam. Pers)	Bitter melon (<i>Momordica charantia</i> L.)	Yellow fruit night shade (<i>Solanum xanthocarpum</i> Schrad &H.Wendle)
			
Chick weed (<i>Stellaria media</i> (L.) Vill)	Curry leaves. (<i>Murraya koeningii</i> (L. spreng)	Nongmangkha (<i>Phlogocanthus</i> <i>thyrsiflorus</i> Nees)	Chinese lard plant (<i>Hodgsonia heteroclite</i> Roxb.)
			
Spinach (<i>Spinacia oleracea</i> L)	Indian coral tree (<i>Erythrina variegata</i> L.)	Amla (<i>Phyllanthus emblica</i> L)	Mulberry (<i>Rubus fruticosus</i> L)

In conclusion the healthcare system of rural India mostly depends on the knowledge of local medicines, mainly derived from plant. Exploring this knowledge will always be beneficial to human kind as this knowledge may lead to effective drug discovery and will act as a first aid to many diseases. Plants are natural antioxidants and effective herbal medicines, in part due to their anti-diabetic

compounds, such as flavonoids, tannins, phenolic, and alkaloids that improve the performance of pancreatic tissues by increasing the insulin secretion or decreasing the intestinal absorption of glucose. In the same context, more researches are needed in order to separate the active components of plants and molecular interactions of their compounds for analysis of their curative

properties not only for diabetes but for other ailment also. Traditional knowledge on medicinal plants is under the threat of extinction with current rate of modernization. Hence, it needs a comprehensive study for documentation of the medicinal plants and their conservation.

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