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Traditional knowledge for antidiabetic herbs from Majuli Island (Assam), India

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Abstract

A study has been conducted during 2003 -2007 for Medico floristic evaluation and compilation of indigenous knowledge of the people of the River Island Majuli. The people of Majuli are very poor and are not acquaintance with recent scientific developments. The area is also inhabited by a number of communities namely, Deori, Mising, Koch, Kachari, Brahmin, Kalita, Kalibatra, Kayastha, Nath, Chutia, Bengali etc. traditionally using medicinal plants for curing and control of several diseases. About 52 plant species were recorded from villages of two sub-divisions viz. Kamalabari and Garamur of Majuli that used as anti-diabetes. Among the recorded species near about 50% are wild and indigenous. Out of the 52 species almost all were recorded to use as plant extracts. Different plant parts of the species were utilized such as leaves of 16 plant species, fruits of 10 plant species, tender shoots of 5 plant species, seeds of 5 plant species, whole plant of 4 species, rhizome of 4 plants, stem and stem bark of 3 plant, flowers of 3 plant, bulbs of 2 plants and root of 1 plant species. Phytomedicines are commonly practices by the ethnic of Majuli mainly by tribes and Bhakat (Devotee) of Satra and method of indigenous preparation for prevention, curing and control of diabetes reported.

Keywords: Medico floristic, ethno medicinal, epidemic, Ayurveda, Bhakat (Devotee) of Satra

1. Introduction

In most of developing countries, the indigenous of herbal treatments are a part of the culture and the dominant method of healing therapy. These remedies, with a considerable extent of effectiveness, are socially accepted, economically viable and, mostly, are the only available source. Since past people are observed to use plants in as medicine and inherited them traditionally, therefore, have an important role in the maintenance of health all over the world. Thus, there is a large health and healing related knowledge base at hand in all ethnic communities across the diverse ecosystems. However, over the last few centuries, this knowledge base has been diluted with increased influences from the mainstream culture, which is derisive of local health traditions. It is important to urgently put in place effective documentation and assessment programs to revitalize local health traditions, otherwise, this great people's health culture will be irretrievably lost. All such traditional phyto-medicines can be considered as folk medicines and are continues generation after generation for household remedies. The World Health organization (WHO) has listed 20,000 medicinal plants in practice for treatment of diseases in different parts of the world. Other estimates indicate the number to range between 35,000 and 70,000 worldwide [1-2]. Asia, Africa and East European countries have officially recognized the use of plant-based traditional medicine in their health care systems. The WHO has estimated that 80% of the world's populations rely primarily on traditional medicine [3-4]. Due to lack of communication, intermingling and breeding of ideas, and varying ways of life, many of these earlier remedies survived only by word of mouth from generation to generation. This category of information and their uses still dominates the healing tradition in the world.

Many of the hypoglycemic plants reported so far are folklore but their introduction into the modern therapy needs to found out animal test system along with subsequent pathological treatment of diabetes in human. Hypoglycemic activity has been reported for plant species my many researcher in last many decades [5]. Few of such potential oral hypoglycemic agents as the cyclopropanoid amino acids and hypoglycins A and B, are extracted from the unripe fruit of the *Blighia sapida*, and even highly toxic to use as insulin substitutes. However, the nature of action differs from insulin, these amino acid groups observed to act as anti-metabolites owing the property to block oxidation of fatty acids pathway. Thus the cyclopropanoid amino acids and hypoglycins A and B may reduce liver glycogen subsequently and induces hypoglycemia [6].

Almost 800 plant species of the world are reported so far having antidiabetic potential for

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lowering effect of blood glucose in the laboratory experiments [7]. These plant species are rich source of glycosides, alkaloids, terpenoids, flavonoids, carotenoids, etc [8]. Since past, Indian Ayurvedic system of medicines 158 plant species has reported to control diabetes and about 172 plant or plant products for treating diabetes [9, 10]. Of many scientific works have been carried out to explore folklores / traditional of medicinal plants and indigenous knowledge base from the north eastern part of the country is very few [11-18]. Study on plant with traditional antidiabetic properties in Majuli may be meager except one report on *Bonnaya reptans* which is used by Yogi (Nath) community of Majuli, Island [19]. However, these works could not reach to focus the indigenous knowledge base of inhabitant of Majuli Island subjected to the plant species uses for treatment of diabetes. Because of its remoteness, the communities of Majuli have limited privilege access to primary health care. Therefore, by this study it was aimed to document the indigenous knowledge for treatment of diabetes using of plants by the people of Majuli including the process phototherapy of such plants with hypoglycemic activities so as to help the researchers to provide clue to isolate bioactive compounds for successful clinical trials.

2. Materials and methods

2.1 The study area

Majuli lies between the planes created by the river Brahmaputra and Luit Suti. The vast area is partially of erosional and partly of depositional origin. The Island is located in the alluvial tract of the Bramhputra valley at about 40 km distance from Jorhat. It lies on the eastern part of Assam bordering Jorhat district its south between 93°37' to 94°50' North longitudes and 23°40' to 27°10' East latitudes. Majuli is a newly formed district of Assam. The average annual rainfall is 1783 mm. The lowest temperature recorded in January ranging from minimum 5.24 °C and maximum 17.92 °C. The maximum mean temperature is experienced in July with a range 26.45 °C to 36.4 °C. The total area of the Majuli Island is 552.68 Sq Km.

A total of two satras and eight villages were surveyed to assess the anti diabetic plant species use by the people of Majuli Island. These are Chamaguri Satra, Dakhinpat Satra, Kamar Gaon, Major Deuri Gaon, Potia Gaon, Phuloni, Ratanpur Miri Gaon, Sriram Chapori, Sumoimari and Uppar Katoni. The 'Satras' in Assam are the religious hub of 'Navavhaysnavisim of Sankardeva'. The communities living in these villages are Deori, Mising, Koch, Kachari, Brahmin, Kayastha, Kalita, Kaibatra, Nath, Chutia, Bengali etc. The Participatory Rural Appraisal (PRA) and group discussion were conducted to develop package for planning, implementation, monitoring and evaluation of selected medicinal plants from the study area (Fig.1). Detail information was collected in the course of ethno-botanical studies. Questionnaire was prepared to interview local traditional healers (medicine men) and the diabetic patients. Recorded information received during interviews such as local name of plant species, plant part(s) use and doses of medicinal plants. The same was again verified through interaction with treatment beneficiaries of inhabiting communities. Thirty such medicine men and diabetic patients including three women were interviewed for phyto-medicine prescription to diabetic patients of the locality. A few traditional healers with their village name are presented in

fig.2. Specific quarries were made to know the local uses of plants, ailments for which used, mode of drug preparation, recommended dose. Medico-floristic evaluation of Majuli Island was conducted by frequent field trips during 2003-2007 to collect information. Various interviews were conducted with elderly persons, local medicine man (Herbal doctors) and household ladies in different villages of the area individually. Eighteen diabetic patient of the Majuli subdivision was interviewed with a questionnaire about their awareness for plant medicine received from local medicinemen and their won indigenous knowledge for their diabetes treatment. Indigenous plants were collected, identified according to flora of Majuli [20]. The voucher specimens were deposited in herbarium of the institute for future references. The medicine men of villages were explored for about the diagnosis and treatment of several ailments apart from folklores and tales about plant, their blessings, origin, importance and importance of forest products.

3. Results and Discussion

The study was primarily conducted in Kamalabari and Garamur sub-division of Majuli. During the study documented for fifty- two species of anti diabetes plants from villages of belong to 33 angiosperm families (Table1). Of them, sixteen (16) plant species i.e. *Adhatoda vasica*, *Andrgraphis paniculata*, *Azadirachta indica*, *Coccinia indica*, *Curcuma longa*, *Dillenia indica*, *Emblia officinalis*, *Garcinia pedunculata*, *Ipomoea aquatica*, *Murraya koengii*, *Momardica charantia*, *Ocimum sanctum*, *Phlogocanthus thyriflorus*, *Syzygium cumini*, *Swertia chirayita* and *Trigonella foenum graecum* are recorded as very common plant species among the local medicine men utilized for control or treatment of diabetes. Plant species utilized by different communities of the study villages i.e. Deori (De), Mising (Mi), Koch (Ko), Kachari (Ka), Brahmin (Br), Kayastha (Kay), Kalita (Kal), Kaibatra (Kai), Nath (Na), Chutia (Ch) and Bengali(Be) are presented in table1. Although medicine men planted almost all the plant species they use as anti diabetes in their homesteads however, about half of them were recorded from wild in their locality. A few of the plant species were observed as unique to the ethnic tribes of Majuli and 'Bhokat' of Satras. Such medicinal uses were obtained from leaves, root, bark and fruit. The study also documented different plant parts of the species were utilized for antidiabetic. Consequently found that among the plant species leaves were utilized for 16 plant species, fruits of 10 plant species, tender shoots of 5 plant species, seeds of 5 plant species, whole plant of 4 species, rhizome of 4 plants, stem and stem bark of 3 plant, flowers of 3 plant, bulbs of 2 plants and root of 1 plant species (Table 1). The study recorded for use of the whole tender herb for making the herbal preparations for a few cases. All required preparations were made using water hot or cold as the medium, except a few cases that were cooked and taken as vegetables. The anti diabetes phytotherapies were given to take orally to the patients either in the form of crude extract or juice and decoction or leaf infusion. The traditional healers (fig.2) were found to practice same plants for curing other diseases such as liver, kidney, urinary system, nerve system and general disability. Phytomedicinal knowledge of the medicine men was difficult to document due to their unwillingness to share and remained endemic and kept secret by certain persons or families.



Fig 1: Participatory Rural Appraisal (PRA) and group discussion in study area of Majuli



Fig 2: A few traditional healer of Majuli, Assam

Traditional phytotherapies as documented from interview and group discussion in the study villages of Majuli are presented below. These phytotherapies are used by people of in the form of extracts, powder, leaves, fruits, vegetables etc.

1. *Adhatoda vasica* Nees

Family: Acanthaceae

Local name: Tita bhak (As)

Method of use: Extract obtained from the fresh leaves of plant mixed with water. About 10 ml of extract is use triplicate per day for one month. As per the traditional healer this formulation shows symptomatic hypoglycemic action to lower blood glucose level of diabetics. Similar traditional use of this plant species was also reported from Attock, Pakistan [21]. It was also found that ethanol extract of leaves and roots of *Adhatoda vasica* (100 mg/kg b.wt.) has significant ($P < 0.05$) effect in lowering of blood sugar of the diabetic rats. [22]

2. *Aegle marmelos* (L) Correa.

Family: Rutaceae

Local name: Bel

Method of use: Extract of leaves was given to treat diabetic patient by the traditional healers of Majuli. Use of plant parts among the local people was not much popular. However, in

published literature four different recipes had already been reported the use of *A. marmelos* as traditional antidiabetic medicine [23-25]. Leaf extract of the plant is also being used in Ayurveda as a medicine for diabetes [26]. It is also reported that compounds isolated from *Aegle Marmelos* have properties to treat cancer, diabetes and cardiovascular diseases [27].

3. *Allium cepa* L. ver. Majuli

Family: Liliaceae

Local name: Piyanj /Asomiya piyanj

Method of use: One tea spoonful of fresh juice extracted from the bulb was given to the patient thrice a day for 15 days before meal. The study observed that traditional healers of Majuli effectively treated diabetic patients for the control of blood sugar and high blood pressure. Traditional use of same species but different variety was also recorded to use for treatment of diabetes mellitus [28]. Literature also revealed the subsistence of antidiabetic recipes in different parts of the country [21, 29].

4. *Allium sativum* L. (Ban Nohuru)

Family: Liliaceae

Local name: Nohuru

Method of use: One tea spoonful of fresh juice of the bulb was recorded to administer thrice a day for 15 days before meal. This was also recorded as effective treatment of diabetic rats and observed to reduce hyperglycaemia, cellular toxicity and restored damage to liver, kidney and pancreatic tissues of diabetic rats [30].

5. *Andrgraphis paniculata* Brum.f. Nees

Family: Acanthaceae

Local name: Kalmegh

Method of use: Hot water extracts of dried leaves and stems which was bitter in test and black tea color. 25ml of the extract with 100 ml water was given to the diabetic patient by the local healers as continuous dose for 15 to 30 days twice a day before meal and claim to control blood sugar level of the patient. Similar types of use also available in literature of treatment of diabetes [31]. A few researches also evaluated the traditional use and revealed that *A. paniculata* and andrographolide could produce hypoglycemic effects by inhibiting alpha-amylase and alpha-glucosidase enzymes [32, 33].

6. *Annona squamosa* (L.)

Family: Annonaceae

Local name: Squash/Custard apple

Method of use: Hot water extract of 2 teaspoonfuls of leaves powder was given twice a day for 3 to 4 month continuously to control blood sugar. More traditional use of this plant is reported from the villages of Aligarh district in the state of Uttar Pradesh and Chotanagpur district in the state of Bihar, India where young leaves of are used for its antidiabetic activity by tribal men [34, 26].

7. *Azadirachta indica* L.

Family: Meliaceae

Local name: Maha neem

Method of use: Aqueous extract leaf or powdered leaves was recorded to administer by the local healers to cure and control of diabetic patients. Sometimes 5 numbers of fresh leaves were also given to take in the morning empty stomach. The plant species was recorded to use in Ayurveda for treating

various diseases, one of which is diabetes mellitus [35]. Literature also revealed that 15 ml water extract of leaves once a day in empty stomach continuously one month can cure of diabetes [36].

8. *Bacopa monnieri* L.

Family: Scrophulariaceae

Local name: Brahmi

Method of use: Extract of whole plant is given to diabetic patient by the local healers as continuous dose for 15 to 30 days twice a day and claims to control blood sugar level of the patients of Koch and Kaibatra communities. The plant species also said to have use of many Ayurvedic medicine formulations and can control diabetic [37].

9. *Cajanus cajan* L.

Family: Fabaceae

Local Name: Arahar

Method of use: The extract of tender leaves was recorded to prescribe by the traditional healers to control blood sugar level in Majuli. Similar use elsewhere in India was reported for the leaves and seeds also which are cooked and is recommended to diabetics [38].

10. *Cassia fistula* L.

Family: Fabaceae

Local name: Sunaru

Method of use: Pulp of ripen *C. fistula* pod was recorded to prepare extract in water and administered for treatment of diabetes. This extract was recorded to utilize by few occasions only. Almost similar types of recipe made from flower of *C. fistula* is also given by other communities of India [39].

11. *Catharanthus roseus* (L.) G. Don.

Family: Apocynaceae

Local name: Nayantara

Method of use: Grounded extract from fresh flowers and leaves were recorded to use by the people in a small tea spoon (2.5ml) following morning. This plant was also recorded for hypoglycemic action by many workers [40-42].

12. *Cinnamomum tamala* Nees & Eberm.

Local name- Patcheni

Family: Lauraceae

Method of use: Warm water extract of 2 teaspoonfuls leaves powder four times a day is recorded to prescribe for a month to control blood sugar level by the local medicine men. Scientific study also shown that *C. tamala* leaf extract uphold the insulin release from the undestroyed β -cells and recover the oral glucose tolerance by intensifying the occurrence of insulin [43].

13. *Citrus aurantifolia* (Christm.) Swingle.

Family: Rutaceae

Local name: Gol-nemu

Method of use: Four to six seeds are crushed and advice by the local healer of Majuli to take as a dose twice a day for 30 days found to control diabetes. Available literature shows that Traditional Medicine Practitioners of North Central, Nigeria recommended to take decoctions or infusions of the plant against diabetes mellitus [44].

14. *Coccinia indica* Wight & Arn

Family: Cucurbitaceae

Local name: Kunduli

Method of use: *Coccinia indica* is a perennial creeper found in wild and cultivated condition in the homesteads in Majuli. Diabetic people use to take fruits as vegetable traditionally to maintain blood sugar level. There is no scientific evidence that fruit of the plant has antidiabetic properties. However, a number of studies revealed that leaves extracts of *Coccinia indica* has potential hypoglycemic action in patients with mild diabetes [45-47].

15. *Costus speciosus* (J. Koenig) Sm.

Fam: Zingiberaceae

Local name: Jamlakhuti

Method of use: Two inches thumb size rhizome of *C. speciosus* grounded in mortar and made extract in 50ml lukewarm water and mixed with equal amount of milk. This formulation was given to take in empty stomach to control the blood sugar level. However, in other part of the country leaves only reported to use to decreasing blood glucose level [48] and also have hypoglycemic properties and insulin potentiating action [49].

16. *Curcuma aromatica* Salisb.

Family: Zingiberaceae

Local name: Bonoria Halodhi

Method of use: Fresh rhizome of *C. aromatica* was recorded for use as antidiabetic medicine by the traditional healers of Majuli Island particularly popular among Mishing communities. However, there is no such use is reported so far for antidiabetic properties of this plant.

17. *Curcuma longa* L.

Family: Zingiberaceae

Local name: Halodhi

Method of use: Fresh rhizome and dried powder of rhizomes are very common among the diabetic patients and use to take regularly to control the blood sugar and was recorded while taking interview and group discussion in Majuli. It is evident that rhizome and roots of this plant are used in Ayurvedic medicine for treatment of diabetes [50]. Later, scientific studies evaluated that curcumin present in *C. longa* is useful in reducing glycemia and hyperlipidemia [51].

18. *Dendrocalamus hamiltonii* Nees & Arn. ex Munro.

Family: Bambusaceae

Local name: Kako Banh

Method of use: The water extract of the tender stem is given to control diabetes and found to effective while taken regularly for 3 months. This plant is available in the river side and in some homesteads of Majuli Island. This plant species reported to use as in Indian system of Ayurvedic medicine and recently scientific study had also proven the hypoglycemic activity of *Dendrocalamus hamiltonii* [52, 53].

19. *Dillenia indica* Linn.

Family: Dilleniaceae

Local name: Ou tenga

Method of use: The fruit are cooked as vegetables and used by rural inhabitants of the area for diabetes mellitus. It was also found as common practice that mature fruits were sliced and sun dried and powdered in mortar and 1 tea spoonful powder is use to take as morning tea in warm water to control diabetes. Similar use also reported by other workers also for control of sugar level [54, 55].

20. *Emblica officinalis* Gaertn.

Family: Euphorbiaceae

Local name: Amlokhi

Method of use: Juice of eighteen-twenty mature fruit to be added with four tea spoonful of honey to be take twice daily is advice for few days to control blood sugar of the diabetic patients of the region. Many researchers mentioned the effect of Amlokhi fruits for lowering blood sugar level ^[56].

21. *Enhydra fluctuans* Lour.

Family: Asteraceae

Local name: Haleshi sak

Method of use: This species is frequently found in swampy/water logged area of Majuli and also uses to take as leafy vegetables by different communities. The extract of tender shoot of the herb was recorded to administer as antidiabetic decoction to control blood sugar level. Literature reveals that in Thoubal district of Manipur this wetland herb is use as traditional medicine for diabetes ^[57].

22. *Euphorbia hirta* Linn.

Family: Euphorbiaceae

Local name: Gakhiroti bon

Method of use: Decoction of whole plant was recorded as traditionally given medicine to treat diabetes by the healers of Majuli Island. *E. hirta* is reported for traditional use for treating gastrointestinal, bronchial and respiratory diseases, diabetes and also conjunctivitis ^[58, 59].

23. *Ficus glomerata* Roxb. Syn. *Ficus racemosa* L.

Fam: Verbenaceae

Local name: Dimoru

Method of use: Extract of stem bark of the plant found to use traditionally by the people to recovery from the diabetes with a continuous administration of minimum 15 days at least once in a day in the morning before meal. However, in other part of the country fruits of the plant species was reported have antidiabetic property ^[60].

24. *Garcinia padunculata* Roxb.

Family: Clusiaceae

Local name: Borthekera

Method of use: Mature fruits are found in April-May of every year. Fruits are sliced and sun dried and stored in air tight container. Such 3 to 5 slice are boiled in water and the extract is given to take by the diabetic patients. This was recorded as common practice among the traditional healers of Majuli. Same is also reported by other workers of Assam for treatment of diabetes and also scientifically evaluated the mode of action ^[61, 62].

25. *Gymnema sylvestre* (Retz.) Schult.

Family: Asclepiadaceae

Local name: Gurmar

Method of use: *Gymnema sylvestre* is a woody, vine-like climber and easy to grow as a houseplant or in the garden. Traditional healer of Majuli prepared tea from the dried leaves of *Gymnema sylvestre* mixing with the leaves of *Ocimum sanctum* (Tulsi) in equal quantity twice a day is found to administered by the local medicine men to treat diabetes. Aqueous decoction of leaves and stem alone reported lowering of blood sugar of diabetic patients. This herb is native to the tropical forests of India and Southeast Asia, where it has been used as a naturopathic treatment for diabetes for nearly two thousand years ^[63-64].

26. *Heliotropium indicum* Linn

Family: Heliotropiaceae

Local name: Hatisuria bon

Method of use: Aerial part of *H. indicum* was found to administer by the healers of Deori communities of Majuli for treatment of diabetes. Traditional use of this plant as antiviral, antitumor, antidiabetic and antihyperlipidemic also reported by many workers ^[65, 66].

27. *Ipomoea aquatica* Forssk.

Family: Convolvulaceae

Local name: Kolmou

Method of use: Fresh tender shoots extract is given to take after food to control blood sugar level by the traditional healer of Majuli, treated up till to sugar level comedown to normal. This wetland herb is found to take by the people of Majuli as leafy vegetable also. This traditional medicinal plant is evaluated for antidiabetic properties that plant extracts inhibit the absorption of glucose from the intestine ^[67].

28. *Melastoma malabathricum* (L.) Smith

Family: Melastomataceae

Local name: Putukola

Method of use: The tender shoots were found to make decoction and given to take traditional healers for treatment of diabetes in Majuli. Available literatures revealed that the plant is also used as antidiabetic medicine traditionally in Malaysia ^[68, 69].

29. *Momordica charantia* L.

Family: Cucurbitaceae

Local name: Tita kerela

Method of use: The juice obtained from the fresh fruits of plant use to cure diabetes. The patient reported to get benefit by the use of one small cup daily. The leaves and fruit either have been used to make teas and beer or to season soups or used as vegetable. *M. charantia* is one of the plants that have been investigated thoroughly for the treatment of diabetes ^[70] and its various extracts and compounds are its hypoglycemic effect ^[71].

30. *Moringa oleifera* Lam

Family: Moringaceae

Local name: Sajina

Method of use: Fresh pods use as vegetable and dry seed powder and taken to control diabetic. Tender white roots extract also found to administer by Mishing community healers of Majuli. A numbers of study have been reported for the antidiabetic potential pods, seeds and leaves of *M. oleifera* ^[72-74].

31. *Morus indica* Linn

Family: Moraceae

Local name: Nuni

Method of use: Water extract of tender leaves are given to take by diabetic patients by traditional healer of Samguri Satra, Majuli for treatment of diabetes. Similar traditional use elsewhere in India is also reported ^[75].

32. *Mucuna prurita* Hook. Syn. *M. pruriens* (L.) DC.

Local name: Bandar-kekowa

Family: Fabaceae / Papilionaceae

Method of use: Powder of *Mucuna pruriens* seeds is found to treat blood sugar patient. However the use was referred by only one medicine man during entire study. Further research

revealed that *M. pruriens* have valuable medicinal properties including for its anti-diabetic, aphrodisiac, anti-neoplastic, anti-epileptic, and anti-microbial activities^[76].

33. *Murraya koengii* L.

Family: Rutaceae

Local name: Carry leaf/ Narashiva

Method of use: It is widely used traditionally as anti diabetic medicine advised by the local medicinemen to control blood sugar. Ten fresh leaves of the plant are given to take every morning with meal for 3 to 4 months regularly can control blood sugar. Scientific study conducted on *Murraya koenigii* leaves extract and revealed decisive antidiabetic consequence at doses of 250 & 500 mg/kg. b.w. in alloxan induced diabetic albino rats^[77].

34. *Ocimum sanctum* L.

Family: Labiatae

Local name: Tulsi

Method of use: Aqueous extract of Tulsi leaves (*Ocimum sanctum*) have been traditionally used in treatment of diabetes. Leaves of these plants species are dried under shade, then ground to made powder and use 21 gm twice a day. According to rural inhabitants, this powder is dietary therapy and drug treatment for diabetes. Antidiabetic properties of tulsi were also documented in Ayurveda^[78]. Leaf extract of the plant was evaluated for enhancing the physiological pathways of insulin secretion^[79].

35. *Phlogocanthus thyrsoiflorus* Nees.

Family: Acanthaceae

Local name: Titaphul

Method of use: Flowers of *P. thyrsoiflorus* was recorded to use by the people of Majuli as medicine to control diabetes. Cooked the fresh flowers and take with meal. The traditional healers treated with leaves of the plant for diabetes mellitus in Kamrup district of Assam^[80]. Anti hyperglycemic effect of aqueous extract of the flower of *P. thyrsoiflorus* is evident from a few research works also^[81].

36. *Portulaca oleracea* L.

Family: Portulacaceae

Local Name: Malbhug Khutora

Method of use: Decoction of herb is given to take as remedy for diabetes. The plant is also edible as seasonal vegetable, taken after cooking along with other leafy vegetables and popular to the people of Majuli. Traditional use of the plant species for treatment of Type II diabetes mellitus is also known from china^[82].

37. *Psidium guajava* L.

Family: Myrtyaceae

Local name: Madhuri-um

Method of use: Hot water extract of tender shade dry leaves of *Psidium guajava* was documented for using by traditional healer to reduce blood glucose level of diabetic patients. This hot tea was also very popular among the local people of the area. Scientific investigation also proven that oral administration of the ethanol extract led to a significant blood glucose lowering effect in alloxan-induced hyperglycemic rats^[84].

38. *Saraca indica* Linn

Family: Caesalpinaceae

Local name: Ashok

Method of use: Fresh flowers of *S. indica* were recorded to use as antidiabetic by the traditional healer of Dakhinpat satra, Majuli. Similar types of use also reported in Ayurveda^[85].

39. *Sesbenia aegyptiaca* L

Family: Fabaceae

Local name: Bog phul

Method of use: Grinded tender leaves and roots in warm water extracts was given twice or thrice daily up to 2 weeks to treat diabetic patients of the Island people. Similar use was also documented not only for control diabetes but also for other ailments such as antihelminthic, colic and skin diseases^[86].

40. *Solanum nigrum* L.

Family: Solanaceae

Local name: Pichkati/ Loskochi

Method of use: Tender shoots of *Solanum nigrum* are cooked and popular as leafy vegetable among the people of the Island. Tender shoot tip with leaves are boiled in water and condensed. The decoction thus made is given to take before meal to control blood sugar level by the traditional healers of Majuli. *S. nigrum* is also reported as traditionally use herb to treat ailments like pain, inflammation and fever^[87] and are recommended to consume daily or frequently for streamlining diabetes in the form of natural food^[88].

41. *Spondias pinnata* (Linn. f) Kurz

Family: Anacardiaceae

Local name: Amara

Method of use: Mature fruits and stem bark extract of *S. pinnata* are traditionally used to treat diabetes in Majuli. The scientific investigation also evident the folklore remedies different extracts of bark and root of *S. pinnata* administered in diabetic rats and found significant reduction in blood glucose level^[89, 90].

42. *Streblus asper* Lour.

Family: Moraceae

Local name: Soura

Method of use: The survey recorded the warm water extract of ripen fruits and stem bark of *Streblus asper* given by traditional healers of Majuli. Although, different plant parts of *S. asper* reported to use in ulcer, toothache, dysentery, cancer, ulcer etc in Ayurvedic Pharmacopoeia of India^[91], no report was found on traditional therapy as antidiabetic medicine. A steroid compound present in methanolic and petroleum ether extract of stem and roots bark of *S. asper* in STZ-induced diabetic rats revealed significant hypo-glycemic activity^[92].

43. *Swertia chirayita* (Roxb. ex Fleming) H. Karst.

Family: Gentianaceae,

Local name: Chirota

Method of use: Hot water extract of whole plant of *Swertia chirayita* was documented for use to control sugar of the diabetic patients and was administered twice a day before diet for a minimum of 15 days traditionally by the people of Majuli. A numbers of both traditional and scientific investigation of this plant species reported as mentioned by Arya *et al.*^[93].

44. *Syzygium cumini* Skeels (Syn. *Eugenia jambolana* Lam. or *Syzynium jambolana* Dc)

Family: Myrtaceae

Local name: Kola jamun (black plum)

Method of use: Fresh fruit and dry seed powder is used to treat diabetes by the traditional healer and reported very effective to reduce blood sugar level. Use of fruits in Ayurveda are reported by other also as antidiabetic as well as stomachic, astringent, antiscorbutic, diuretic and in chronic diarrhea and enlargement of spleen^[94,95]. Seed extract of the plant was reported significant decrease the blood glucose, blood urea, serum cholesterol and serum triglyceride levels in alloxan induced diabetic rats^[96].

45. *Terminalia cebula* Retz

Family: Combretaceae

Local name: Silikha

Method of use: Ripen fruit or dried fruits pulp extracted in warm water and was recorded to given for treatment and control of diabetic patient with single dose continuously for 30 days. Similar treatment was documented in Ayurvedic system of medicine and said to be used extensively in throughout India, Burma and Sri Lanka^[97]. Scientific validation was carried out by many workers on *T. cebula* fruits on streptozotocin (STZ)-induced experimental diabetes in rats and observed that the efficacy of the fruit extract was comparable with glibenclamide, a well known hypoglycemic drug^[98].

46. *Tinospora cordifolia* (Lour.) Miers.

Family: Menispermaceae

Local name: Hagunilota

Method of use: Traditional use of aqueous extract of *Tinospora cordifolia* stem was documented from Majuli prescribed by healers to the diabetic patient for control their blood sugar level. It is also documented for traditional and scientific investigation of *T. Cordifolia* by many workers and mentioned about antidiabetic properties^[99, 100].

47. *Trichosanthes cucumerina* L.

Family: Cucurbitaceae

Local name: Dhunduli

Method of use: Fruit juice of the plant was documented to use for control of blood sugar. The fruit is also a vegetable for the people of the River Island. Studies on the pharmacological activities revealed to have antidiabetic activity in seeds of *T. cucumerina*^[101].

48. *Trigonella foenium graecum* L

Family Name: Leguminosae

Local name: Methiguti

Method of use: one tea spoonful seed powder of plant in 200 ml hot water kept for overnight and taken in the morning before food daily for a month. It is popular among the people of Majuli to reduced blood glucose level amongst diabetics. Study revealed that *Trigonella foenium graecum* have insulin-stimulating properties and beneficial for treatment of type 2 diabetes^[102].

49. *Vitex negundo* L.

Family: Lamiaceae

Local name: Posotia

Method of use: Leaves are extracted in warm water and given to take in empty stomach in the morning by the traditional healers of Majuli Island to reduce blood sugar level. Study also marked that both aqueous and ethanol leaf extract of *Vitex negundo* posses antidiabetic properties and effective while using alloxan induced diabetic model in rats^[103].

50. *Withania somnifera* (L.) Dunal.

Family: Solanaceae

Local name: Ashwagandha

Method of use: 50g fresh leaves of the plant are extracted in 200 ml water and kept for whole night. In the morning before breakfast given to take 50ml of water extract to treat diabetes. Enormous reports also available on traditional uses and antidiabetic activities of *W. somnifera*^[104].

51. *Zingiber officinale* Rosc.

Local name: Ada (Zinger)

Family: Zingiberaceae

Method of use: Warm water extract of underground rhizome of *Zingiber officinale* powder was recorded to advice as antidiabetic dose to the patients for regular intake to control the sugar level. Numerous studies observed that intake of ginger extract can considerably decreased blood glucose level in Type 1 and Type 2- induced diabetic^[105, 106].

52. *Zizyphus jujuba* Mill.

Family: Rahamnaceae

Local name: Bogari

Method of use: About 4-5 fresh leaves are plucked washed with clean water and grinded in to paste. The paste was given to take daily by the diabetic patients to lower blood glucose level. Advance study on oral administration of *Z. jujuba* extracts from roots and leaves shown antidiabetic and antioxidant effects in diabetic rats^[107].

Table 1: Plant species used for treatment of diabetes by Indigenous people of Majuli

S. No.	Botanical name	Local name	Family	Parts used	*Community used
1	<i>Adhatoda vasica</i> Nees	Titabahak	Acanthaceae	Leaf	Common
2	<i>Aegle marmelos</i> (L) Correa.	Bel	Rutaceae	Leaf	Kay, Na, Ch
3	<i>Allium cepa</i> L.	Piaz	Liliaceae	Corm	Mi, De, Ch
4	<i>Allium sativum</i> L.	Naharu	Liliaceae	Corm	Mi, De, Ko
5	<i>Andrgraphis paniculata</i> Brum.f. Nees	Kalmegh	Acanthaceae	Whole plant	Common
6	<i>Annona squamosa</i> (L.)	Squash	Annonaceae	Leaf	Stras, Begali
7	<i>Azadirachta indica</i> L.	Maha neem	Meliaceae	Leaf	Common
8	<i>Bacopa monnieri</i> (L.) Wettst.	Brahmi	Scrophulariaceae	Whole plant	Ko, Kai, Br
9	<i>Cajanus cajan</i> L.	Arahar dal	Papilionaceae	Leaf	Kay, Br, De, Ko
10	<i>Cassia fistula</i> L.	Sunaru	Fabaceae	Pod pulp	Ch, Ko, Kai
11	<i>Cataranthus roseus</i> L.	Sada bahar	Apocynaceae	Flowers and leaf	Kal, Mi, Ka, Ch
12	<i>Cinnamomum tamala</i> Nees & Eberm.	Patcheni	Lauraceae	Leaf	Kay, Br, Na
13	<i>Citrus aurantifolia</i> (Christm.) Swingle.	Gol Nemu	Rutaceae	Seed	Ko, De, Mi
14	<i>Coccinia indica</i> Wight & Arn	Kunduli	Cucurbitaceae	Fruit	Common
15	<i>Costus speciosus</i> (Koenig) Sm.	Jamlakhuti	Zingiberaceae	Rhizome	Kay, Br, Ko

16	<i>Curcuma aromatica</i> Salisb.	Bon halodhi	Zingiberaceae	Rhizome	De, Mi, Ka
17	<i>Curcuma longa</i> L.	Halodhi	Zingiberaceae	Rhizome	Common
19	<i>Dendrocalamus hamiltonii</i> Nees & Arn. ex Munro.	Kako Banh	Bambusaceae	Tender stem	Kay, De
20	<i>Dillenia indica</i> Linn.	Outenga	Dilleniaceae	Fruits	Common
21	<i>Emblica officinalis</i> Gaertn.	Amlokhi	Euphorbiaceae	Fruits	Common
22	<i>Enhydra fluctuans</i> Lour.	Haleshi sak	Asteraceae	Tender shoot	De, Mi, Kai, Be
23	<i>Euphorbia hirta</i> Linn.	Gakhiroti bon	Euphorbiaceae	Whole plant	Kay
24	<i>Ficus glomerata</i> L.	Dimoru	Moraceae	Stem bark	Kal, Ko
	<i>Garcinia padunculata</i> Roxb.	Bor thekera	Clusiaceae	Fruits	Common
25	<i>Gymnema sylvestre</i> (Retz.) Schult.	Gurmar	Asclepiadaceae	Leaf	Br
26	<i>Heliotropium indicum</i> Linn	Hatisuriabon	Heliotropiaceae	Aerial part	Mi, Ch
27	<i>Ipomoea aquatica</i> Forssk	Kolmou	Convolvulaceae	Tender shoot	Common
28	<i>Melastoma malabathricum</i> (L.) Smith	Putukola	Melastomataceae	Tender shoot	Br, Ka, Ch
29	<i>Momardica charantia</i> L.	Titakarella	Cucurbitaceae	Fruits	Common
30	<i>Moringa oleifera</i> Lam	Sajina	Moringaceae	Seed	Mi, De
31	<i>Morus indica</i> Linn	Nuni	Moraceae	Leaf	Kal, Kay
32	<i>Mucuna prurita</i> Hook	Bandar kekuwa	Fabaceae	Seed	Ch, Ka
33	<i>Murrya koengii</i> L.	Narashiva	Rutaceae	Leaf	Common
34	<i>Ocimum sanctum</i> L.	Tulsi	Lamiaceae	Leaf	Common
35	<i>Phlogocanthus thyrsoiflorus</i> Nees.	Titaphul	Acanthaceae	Flowers	Common
36	<i>Portulaca oleracea</i> L.	Malbhug Khutura	Portulacaceae	Whole plant	Mi, Ch, Ko, Ka
37	<i>Psidium guajava</i> L.	Madhuriam	Myrtaceae	Leaf	Br, Na, Kay
38	<i>Saraca indica</i> Linn	Ashok	Caesalpiniaceae	Flowers	Kay
39	<i>Sesbenia aegyptiaca</i> poir.	Bog phul	Fabaceae	Leaf and root	Br, Kal, Ko, Na
40	<i>Solanum nigrum</i> L.	Loskasi	Solanaceae	Tender shoot	Kai, Ko, Kal, Na
41	<i>Spondias pinnata</i> (Linn. f) Kurz	Amara	Anacardiaceae	Fruit	Br, Kay, Kal
42	<i>Streblus asper</i> Lour.	Soura	Moraceae	Fruit and Bark	Mi, Ch
43	<i>Swertia chirayita</i> (Roxb.)	Chirota	Gentianaceae	Whole plant	Common
44	<i>Syzygium cuminii</i> Skeels	Jamun	Myrtaceae	Fruit and seed	Common
45	<i>Terminalia cebula</i> Retz.	Silikha	Combretaceae	Fruit	Kay, Ko, Kai
46	<i>Tinospora cordifolia</i> (Lour.) Miers.	Hagunilota	Menispermaceae	Stem	Br, Kay
47	<i>Trichosanthes cucumerina</i> L	Dhunduli	Curcubitaceae	Fruit	Ch, Be
48	<i>Trigonella foemum</i> Graecum L.	Methri	Papilionaceae	Seed	Common
49	<i>Vitex negundo</i> L.	Posotia	Lamiaceae	Leaf	De, Ko
50	<i>Withania somnifera</i> (L.) Dunal.	Ashwagandha	Solanaceae	Leaf	Br
51	<i>Zingiber officinale</i> Rosc.	Ada	Zingiberaceae	Rhizome	Br, Kal, Kay
52	<i>Zizyphus jujuba</i> Mill.	Berri	Rhamnaceae	Leaf	De, Mi, Ch

*Parentheses as Deori (De), Mising (Mi), Koch (Ko), Kachari (Ka), Brahmin (Br), Kayastha (Kay), Kalita (Kal), Kaibatra (Kai), Nath (Na), Chutia (Ch) and Bengali(Be).

4. Conclusion

The socioeconomic condition of the people of Majuli is poor and they still use the traditional medicine system for generation to generation. Ample allopathic health care facilities are yet to reach in Majuli, so people have to depend on herbal medicines and different taboos and beliefs. Majuli Island is being rich in herbal resources; offer a great scope for medico floristic studies. Inhabitants and two major tribal communities of Majuli i.e. Mishing and Deori have developed their traditional health care systems by trial and error method. This traditional knowledge needs scientific scrutiny to get further benefits the humankind from various perspectives. The habitat and the environment in which the folklore evolved are now disappearing at a faster rate due to modernization. Regarding antidiabetic use of plant species while undertaken this study in Majuli it was assumed that due to its remoteness and geographical isolation of the island might have given adequate prospect to unearth novel traditional knowledge. However, after documentation of the plant species used for antidiabetic phytotherapies and validated with existing literatures revealed that nothing is new and almost similar kind of system was recorded. The reason may be due the existence of numerous satras in Majuli which are the major player of importing traditional knowledge from other part of India as well as abroad. For example, 'Shrimanta Sankar Dev' was the principal activates who brought Navavaishnavism in to Assam in fourteenth century. However, it cannot be

ascertained without extensive scientific investigation about their origin, whether they are imported or aboriginal.

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