



Traditional medicinal plants used against diabetes by the tribes of Gajapati district in Odisha - An ethnobotanical exploration

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Key words: Ethnomedicines, Diabetes mellitus, Tribes, Gajapati district, Odisha.

<http://dx.doi.org/10.12692/ijb/16.4.354-365>

Article published on April 29, 2020

Abstract

The use of herbal medicine is traditionally rooted in India and still an essential part of public healthcare. In recent times, a radically increasing incidence brought *Diabetes mellitus* and its therapy to the focus of public health interests in India. The current study focuses on the exploration of ethnomedicinal knowledge of plants used against diabetes by the tribes of Gajapati district of Odisha. Preparations of information of the anti-diabetic plants were recorded by the help of the tribes of the district namely Savara, Shaber, Lodha and Kandha. Documentation of aboriginal knowledge related to anti-diabetic properties of native plants was made by interaction with local traditional medicine men. A total of 66 species belonging to 29 families were recorded as being used for the treatment of diabetes in the area under study. The most frequently mentioned plants were *Aegle marmelos*, *Andrographis paniculata*, *Asparagus racemosus*, *Azadirachta indica*, *Clerodendrum philippinum*, *Cucurma longa*, *Gymnema sylvestre*, *Helicteres isora*, *Hemidesmus indicus*, *Hybanthus enneaspermus*, *Pterocarpus marsupium* and *Woodfordia fruticosa*. Most of the herbal preparations of plants used against diabetes were prepared from leaves followed by roots and fruits. However, the available data regarding the anti-diabetic activity of some plants identified in this survey is not sufficient to recommend their use. Pharmacological investigation and clinical intervention studies are required to provide evidence for a safe and effective use of the identified plants in the treatment of diabetes.

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Introduction

Diabetes mellitus is considered as one of the most common and serious metabolic disorders affecting a large number of populations throughout the world. It is considered as one of the five leading causes of death in the world (Joseph and Jini, 2011). It is expected that the silent killer will result in increase of death by 2-3 folds by 2030 (Shaw *et al.*, 2018). The major parameters responsible for diabetes are modern life style, sedentary habits, unbalanced diet, workloads affect the elite class genre of population. At the same time the high cost of allopathic drugs is the major concern among the rural poor. Currently it is estimated 25% of the world's population is affected by diabetes (Maryam, 2015).

Diabetes is a state in which the homeostasis of lipid and carbohydrate metabolism is improperly regulated by insulin in the pancreas. It damages the blood vessels and nerves and if uncontrolled it leads to complications like retinopathy, nephropathy and cardiopathy (Nagappa *et al.*, 2003). There are two major forms of diabetes - Type I (insulin-dependent Diabetes mellitus) and Type II (non-insulin-dependent Diabetes mellitus). Type I Diabetes mellitus occurs when the pancreatic β - cells are destroyed which are responsible for secreting insulin. Type II Diabetes mellitus results when pancreas gradually losses its ability to produce insulin (Ahmed *et al.*, 2017). Among all the constraints in treating diabetes, the major constrain is available therapy i.e. the use of allopathic drug which are reported to produce serious adverse side effects. Therefore, there is a need to acquire knowledge about the different indigenous plants and several herbal formulations to cure diabetes (Satyanarayana *et al.*, 2006). Presently a good number of herbal medicines have been recommended by WHO for the treatment of Diabetes mellitus apart from currently available therapeutic options (WHO, 2000). The ethnomedicinal literature indicates more than 800 plant species to possess hypoglycaemic activity (Alarcon-Aguilara *et al.*, 1998). Lately, the WHO advocated the use of medicinal plants for the management of *Diabetes mellitus* and further suggested to encourage the

expansion of scientific analysis of hypoglycaemic properties of different plant species (Akah *et al.*, 2011). Several successful reports have confirmed the efficacy of various herbal formulations which were found to be effective in the treatment of diabetes (Chikejie *et al.*, 2015). Since time immemorial, individual with diabetes have been treated orally with folk medicine of a variety of plant extracts.

The main objective of this study was to carry out a thorough survey of all the anti-diabetic plants used by the major tribes of Gajapati district of Odisha.

Materials and methods

The area under study i.e. Gajapati district (Fig.1) is located in the southern part of the state of Odisha. It lies between 18.6^o to 19.39^o North latitude and 83.48^o to 84.08^o East longitudes. The district is surrounded on the south by Srikakulum district of the state of Andhra Pradesh and three districts of Odisha in the other directions namely Ganjam in the east, Rayagada in the west and Kandhamal in the north.

The geographical situation of the district is characterised by undulated topography with hilly terrain where temperature varies from 10-37 °C in tribal blocks and 16-39 °C in the plain blocks with humid climate. The district has light textured brown forest soil which is highly acidic in nature. The main soil types are clay and sandy loam.

An exhaustive survey was carried out in the area under study for collection, documentation and identification of the plants used against diabetes by the tribes of the local population. Plants with anti-diabetic properties were documented basing on the interviews with herbal medicinal practitioners, medicine men and knowledgeable aged population of the tribal pockets of the 7 blocks of the district. The plant list was prepared based on the interviews and questionnaires.

The investigation was aimed to reveal (elucidate) the traditional medicinal practices among the tribal folks. Details of list of plants, its parts used, mode of

treatment, methods of preparation and administration were recorded. Certain proofs were also recorded from patients who were administered with the medicinal dosages against diabetes. The

voucher specimens were collected, identified and deposited as herbarium samples in the Department of Botany, School of Applied Sciences, Centurion University, Bhubaneswar, Odisha.



Fig. 1. Map of Gajapati district of Odisha.

Results and discussion

An aggregate of 66 plant species belonging to 29 families were recorded and identified to be anti-diabetic (Table 1). Most of the species belonged to family Fabaceae followed by Cucurbitaceae, Rutaceae, Menispermaceae, Myrtaceae and Acanthaceae.

The herbal formulations prepared were either in crude form or are mixtures of various ingredients. From the survey, it was observed that maximum percentage of formulations were prepared from leaves followed by roots for the treatment of diabetes.

People of Gajapati district are famous for administering plant formulations to treat various diseases (Fig. 2). Tribal medicine men have a thorough knowledge about the ethnomedicinal uses

of plants and its formulations used to treat diabetes. They validate the disease through common clinical symptoms like excessive thirst or urination, fatigue, weight loss or blurred vision, slow healing of cuts and wounds, always feeling hungry etc.

Among the plants listed the widely used medicinal plants by the tribes are *Aegle marmelos*, *Andrographis paniculata*, *Asparagus racemosus*, *Azadirachta indica*, *Carica papaya*, *Cucurma longa*, *Helicteres isora*, *Hemidesmus indicus*, *Madhuca indica*, *Phyllanthus emblica*, *Pterocarpus marsupium* and *Woodfordia fruticosa*. Through exhaustive review of literature it is found that among the 66 plant species used by the tribes, 18 species have been proven as anti-diabetic through various experiments (Table 1).

Table 1. List of Ethnomedicinal plants used by the tribes of Gajapati district of Odisha for the treatment of Diabetes.

Botanical name with voucher no. and family name	Local name	Habit	Mode of administration and locality (Loc.)	References (Biological activity)
<i>Abroma agusta</i> Linn. f. [SJ-2014] Sterculiaceae	Pishacha-ganjei (O)	Shrub	The juice (10 ml) of the root bark or fresh stem-bark and flower juice (10 ml) is given once in a day for 7 days. [Loc.-Gosani]	---
<i>Abrus precatorius</i> Linn. [SJ-1006] Rutaceae	Kaincha (O), Karjani (Kon)	Climber	Fresh leaf-juice (about 15 ml) taken once early in the morning. [Loc.-Gumma]	---
<i>Aegle marmelos</i> (Linn.) Corr. [SJ-2 001] Rutaceae	Bela (O), Sinjo (S)	Tree	Tender leaf juice (10 ml) mixed with 2-3 drops of honey given twice daily (evening and morning) on empty stomach to reduce blood sugar within 3-4 weeks. [Loc.-Mohana]	Mudi <i>et al.</i> (2017) Ansari <i>et al.</i> (2017) Panaskar <i>et al.</i> (2013)
<i>Aerva lanata</i> (Linn.) Juss. ex Sch. [SJ-1070] Amaranthaceae	Paunsia (O), Lopongarak (Kon)	Herb	Root paste (5 g) or decoction of the whole plant (10-15 ml) is given two times a day for 10 days to correct cardiac problem caused due to diabetes. [Loc.- R. Udayagiri]	---
<i>Ajuga macrosperma</i> Wall. ex Benth. [SJ-1056] Lamiaceae	Rit mel (S)	Herb	Leaf powder (2g) mixed with powder of 3-5 black pepper (<i>Piper nigrum</i>) taken once daily for 15 days in both diabetes and body swelling. [Loc.-Mohana]	---
<i>Aloe vera</i> (Linn.) Burm.f. [SJ-1034] Liliaceae	Ghee-kuanri (O), Ghee-kumar (S).	Shrub	About 5 ml of leaf juice mixed with 8-10 drops of Tulsa juice (<i>Ocimum sanctum</i>) given twice a day for fifteen days in acute cases. [Loc.-Nuagada]	---
<i>Andrographis paniculata</i> (Burm.f.) Wall. ex Nees. [SJ-1004] Acanthaceae	Bhuinimba (O), Bhuingkara (Sao).	Herb	About 10ml of leaf/root-decoction given once a day for six months against both hyperglycaemia and gastric disorder. [Loc.-Mohana]	---
<i>Asparagus racemosus</i> Willd. [SJ-1026] Liliaceae	Chhatuary (O), Kedarnari (S), Penhepari (Kon)	Herb	Tuberous root powder (5g) mixed with 5 drops of honey given to the patient once in a day for one month to restore potency. [Loc.-Rayagada]	Somania <i>et al.</i> (2012) Hannan <i>et al.</i> (2007)
<i>Azadirachta indica</i> A. Juss [SJ-1064] Meliaceae	Nimba (O), Nim (S)	Tree	About 10 ml of leaf/root-decoction given once a day for six months against both hyperglycaemia and gastric disorder. [Loc.- Mohana]	Kazeem <i>et al.</i> (2013) Perez <i>et al.</i> (2013) Gupta <i>et al.</i> (2016)
<i>Bacopa monnieri</i> (Linn.) Penn. [SJ-1015] Scrophulariaceae	Brahmi (O), Panikundi (Sao)	Herb	Leaf juice (15 ml) along with equal amount of leaf juice of 'Bela' (<i>Aegle marmelos</i>) is prescribed for one month to reduce blood sugar. [Loc.-Mohana]	---
<i>Boerhaavia diffusa</i> Linn. [SJ-1029] Nyctaginaceae	Puruni (O), Choic arak (Sao)	Herb	The leaf juice (10 ml) is used to reduce sugar in urine. The patient is also advised to take the leaves and tender branch tips as vegetables. [Loc.-Rayagada]	Pari and Satheesh (2004) Chopra <i>et al.</i> (1958) Kirtikar and Basu (1933)
<i>Caesalpinia bonduc</i> (Linn.) Roxb. [SJ-107] Caesalpiniaceae	Gila (O), Bagni (S, Kon).	Tree	Seeds (5g) are pounded and given in early morning with 100 ml goat milk for 15 days. [Loc.-Rayagada]	---
<i>Carica papaya</i> Linn. [SJ-201] Caricaceae	Amruta-bhanda (O), Bhanda (S)	Tree	Green fruits are boiled and made into a paste and given with a pinch of common salt and jeera powder for six months. [Loc.- Mohana]	Oke (1998)
<i>Cassia auriculata</i> Linn. [SJ-1021] Caesalpiniaceae	Tarwar (O, S)	Shrub	Leaf juice (10 ml) mixed with 5 g old jaggery given once daily for one month at early stage of the disease. [Loc.-Rayagada]	---
<i>Catharanthus roseus</i> (Linn.) G. Don. [SJ-1077] Apocynaceae	Sadabihari/Ainshakati (O, Kon)	Shrub	Fresh twig with two leaf buds is given daily for 7 days on empty stomach. During this administration, eating sugar is strictly prohibited. [Loc.- Gosani]	Ohadoma and Michael (2011)
<i>Cissampelos pareira</i> Linn. var. <i>hirsuta</i> (DC.) Forman [SJ-1044] Menispermaceae	Akanabindi (O), Telomalla (Sao), Pitu-sing (Kon)	Climber	About 60 g of the root is boiled in half a litre of water for 20-30 min in a closed vessel. About 30-50 ml of this preparation is given two or three times daily to correct the kidney disorder caused by diabetes. [Loc.- Rayagada]	---
<i>Clerodendrum philippinum</i> Schauer [SJ-1067]	Brajamalli (O), Dilbari (Sao)	Small Shrub	Leaf juice (10 ml) mixed with equal amount of 'Tulsi' (<i>Ocimum sanctum</i>) juice is given once	Kar <i>et al.</i> (2015)

Verbenaceae			in a day for 3 days to reduce sugar content in blood. [Loc.-Mohana]	
<i>Clerodendrum phlomidis</i> Linn.f. [SJ-1088] Verbenaceae	Dankari (O), Panjot (S)	Large Shrub	Aqueous extract (10 ml) of leaf is hypoglycaemic and given twice a day for 3 days. [Loc.-Nuagada]	---
<i>Clerodendrum serratum</i> (Linn.) Moon [SJ-1017] Verbenaceae	Budha rasuna (O), Neta (Sao)		Paste of root (15 g) and 7 'Gola maricha' (<i>Piper nigrum</i>) is given in 3 doses at half an hour intervals to cure chest pain and heart palpitation due to acute diabetes. [Loc. - Mohana]	Kar <i>et al.</i> (2014)
<i>Coccinia grandis</i> (Linn.) Voigt. [SJ-1085] Cucurbitaceae	Kunduri (O), Bano-kundri (Kon,S)	Climber	Decoction of the twig of plant along with flowers and young fruits given once daily for seven days to lower sugar in blood. [Loc.-Gosani]	---
<i>Cocculus hirsutus</i> (Linn.) Diels. [SJ-2005] Menispermaceae	Musakani (O), Dahidahiya (S)	Twiner	Leaf juice (5 ml) mixed with equal amount of stem juice of 'guduchi' (<i>Tinospora cordifolia</i>) prescribed daily for 15 days. [Loc.-Mohana]	Badole <i>et al.</i> (2006)
<i>Cressa cretica</i> Linn. [SJ-1023] Convolvulaceae	Rodanti (O)	Herb	The infusion of the whole plant, sweetened with jaggery is taken thrice daily after meals for impotency and loss of weight caused by diabetes. [Loc.-Gumma]	---
<i>Cucumis sativus</i> Linn. [SJ-1090] Cucurbitaceae	Kakudi (O).	Herb	Seeds (2 g) made into a paste with fermented rice water and is given daily for 15 days to reduce the sugar level in blood. Those who suffer from diabetes and those who want to lose weight should make a liberal use of cucumber. [Loc.-Rayagada]	---
<i>Curculigo orchidoides</i> Gaertn. [SJ-1007] Hypoxidaceae	Talamuli (O), Tarmuli (S)	Herb	Root or rhizome paste (10 g) with fermented rice water is recommended daily for seven days on empty stomach to reduce blood sugar. [Loc. - Gumma]	---
<i>Curcuma longa</i> Linn. [SJ-1059] Zingiberaceae	Haladi (O, Sao)	Herb	15-20 ml of fresh juice of the rhizome with equal amount of fruit juice of 'Aenla' (<i>Phyllanthus emblica</i>) given three times in a day for 15 days against glycosuria. [Loc.-Nuagada]	---
<i>Cyamopsis tetragonoloba</i> (Linn.) Taub. [SJ-1036] Fabaceae	Guanra (O, S).	Herb	Fruits fried in cow-ghee given to get relief from general weakness during the disease. [Loc.-Gosani]	---
<i>Ficus racemosa</i> Linn. [SJ-2012] Moraceae	Dimiri (O), Dumar(Kon)	Tree	A paste (50 g) made out of the boiled unripe fruit and equal quantity of fine rice, given with normal meal for 2-3 months to reduce the sugar level in urine. [Loc.-Nuagada]	---
<i>Gmelina arborea</i> Roxb. [SJ-1006] Verbenaceae	Gambhari (O), Gumna (Kon)	Tree	Juice of the young leaves with 2-3 drops of honey is given three times a day after food for 10 days to rectify the eyesight problems due to diabetes (i.e. diabetic retinopathy). [Loc.-Gosani]	---
<i>Gymnema sylvestre</i> (Retz.) R.Br. ex Schult. [SJ-1051] Asclepiadaceae	Gudamari (O).	Climber	Dried leaf powder (2-3 g) is given with water. Seven fresh leaves are prescribed daily in the morning in empty stomach for 15 days. [Loc.-Rayagada]	---
<i>Helicteres isora</i> Linn. [SJ-1003] Sterculiaceae	Modimodica (O), Petkamra(S).	Shrub	One teaspoonful root/bark powder given once daily for 15 days early in the morning before breakfast. [Loc.-Gosani]	---
<i>Hemidesmus indicus</i> (Linn.) R.Br. [SJ-1079] Violaceae	Sugandhi-lai (O), Godmela (Kon)	Twiner	Powdered roots (5 g) given 2-3 times a day in a cup of hot cow-milk for one month to reduce sugar content in blood as well as urine. [Loc.-Nuagada]	---
<i>Hybanthus enneaspermus</i> (Linn.) F.V. Muel [SJ-1010] Violaceae	Madanamastaka (O), Birsuraj-mukhi (S)	Herb	20g of whole plant (including roots) ground with 3 'Gola marich' (<i>Piper nigrum</i>) and the paste given in the morning on empty stomach for one month. [Loc.- Gumma]	---
<i>Hygrophila auriculata</i> (Schum.) Heine	Koili-khia (O, S)	Herb	5 ml of leaf juice along with 5-10 drops of honey is given at evening for 15 days. [Loc.-	---

[SJ-1039]	Nuagada]			
Acanthaceae				
<i>Ichnocarpus frutescens</i> (Linn.) R.Br.	Suam-lai (O), Ono- sing (Kon)	Shrub	Fresh juice of leaf and fruit along with two black pepper (<i>Piper nigrum</i>) given early in the morning on empty stomach. [Loc.-Gosani]	---
[SJ-1011]				
Apocynaceae				
<i>Lablab purpureus</i> Linn. [SJ-1054]	Shimba (O)	Herb	Tender pods cooked and eaten give relief in diabetes. [Loc.-R. Udayagiri]	---
Fabaceae				
<i>Lawsonia inermis</i> Linn [SJ-1013]	Manjuati (O), Mindi (S, Kon)	Shrub	Decoction of equal quantity of flowers and seeds (2-5 g each) is given once a day for 10-15 days to reduce the sugar level in urine. [Loc.-Nuagada]	---
Lythraceae				
<i>Macrotyloma uniflorum</i> (Lam.) Verdc. [SJ-1002]	Kolatha (O)	Herb	50 g of seeds are boiled with water for about half an hour. The water is taken in empty stomach every day to control blood sugar level. [Loc.-R. Udayagiri]	---
Fabaceae				
<i>Madhuca indica</i> Gmel. [SJ-1075]	Mahula (O), Aba (S), Mahua (Kon)	Tree	Decoction of bark (15 g) is prescribed internally in diabetes mellitus with beneficial results. [Loc.-Nuagada]	---
Cucurbitaceae				
<i>Momordica charantia</i> Linn. [SJ-1024]	Kalara (O), Kirla (Kon)	Herb	Decoction of the fruits is given to the patients in the morning in empty stomach at least for one month. The patient is also advised to take the fruit as vegetable in his daily diet. A mixture of 'Jamu' (<i>Syzygium cumini</i>), 'Gudamari' (<i>Gymnema sylvestre</i>), 'Nimba' (<i>Azadirachta indica</i>) and Kalara (leaves only) in the ratio 1:1:1:2 is an effective remedy for diabetes. [Loc.-Mohana]	Mahmoud <i>et al.</i> (2017) Ma <i>et al.</i> (2017)
Cucurbitaceae				
<i>Moringa oleifera</i> Lam. [SJ-1045]	Sajana (O), Mungaara (Kon), Munga arak (S)	Tree	Fruit juice (15-20 ml) along with little old jaggery given once daily for 7 days. Patients are advised to take fruits and leaves as vegetables in daily diet at least 15 days per year. [Loc.-Kasinagar]	---
Moringaceae				
<i>Murraya koenigii</i> (Linn.) Spreng. [SJ-1068]	Bhrusunga (O), Puspa (Bond), Mirsinga (Kon)	Shrub	Eating 7 fresh fully-grown curry leaves every morning for three months is said to prevent diabetes due to hereditary factors. It also cures diabetes due to obesity. As the weight drops, the diabetic patients stop passing sugar in urine. [Loc.-Kasinagar]	Narayan and Sastry (1975) Yadav <i>et al.</i> (2002) Kesari <i>et al.</i> (2005)
Rutaceae				
<i>Naringi crenulata</i> (Roxb.) Nicolson [SJ-2020]	Benta(O), Kumbali (Sao)	Small tree	Aqueous extract of fruit pulp of this plant along with seeds (5 g) of 'Methi' (<i>Trigonella foenum-graecum</i>) is prescribed for 7 days to keep diabetes in control. [Loc.-R. Udayagiri]	Mekap <i>et al.</i> (2016)
Rutaceae				
<i>Oxalis corniculata</i> Linn. [SJ-1005]	Ambiliti(O), Tandi/Chatamarak (S)	Herb	A tablespoon of fresh juice mixed with butter of cow's milk is given once daily for 15 days to curb excessive thirst caused by diabetes or severe heat. [Loc.-Gosani]	Mekap <i>et al.</i> (2016)
Oxalidaceae				
<i>Pistia stratiotes</i> Linn. var. <i>cuneata</i> Engl. [SJ-1025]	Borajhanji (O), Takapana (Kon)	Shrub	The juice (10 ml) of young plants mixed with equal amount of green coconut milk is given to reduce sugar content in blood. [Loc.-Rayagada]	---
Araceae				
<i>Paspalum scrobiculatum</i> Linn. [SJ-1065]	Kodua (O), Janhe (S), Gara-kode (Kon)	Herb	Mature grains (10 g) of this plant are made into a paste with the latex (1 ml) of banyan prop roots (<i>Ficus benghalensis</i>) and given once daily for 7 days to lessen the excessive appetite during diabetes. [Loc.-R. Udayagiri]	---
Poaceae				
<i>Phyllanthus emblica</i> Linn. [SJ-1047]	Aenla (O), Meral (Kon), Ener (S)	Tree	5 g paste of fresh leaves given daily for one month in empty stomach to reduce sugar in blood. Paste prepared from equal quantity of boiled fruits of this plant and the fruits of 'Bahada' (<i>Terminalia bellirica</i>) given with 50 ml cow's milk twice daily one hour before food. [Loc.-Kasinagar].	Nampoothiri <i>et al.</i> (2011)
Euphorbiaceae				
<i>Phyllanthus fraternus</i> Linn. [SJ-1019]	Bhuinanla (O), Bariamla (S)	Herb	Juice of the whole young plant given in every stages of the disease. [Loc.-Kasinagar]	---

Euphorbiaceae					
<i>Portulaca oleracea</i> Linn. [SJ-1080] Portulacaceae	Balibalua (O), Dali ara (Kon)	Herb	A teaspoon of its seed given every day with hot water for 2-3 months to treat diabetes. [Loc.-R. Udayagiri]	---	
<i>Psidium guajava</i> Linn. [SJ-1027] Myrtaceae	Pijuli (O), Chaulia (S).	Tree	Juice (about 10 ml) of vegetative as well as reproductive buds given daily, once in the evening for at least one month. [Loc.-Kasinagar]	---	
<i>Pterocarpus marsupium</i> Roxb. [SJ-1052] Fabaceae	Piyasala(O), Hid (Sao), Murga (S), Bia (Kon)	Tree	Heartwood soaked overnight with water and the filtrate (10 ml) is given daily for one month. Seeds of this plant is also used but found less efficient than the wood. [Loc.-Kasinagar]	---	
<i>Pterocarpus santalinus</i> Linn.f. [SJ-1055] Fabaceae	Rakta-chandana (O, S)	Tree	Heartwood rubbed on a piece of stone and the paste (about 5 g) given with a glass of water to lessen excessive urination. [Loc.-Gumma]	---	
<i>Pueraria tuberosa</i> DC. [SJ-1012] Fabaceae	Handiphuta (O), Tirra (Sao)	Climbing shrub	2 g each of root powder of this plant and 'Satabari' (<i>Asparagus racemosus</i>) mixed with a banana and 100 ml milk is given once in a day for one month. [Loc.-R. Udayagiri]	---	
<i>Rhinacanthus nasutus</i> (Linn.) Kurz. [SJ-1048] Acanthaceae	Kaura-saga (O).	Shrub	Juice of the leaves (5-10 ml) along with the fruit juice (10 ml) of 'Aenla' (<i>Phyllanthus emblica</i>) is given. Stem powder is also given with hot water for 10 days. [Loc.-Kasinagar]	---	
<i>Scirpus grossus</i> Linn.f. [SJ-1062] Cyperaceae	Kesara-mula (O), Jomekasari (S)	Herb	Tuber powder (5 g) of this plant along with 2 ground nut seeds is given daily for one month to check loss of weight during the disease. [Loc.-Gumma]	---	
<i>Sida cordifolia</i> Linn. [SJ-1031] Malvaceae	Bisiripi(O), Huringmindi-lata (Kon)	Shrub	Root powder (2-3 g) with one glass of milk given daily is effective within a short period. [Loc.-R.Udayagiri]	---	
<i>Solanum viginiarum</i> Linn. [SJ-1060] Solanaceae	Ankaranti (O), Rangani janum (S)	Shrub	One gram of powdered root is given twice a day with 250 ml goat's milk. This treatment should be continued till the weakness due to this disease is completely over. [Loc.-Kasinagar]	---	
<i>Sphaeranthus indicus</i> Linn. [SJ-1020] Asteraceae	Bhuinkadamba(O), Koirab (Kon), Belaunga(S)	Herb	Paste (15 g) of the aerial part of this plant given with little old jaggery twice a day for 3 days to check the excessive urination. [Loc.-Gumma]	---	
<i>Striga densiflora</i> (Benth.) Benth. [SJ-1009] Myrtaceae	Phuruphuria (O,S)	Herb	Fruits (5 g) are powdered and taken with warm water for 15 days to cure the disease. [Loc.-Gosani]	---	
<i>Syzygium cumini</i> (Linn.) Skeels [SJ-1050] Myrtaceae	Jammu (O), Neredu (S)	Tree	10 g each of the leaves of this plant and 'Gudamari' (<i>Gymnema sylvestre</i>) are boiled in 50 ml of water till it reduces to about 500 ml. The filtered extract is then given along with 5 g of jaggery daily for two months. [Loc.-R.Udayagiri]	---	Brahmachari and August (1961) Rahman and Zaman (1989)
<i>Talinum triangulare</i> Willd. [SJ-1001] Portulacaceae	Bilati poi (O), Kana phul (Kon)	Herb	Powder (5 g) or decoction (20 ml) of whole plant or root mixed with date palm juice (10 ml) is given to cure diabetes. [Loc.-Gumma]	---	
<i>Terminalia arjuna</i> (Roxb. ex DC.) Wt. & Arn. [SJ-1058] Combretaceae	Arjuna (O), Kowa (Sao), Kahua (S).	Tree	Bark powder (1g) mixed with the decoction (10 ml) of the fresh bark and 5 drops of honey given on empty stomach twice daily for 7 days. [Loc.-Rayagada]	---	Biswas et al. (2011) Khaliz et al. (2013)
<i>Tinospora cordifolia</i> (Willd.) Hook f. & Thoms. [SJ-1033] Menispermaceae	Guluchi-lata (O),Gursilai (Kon), Gurach (S).	Herb	15-20 ml stem juice with 2drops of honey is given twice a day for 15 days. Stem powder (5 g) of this plant and 2-3 g of 'Pippali' powder (<i>Piper longum</i>) are prescribed for 7 days for oral ulcers of diabetic patients. [Loc.-Nuagada]	---	Sangetha et al. (2013) Rajalakshmi and Anita (2016)
<i>Toddalia asiatica</i> (L.) Lam. [SJ-2025] Rutaceae	Tundapoda (O), Kanj (S)	Scandent Shrub	Leaf powddder (10 g) of this plant mixed with stem juice of 'Gulduchi' (<i>Tinospora cordifolia</i>) is given with 50 ml cow milk to	---	Mekap et al. (2016)

reduce blood sugar. [Loc.- Gosani]				
<i>Trichosanthes dioica</i> Roxb. [SJ-1083] Cucurbitaceae	Potala (O).	Herb	Juice of the leaves and roots (5 ml) is given daily on empty stomach for 10 days against excessive urination and sugar in urine. [Loc.- Gosani]	---
<i>Triumfetta rhomboidea</i> Jacq. [SJ-1046] Tiliaceae	Bacchua (O), Jhinhirita (S).	Shrub	Leaf powder (3g) is taken daily with cold water for 15 days against diabetes. [Loc.-Gumma]	---
<i>Woodfordia fruticosa</i> (Linn.) Kurz. [SJ-1022] Lythraceae	Dhatuli (O), Ichak (S), Dhatki(Kon)	Shrub	Dried flowers (2-3 g) along with 100 ml of fermented rice water is given once in a day for one month to treat diabetes. [Loc.-Gosani]	---

(O-Odia, Sao-Saora, S-Savara, Kon-Kondha; Loc. - Locality; SJ. - Name of the first author in abbreviated form).

Most of the plant species reported are herbs or shrubs and a few of them are tree species (Fig. 3). This aspect has made the survey as well as collection of plant material bit easy and also towards species conservation. Moreover, the survey also revealed that leaf was the major plant part used (Fig. 4) which is in agreement with earlier studies. The collection and

processing of leaves is easy and does not damage the plant substantially as compared to the collection of roots, tubers or the whole plant. The present study could identify a good number of candidate plants with folklore claims which need further investigation for anti-diabetic treatment.

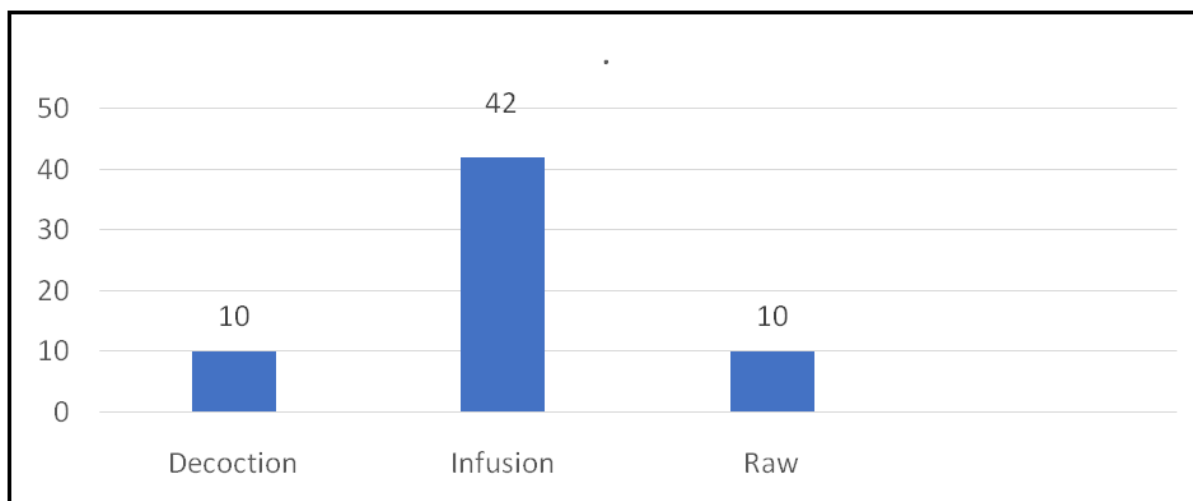


Fig. 2. Traditional formulations adopted by the tribal healers in the preparation of herbal remedies.

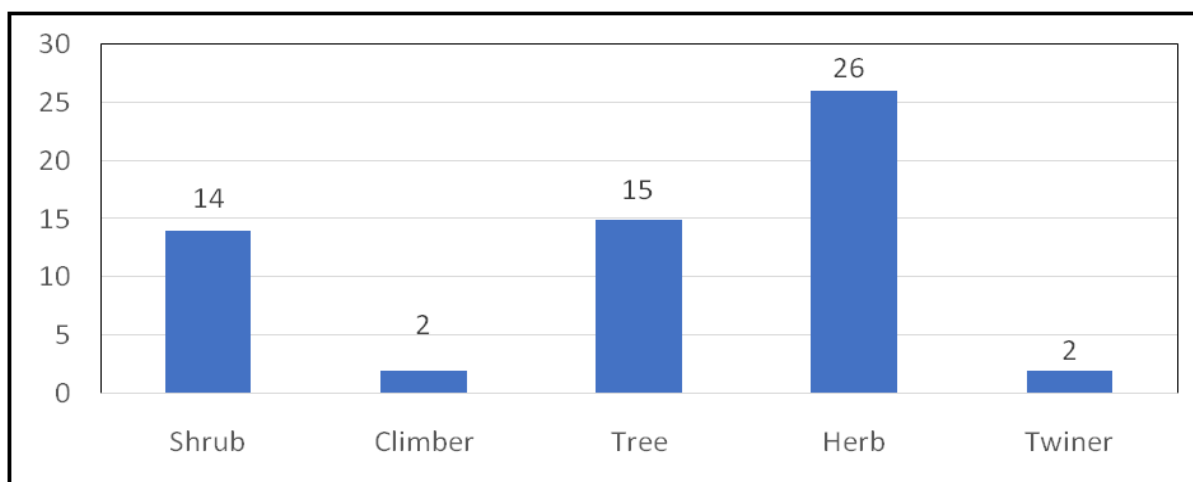


Fig. 3. Frequency of Habit of the Anti-diabetic medicinal plants.

MOP: more than one part

The cure of diabetes is a global problem as the synthetic medicines developed does not give the assurance that the patient can totally recover from diabetes (Li *et al.*, 2004). Therefore, alternative therapy of using indigenous plants and herbal

formulations has taken a forefront (Satyanarayan *et al.*, 2006). The traditional medicine has paved a bright future in treatment of diabetes and to explore the importance of traditional herbs and folklore claims.

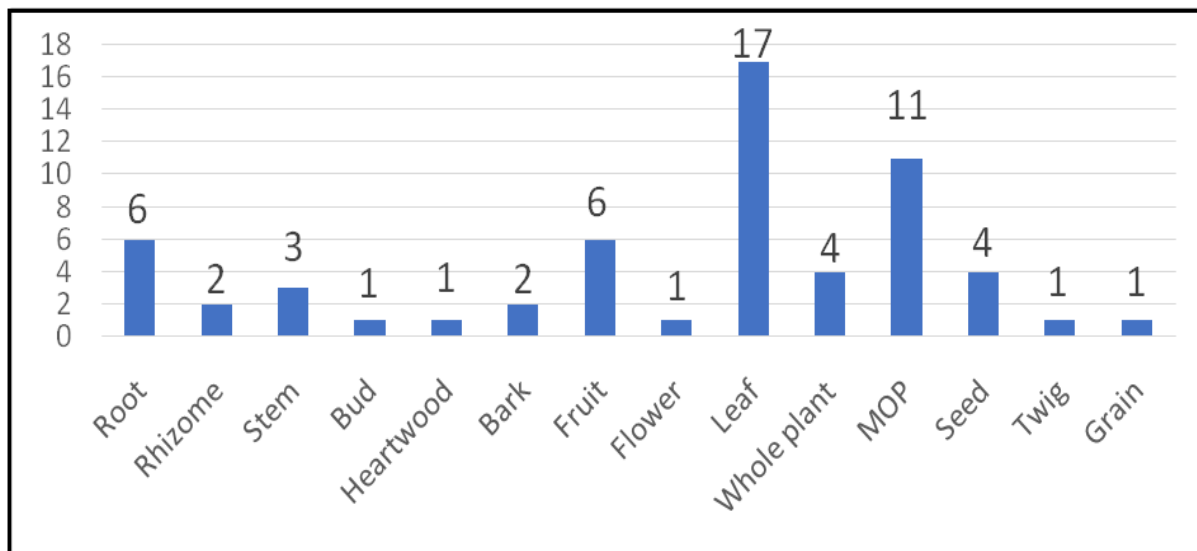


Fig. 4. Frequency of plant part (s) used during preparation of herbal medicines.

Acknowledgements

Authors are thankful to the administration and management of Centurion University of Technology and Management, Odisha, India for providing necessary facilities to conduct the investigation.

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