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Research paper

Antidiabetic plants used among the ethnic communities of Unakoti district of Tripura, India

Ramananda Ghosh Tarafdar*, Sushmita Nath, Anupam Das Talukdar, Manabendra Dutta Choudhury

Ethnobotany and Medicinal Plants Research Laboratory, Department of Life Science and Bioinformatics, Assam University, Silchar, Assam 788011, India

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A B S T R A C T

Ethnopharmacological relevance: A large group of ethnic communities living in Unakoti district of Tripura, India is still dependent on traditional herbal remedies for treatment of diabetes. Valuable information collected from these communities in the present investigation is important in maintaining their indigenous knowledge of folklore medicine.

Methods: Systematic and extensive field surveys were conducted during 2011–2013 among the ethnic inhabitants of Unokati district, Tripura, India covering all the seasons to collect information on their traditional herbal medication system for treatment of diabetes. Obtained data were analysed through fidelity level (FL), use value (UV) and relative frequency of citation (RFC) to authenticate the uniqueness of the species being used for diabetes treatment.

Results: In this current study a total of 39 medicinal plant species belonging to 37 genera and 28 families were presented, used by the traditional healers of Unakoti district, Tripura, India for diabetes treatment. FL, UV and RFC values of collected plants for the selected study area ranges between 06% and 100%, 0.07% and 2.64% and 0.02% and 0.51% respectively. Out of 39 collected plants, 11, 5 and 3 plant species have showed significant (< 50%) FL, UV and RFC values respectively.

Conclusion: Like many other ethnic communities of the world, inhabitants of Unakoti district depend on a traditional medication system to treat diabetes. Documented floras are locally available and need proper further pharmacological validation to endorse their traditional use in a modern health care system. This will help in the development of effective herbal antidiabetic medicines in near future.

1. Introduction

World Health Organisation (WHO) data suggests (WHO, 2013) that 90% people around the world are suffering from Type 2 diabetes (T2DM). 80% deaths of total world population occur in developing countries due to diabetes and India stands second in the world with it. Given the spectrum of currently available antidiabetic drugs, present scenario depicts that this disease will be the 7th leading cause of death by 2030 (WHO, 2013). This alarming statistics demands to develop more new potent antidiabetic drugs. Though, sulphonylurea derivatives and glitazone compounds are potent synthetic antidiabetic drugs, but they failed to restore the glycemic index (Laville and Andreelli, 2000; Iwaki et al., 2003) with adverse side effects *viz*: inhibition of hepatic regeneration (Turmelle et al., 2006), induced obesity (de Souza et al., 2001) and osteoporosis (Rzonca et al., 2004). To curve these side effects of the synthetic products herbal medication can be an effective alternative. Many medicinal plants have been traditionally used as a cure for diabetes but a few of them have received proper scientific validation and clinical scrutiny. Therefore, it is essential to justify a plant's activity scientifically in terms of modern experimental findings (Singh et al., 2012).

In this regard, ethnobotanical knowledge along with rationalised scientific research has formed a building block of drug discovery. Because, traditionally used medicinal plants have an age old history of safe, non-toxic or less-toxic effect in human beings. Present study attempts to investigate and document the traditionally used medicinal plants as antidiabetic folklore medicine by the ethnic communities of Unakoti district (Fig. 1), Tripura, India. Tripura, a small hilly state of North-Eastern India, has unique ethnic culture and diverse vegetation. The state is bounded on the North West, South and South East by Bangladesh, in the East it has common boundary with Assam and Mizoram. The total area of the state is 10,497,697 sq km and located between 22°-56, and 24°-32′ North latitude and between 90°-09′ and 92°-20′ East longitudes. The state covers approximately 6292.681 sq km total forest area with annual rainfall of 247.9 cm in a temperature

* Corresponding author. Tel./fax: +91 3842 270920.
E-mail address: rgtarafdar@gmail.com (R.G. Tarafdar).

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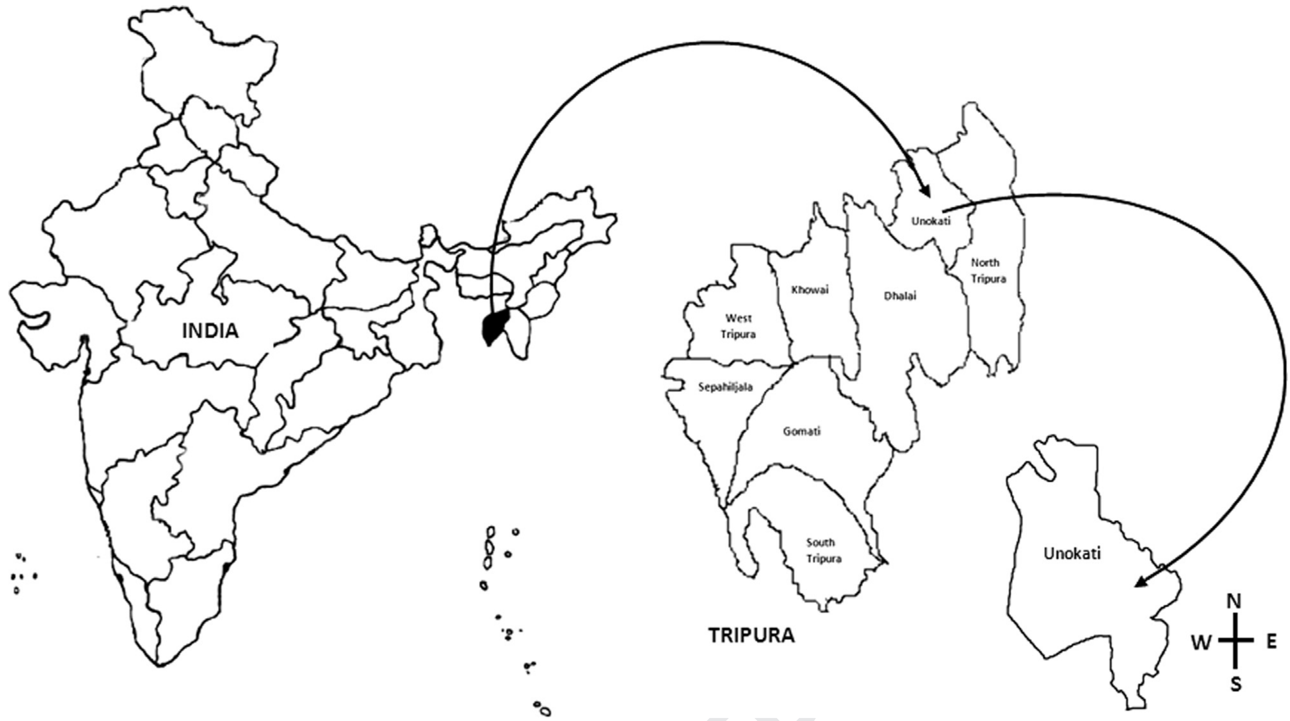

Fig. 1. Map representing the study area (Map not to the scale).

ranging between 10 °C and 35 °C. Tripura is categorised as evergreen forest and moist deciduous forest (Shil et al., 2014). Total 1600 vascular plant species have been reported from the state which constitutes 14% of total flora of India (Deb, 1981 and 1983). The Unakoti district is situated in the Northern most part of Tripura, has a geographical area of 686.97 sq km. The district is bounded by Bangladesh on the Western side, North Tripura District on the Eastern side and Dhalai District on the South-western side. Unakoti is inhabited by various ethnic communities, *i.e. Bangalee*, *Chakma*, *Darlong*, *Halam*, *Rangkhole*, *Lushai*, *Mog*, *Reang*, *Tripuri*.

2. Methods

After regular filed visits, exploration of areas inhabited by the different ethnic communities of the district and interaction with the traditional healers of the district during the year 2011–2013, the ethnomedicinal information collected on 39 plant species used for the treatment of diabetes is enumerated. The information was collected from 35 traditional practitioners (29 men and 6 women). Demographic data of the informants are presented in Table 1. The collected plants were identified by referring to Assam University Herbarium, Department of Life Science and Bioinformatics and voucher specimens were deposited. For each plant species listed, Lation name, local (vernacular) names in Bangalee (B), Chakma (C), Darlong (D), Halam (H), Rangkhole (R), Lushai (L), Mog (M), Reang (R″), Tripuri (T) languages, family and uses are shown in Table 2. From the collected data Fidelity level (FL), User value (UV) and Relative frequency of citation (RFC) index have been calculated. The FL is the ratio between the number of informants who independently suggested the use of a species for the same major purpose and the number of informants who mentioned the plant. Fidelity level is calculated by the following formula:

$$FL(\%) = (N_p/N) \times 100$$

where N_p is the number of informants that claimed a use of a plant species to treat a particular disease and N is the number of informants that used plants as a medicine to treat any given disease (Friedman et al., 1986).

Table 1
Demographic data of informants.

Category		*n*	%
Age	Under 60	02	5.7
	61–75	08	22.8
	Above 75	25	71.4
Sex	Male	29	82.8
	Female	06	17.1
Ethnic group	Bengalee	02	5.7
	Chakma	05	14.2
	Darlong	09	25.7
	Halam	05	14.2
	Rangkhole	01	02.8
	Lushai	03	08.5
	Mog	01	02.8
	Reang	05	14.2
	Tripuri	04	11.4

n = Number of informants.

The UV was calculated on the basis of the following formula (Philips et al., 1994): Q2

$$UV \Sigma U/n$$

where U is the number of use reports for a given plant species cited by each informant and n is the total number of informants interviewed for a given plant. The relative importance of plant species used in the traditional medicine can be determined by UV where most frequently cited plant species show a higher UV and plants with lesser citation show a lower UV.

The RFC index was calculated by using the following formula (Tardio and Pardo-deSantayana ,2008):

$$RFC = FC/N (0 < RFC < 1)$$

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Table 2
List of collected plant species used by the traditional healers of Unakoti District, Tripura, India for treating diabetes.

Sxl. No	Family	Botanical name	Local name	Tribes using the plants	Part used	Preparation	Relevant ethnobotanical/ pharmacological citation	Fidelity level (FL%)	Use value (UV)	Relative frequency of citation (RFC)
1	Acanthaceae	*Adhatoda vasica* Nees.	Vasak pata	C, H	Root, leaf, flower	Decoction	Claeson et al., 2000; Gulfraz et al., 2005; Kumar et al., 2013	15	0.16	0.09
2	Acanthaceae	*Andrographis paniculata* (Burm.f.) Wall. ex Nees	Kalmegh	T	Whole plant	Juice	Zhang and Tan, 2000; Hossain et al., 2007; Nugroho et al., 2012; Jayakumar et al., 2013; Dey et al., 2013; Augustine et al., 2014;	55	1.52	0.31
3	Acanthaceae	*Phlogacanthus thyrsiflorus* Nees	Vasaka	T, R	Flower, leaf	Fresh juice	Gogoi et al., 2013; Chakravarty and Kalita, 2014	33.3	0.58	0.14
4	Apocynaceae	*Catharanthus roseus* G.Don.	Nayantara	C, D, H	Leaf	Juice	Singh et al., 2001; Nammi et al., 2003; Mostofa et al., 2007; Islam et al., 2009; Ahmed et al., 2010; Rasineni et al., 2010; Tiong et al., 2013;	60	1.69	0.34
5	Apocynaceae	*Holarrhena antidysenterica* (L.) R.Br.	Kurchi	R''	Seed, bark	Seed powder, bark decoction	Jalalpure et al., 2006; Ali et al., 2011; Mana et al., 2011; Korpenwar, 2011; Keshri et al., 2012;	40	0.94	0.17
6	Apocynaceae	*Hemidesmus indicus* (L.) R.Br.	Anantamul	C	Root	Decoction	Sowmia and Kokilavani, 2007; Gayathri and Kannabiran, 2008, Das and Bisht, 2013	57.1	1.66	0.31
7	Araceae	*Alocasia indica* (Roxb.) Schott.	Mankachu, mankanda, hastikarni	D, H	Rhizome	Juice, shade dried powder	Patil et al., 2012; Pal et al., 2014	13.3	0.14	0.05
8	Arecaceae	*Areca catechu* L.	Supari	R''	Nuts	Juice	Mondal et al., 2012; Verma et al., 2012; Ghate et al., 2014	23.5	0.40	0.11
9	Arecaceae	*Cocos nucifera* L.	Dab, Narikel	B, C, T	Fruit and flower	Fresh fruit pulp, flower decoction	Sindurani and Rajamohan, 2000; Naskar et al., 2011; DebMandal and Mandal, 2011	26.7	0.44	0.11
10	Bombacaceae	*Bombax ceiba*.L	Shimul	D, H	Flower and stem bark	Decoction	Patil et al., 2010; Gandhare et al., 2010; Bhavsar and Talele, 2013; Verma et al., 2014	46.6	0.97	0.17
11	Bromeliaceae	*Ananas comosus* (L.) Merr.	Amatoi, Ananash, Ananas, Anamnasam, Bahunetraphalam	T, C, H	Whole plant	Fresh fruit pulp, Leaf decoction	Xie et al., 2005; Xie et al., 2007; Kalpana et al., 2014	33.3	0.58	0.14
12	Caesalpiniaceae	*Cassia fistula* L.	Aragvadha, Suvarnaka, Amultas, Bandarlathi, girimalah	C, H, D	Flower, seed, stem bark	Seed powder, flower and stem bark decoction	Manonmani et al., 2005; Gupta, 2010; Devi, 2011; Einstein et al., 2012; Patil and Patil, 2012; Dutta and Kalita, 2013; Rajalakshmi and Daisy, 2014	71.4	1.90	0.37
13	Caesalpiniaceae	*Cassia sophera* L.	Kalkasunda	D	Seeds and stem bark	Decoction	Aminabee and Rao, 2012	16.7	0.16	0.05
14	Caesalpiniaceae	*Cassia tora* L.	Panevar	H, D	Seeds	Shade dried seed powder	Cho et al., 2005	06	0.07	0.02
15	Cannabinaceae	*Cannabis sativa* L.	Bhang, ganja	C, T, R	Seeds	Smoked seed powder	Levendal and Frost, 2006; Sailani and Moeini, 2007; Tehranipour et al., 2012; Esra et al., 2012	35.2	0.59	0.17
16	Caricaceae	*Carica papaya* L.	Papaya	C	Seeds, fruits	Fruit pulp, shade dried seed powder	Adeneye et al., 2009; Juarez-Rojop et al., 2012; Venkateshwarlu et al., 2013; Elgadir et al., 2014; Ezekwe et al., 2014	66.7	1.75	0.34
17	Combretaceae	*Terminalia chebula* Retz.	Hortokhi	D, H	Seeds	Seed decoction and powder	Sabu and Kuttan, 2002; Rao and Nammi, 2006; Bag et al., 2013	40	0.94	0.14
18	Crassulaceae	*Kalanchoe pinnata* Pers.	Kophpata or patharkuchi	C, T, R	Whole plant	Fresh juice	Biswas et al., 2011; Quazi et al., 2011; Pattewar, 2012	20	0.17	0.02
19	Cucurbitaceae	*Coccinia indica* (L.) Voigt	Telakuchi	C, L, M	Leaf, fruit	Decoction	Kar et al., 2003; Gunjan et al., 2010; Ramakrishnan et al., 2011	62.5	1.71	0.31
20	Cucurbitaceae	*Cucumis melo* L.	Kakur	B, C	Whole plant part	Fruist pulp, plant decoction	Bidkar et al., 2012	20	0.17	0.08
21	Cyperaceae	*Cyperus rotundus* L.	Mutha	D, H	Rhizome	Fresh juice	Raut and Gaikwad, 2006; Meena et al., 2010; Jahan et al., 2013; Imam and Sumi, 2014	33.3	0.58	0.11

Q14

Table 2 (*continued*)

Sxl. No	Family	Botanical name	Local name	Tribes using the plants	Part used	Preparation	Relevant ethnobotanical/ pharmacological citation	Fidelity level (FL%)	Use value (UV)	Relative frequency of citation (RFC)
22	Dioscoreaceae	*Dioscorea alata* L.	Guranialu, Katalu, Chupri alu	B	Rhizome	Decoction	Maithili et al., 2011	15	0.16	0.08
23	Euphorbiaceae	*Cicca acida* Merr.	Meer Harboroi/ Laboir	H, C	Leafs	Decoction	Mackeen et al., 1997; Vongvanich et al., 2000; Lee et al., 2006; Melendez and Capriles, 2006; Sousa et al., 2007; Jagessar et al., 2008; Leeya et al., 2010; Bagavan 5 et al., 2011; Chakrabarty et al., 2012; Yanadaiah et al., 2012; Mondal et al., 2013; Rekka et al., 2014	78	2.11	0.51
24	Euphorbiaceae	*Euphorbia hirta* L.	Bara dudhai	M, B	Whole plant	Fresh juice, Decoction	Kumar et al., 2010a, Kumar et al., 2010b; Upadhyay et al., 2010; Subramanian et al., 2011	37.5	0.61	0.08
25	Euphorbiaceae	*Phyllanthus emblica* L.	Amloki Amla, Amla, Amlika	B, D	Seeds	Roasted seed powder	Liu et al., 2008; Tasanarong et al., 2014; Amiri et al., 2014; Iamsaard et al., 2014	40	0.94	0.05
26	Fabaceae	*Sesbania sesban* (Jacq.) W. Wight	Jayanti	M	Leaf	Decoction	Pandhare et al., 2011; Gomase, 2012.	30	0.5	0.08
27	Lamiaceae	*Ocimum sanctum* L.	Bantha, Ban tulsi	B, H, L	Leaf, stem, flower twing and root	Decoction	Vats et al., 2002; Prakash and Gupta, 2005; Pattanayak et al., 2010.	46.6	0.97	0.11
28	Meliaceae	*Azadirachta indica* Juss.	Inkbow, Neem	B, C, M	Leaf, seed	Leaf decoction, Seed powder	Khosla et al., 2000; Biswas et al., 2002; Hussain, 2002; Chattopadhyay and Bandyopadhyay, 2005; Atawodi and Atawodi, 2009; Bhat et al., 2011; Atangwho et al., 2012; Dallagua et al., (2012)	58.3	1.66	0.31
29	Mimosaceae	*Albizia procera* (Roxb.)	Koroi, gurar, kurha, safed siris	C, M	Leaf, flower, bark	Decoction	Kokila et al., 2013; Khatoon et al., 2014	16.6	0.16	0.08
30	Moraceae	*Artocarpus heterophyllus* Lamk.	Kathal	B	Leaf	Juice	Prakash et al., 2009; Shahin et al., 2012	30	0.5	0.02
31	Moraceae	*Streblus asper* Lour.	Sheora	C, H	Leaf	Decoction	Rastogi et al., 2006; Kumar et al., 2012; Karan et al., 2013	28.5	0.48	0.05
32	Musaceae	*Musa paradisiaca* L.	Mucha	B, M, L	Mucha	Juice, Decoction	Ojewole and Adewunmi, 2003; Parmar and Kar, 2008; Kumar et al., 2012	57	1.67	0.34
33	Myrtaceae	*Syzygium cumini* (L.)Skeels.	Kala jam	R''	Bark, fruit and seeds	Decoction	Kumar et al., 2008; Kumar et al., 2009; Rao and Rao, 2011; Gowri and Vasantha, 2010	80	2.13	0.54
34	Nymphaeaceae	*Nymphaea rubra* L.	Podda kuchok, Jalpadda	R'', H, C	Leaf, stem and flower	Flower extract, Stem and leaf decoction	Raja et al., 2010; Dodamani et al., 2012	10	0.13	0.05
35	Plantaginaceae	*Scoparia dulcis* L.	Nover kotornisam	D, H	Whole plant	Decoction	Latha et al., 2004; Pari and Latha, 2005; Mesia-Vela et al., 2007; Zulfiker et al., 2010; Mishra et al., 2013	100	2.64	0.57
36	Poaceae	*Cynodon dactylon* (L.) Pers.	Durba	B	Whole plant	Fresh juice	Jarald et al., 2008; Karthik and Ravikumar, 2011; Annapurna et al., 2013	25	0.44	0.14
37	Smilacaceae	*Smilax zeylanica* L.	Jangliaushbah	R''	Root and leaf	Decoction	Murali et al., 2012; Rajesh and Perumal, 2014	20	0.18	0.05
38	Verbenaceae	*Clerodendrum viscosum* Vent.	Bhandirah, Basavanapada, Ibbane	C, H	Whole plant	Extract	Shrivastava and Patel, 2007; Dutta Choudhury et al., 2009; Rahmatullah et al., 2012	14.2	0.15	0.08
39	Zingiberaceae	*Elettaria cardamomum* (L.) Maton	Elaichi	B	Fruit, seed and leaf	Fruit and leaf decoction, seed powder	Husain et al., (2014); Al-Judaibi et al., 2014	50	1.48	0.05

Bangalee: B; Chakma: C; Darlong: D; Halam: H; Rangkhole: R; Lushai: L; Mog: M; Reang: R″; Tripuri: T.

where FC is the number of informants who mentioned the use of the species and *N* is the total number of informants.

3. Results

A total of 39 medicinal plant species (37 genera and 28 families) with family name followed by their scientific name, local name, plant part(s) used, tribes using that plant part(s), mode of preparation, Fidelity level (FL), Use value (UV) and relevant ethnobotanical/pharmacological citation are listed (Table 2). Maximum numbers of antidiadetic plants were recorded from Acanthaceae, Apocynaceae, Caesalpiniaceae, Euphorbiaceae (three plant species from each family); followed by Arecaceae, Cucurbitaceae, Moraceae (two plant species from each family) and Araceae, Bombacaceae, Bromeliaceae, Cannabinaceae, Caricaceae, Combretaceae, Crassulaceae, Cyperaceae, Dioscoreaceae, Fabaceae, Lamiaceae, Meliaceae, Mimosaceae, Musaceae, Myrtaceae, Nymphaeaceae, Plantaginaceae, Poaceae, Smilacaceae, Verbenaceae, Zingiberaceae (single plant species from each family). Fidelity level (FL) and Use value (UV) of each species are calculated from the available information. FL, UV and RFC values of collected plants for the selected study area ranges between 06% and 100%, 0.07% and 2.64% and 0.02% and 0.51% respectively (Table 1). Out of 39 collected plants 11 species showed significant (<50%) FL, 05 species showed significant (<50%) UV and 03 species showed significant (< 50%) RFC.

4. Discussion

The existing traditions of treating diabetes using different plant species among different ethnic communities residing in Unakoti district have been collected and summarised. FL indicates the informants' choice for a potential plant species to treat a given disease; UV determined most frequently used plant species, whereas RFC determined the most popular medicinal plants accepted by the majority of the informants for treating diabetes. Therefore, FL, UV and RFC are essential for selecting a plant species to be investigated further. Significant values (<50%) of FL and UV bring forward 5 plant species *viz*: *Scopaia dulcis* L., *Syzygium cumini* L., *Cicca acida* L., *Cassia fistula* L., and *Carica papaya* L., whose further pharmacological studies will help to establish new potent antidiabetic molecule(s) (Fig. 2). Three plant species (*Scoparia dulcis* L., *Syzygium cumini* L., and *Cicca acida* L.) amongst the above showed significant (<50%) RFC values. The current survey establish *Scoparia dulcis* L. as predominantly used plant among Darlong and Halam tribes for treating diabetes (whole plant decoction) with UV (2.64), RFC (0.57) and FL (100%). Caribbean tribes also use this plant in the same manner (Morton, 1981). Works from different parts of the world have established its antidiabetic (Latha et al., 2004 Zulfiker et al., 2010; Mishra et al., 2013), hypertension, hepatitis, and gastric ulcers efficacy (Latha et al., 2004, Mesia-Vela et al., 2007).

Another plant with significant FL (80%), UV (2.13) and RFC value (0.54) is *Syzygium cumini* L.. Reang tribe uses the decoction of plant's bark, fruit and seeds to treat diabetes. The same use prevails in tribes of Southern Assam and Manipur (Banik et al., 2010; Devi et al., 2011) of India and in Southern Brazil, Madagascar (Ayyanar and Babu, 2012) and other parts of the world (Alam et al., 2012). Significant bioactivities *viz*: antidiabetic (Rao and Rao, 2001; Kumar et al., 2009), antibacterial (Gowri and Vasantha, 2010), hepatoprotective (Moresco et al., 2007), strengthening of teeth and gums, treatment of leucorrhoea, stomachalgia, gastropathy, strangury, dermopathy and constipation (Warrier et al., 1996) of *Syzygium cumini* L. were established experimentally. The *Halam* and *Chakma* tribes of the stated study area uses leaf decoction of *Cicca acida* L. (FL: 78%; UV: 2.11, RFC: 0.51) in their folklore medication as antidiabetic therapy. The same use is also documented from Malayali tribes of Tamil Nadu, India and some other parts of North-east India (Mondal et al., 2013; Rekka et al., 2014). Pharmacological report establishes the efficacy of *Cicca acida* L. as a potent antidiabetic candidate (Chakrabarty et al., 2012;Yanadaiah et al., 2012). In addition, the plant also possesses nematicidal (Mackeen et al., 1997), hepatoprotective and antioxidant (Lee et al., 2006), anticancer (Vongvanich et al., 2000),

Fig. 2. Pictures representing the plants with significant (<50%) FL, UV and RFC index.

anticystic fibrosis (Sousa et al., 2007), hypotensive (Leeya et al., 2010), antimicrobial (Melendez and Capriles, 2006; Jagessar et al., 2008), antiplasmodial (Bagavan et al., 2011) activities.

Another two plants *viz*: *Cassia fistula* L. and *Carica papaya* L., in this present survey showed significant (< 50%) FL and UV. On account of this, we can also consider these plants as a plant of importance, though their RFC is > 50%. *Chakma* and *Tripuri* tribes of this district use the flowers, seeds and stem bark of *Cassia fistula* L. (FL: 71.4%; UV: 1.90; RFC: 0.37) as a traditional source of antidiabetic drug. Whereas the tribes of Assam and Manipur, uses bark powder (Devi, 2011; Dutta and Kalita, 2013) for the same. Pharmacological validation was done with stem bark (Rajalakshmi and Daisy, 2014), flower (Manonmani et al., 2005) and whole plant extracts (Einstein et al., 2012). Furthermore this plant is used in cardiac disorders biliousness, rheumatic condition, haemorrhages, wounds, ulcers, boils, various skin diseases (Patil and Patil, 2012), jaundice, syphilis, facial paralysis, piles, microbial and fungal infections, and tumour (Gupta, 2010). Likewise, *Chakma* tribe of the said study area uses fruits (in all forms) and seeds of *Carica papaya* L. (FL: 66.7%; UV: 1.75; RFC: 0.34) to treat diabetes. Other forms of uses *viz*: shade dried seed powder, green leaf decoction, hot infusion of seeds, are practiced in Assam, Manipur (Dutta and Kalita, 2013; Mondal, 2013) and Southwest Nigeria (Adeneye et al., 2009). Works of Venkateshwarlu et al. (2013), Omonkhua et al. (2013), Elgadir et al. (2014) and Ezekwe et al. (2014) establish the pharmacological significance of the plant. Antimicrobial, anthelminitic, antifungal, antiamoebic, atnitumour, antiplasmodial, and contraceptive activities of the plant are also evident from the reports of Kermanshai et al. (2001), Okeniyi et al. (2007) and Hounzangbe-Adote et al. (2005).

5. Conclusion

Like many other ethnic communities of the world, inhabitants of Unakoti district depend on the traditional medication system to treat diabetes. Survey of the district brought forward 39 plants as traditional antidiabetic agents, of which 11, 05 and 03 plants have showed significantly high FL, UV and RFC values respectively. Similar kinds of utilisation of these plants are also traced in other parts of the world. This raises curiosity regarding their further scientific characterisation to endorse their traditional use in modern health care system and identification of new bioactive molecules. Further pharmacological validations of these plants will help in the development of effective herbal antidiabetic medicines in near future.

Uncited reference

Lee et al. (2007).

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