

Plant-based remedies for the management of diabetes

Sumiksha Gupta*, M. C. Sidhu, A. S. Ahluwalia

Department of Botany, Panjab University, Chandigarh, India

Received: 04.02.2017

Accepted: 27.02.2017

Published: 21.03.2017

***Address for correspondence:**

Sumiksha Gupta,
Department of Botany,
Panjab University,
Chandigarh, India.
E-mail: sumiksha666@gmail.com

ABSTRACT

The knowledge related to medicinal plants have been described in Indian Ayurveda System and survived till today through the prevalent sociocultural practices. The present study is an attempt to document anti-diabetic plants from Una district of Himachal Pradesh. A thorough survey was conducted from 500 respondents using a semistructured questionnaire and informal discussions. A total of 84 anti-diabetic plant species have been recorded. These plants include wild (32) or cultivated (41) species. Fabaceae was the dominant family with 10 species. The phytoremedies were prepared using different plant parts or sometimes even the whole plant or in combination with other species. There are only few reports on anti-diabetic use of some wild species from the study area. Further studies of bioactive compounds in these species can depict their hypoglycemic potential. The present study has suggested a strong link between traditional herbal medicines, their documentation and proper chemical characterization to harness their therapeutic potential to the maximum level.

KEY WORDS: Angiosperms, bioactive compounds, diabetes, Himachal Pradesh, phytoremedies, traditional medicines, Una

INTRODUCTION

The plants have played multiple roles as providers of essential commodities such as food, fodder, and medicines. The plants have been explored and exploited for many human ailments including the metabolic diseases such as diabetes mellitus (DM) which is posing a challenge to humankind due to its “killer” and epidemic proportions (Bailey and Day, 1989). Diabetes is predicted to affect 366 million people by 2030 with India and China showing the worst figures every year (WHO, 2006). In this scenario, the division of Traditional Medicines of World Health Organization underlines the age-old usage of medicinal plants and stresses on their proper evaluation for human use. The synthetic hypoglycemic drugs are not only expensive but also have many side effects or complications (Rang and Dale, 1991). On the other hand, the traditional plant medicines are safe, effective, and provide an alternative system to manage diabetes, especially in the developing countries, where 80% of the populations still rely on plant resources for health care needs (Mahady, 2001; Azaizeh *et al.*, 2003).

Around 1,200 herbal remedies were identified for diabetes, out of which some 343 species have been tested for their

glucose-lowering effect. Among these plants, 158 species have been documented in Indian Ayurveda System for “*Madhumeha*” (Rahman and Zaman, 1989; Leena and Jill, 2010). India, also called the “botanical garden of the world” because of its rich biodiversity, has more than 70% of its rural population dependent on traditional plant medicines (Seth and Sharma, 2004). It seems that natural plant wealth of the country holds a key to its traditional wisdom of therapeutic herbs. Himachal Pradesh is blessed with rich plant diversity including medicinal and other useful plants (Sharma, 1976; Uniyal and Chauhan, 1982; Chauhan, 1999 and Gulati *et al.*, 2004). Previous ethnobotanical studies had revealed indigenous knowledge of medicinal species used by the people in different parts of the state (Singh, 1999; Thakur, 2001; Sood *et al.*, 2001; Sharma *et al.*, 2003; Samant *et al.*, 2007; Kaur *et al.*, 2011; Chand *et al.*, 2016). However, a specific report on anti-diabetic medicinal plants from Una district has not figured in any earlier text. A thorough survey has been undertaken to document this traditional wisdom which has survived till date through oral folklores and social customs. The present paper reports the anti-diabetic plants used by or known to the natives of district Una so as to enable their rational utilization, dissemination, and conservation for the future.

MATERIALS AND METHODS

Study Area

Una is one of the 12 districts of Himachal Pradesh lying in the foothills of Shivalik between North latitude $31^{\circ}17'52''$ and $31^{\circ}52'0''$ and East longitude $75^{\circ}58'2''$ and $76^{\circ}28'25''$. The adjoining districts are Kangra, Hamirpur, and Bilaspur. The study area is bounded in the west by Hoshiarpur and Ropar districts of Punjab and by the Solah Singi range in the east. As per census of India 2011, it has a population of 521,057. The total geographical area is 1549 km² which include a forest cover of 185 km². The altitudinal range is from 350 to 1200 m above sea level. "Swan," a seasonal river which flows across the Jaswan Dun valley, is the lifeline of this district. The climate is mostly subtropical and the vegetation consists mainly of dry deciduous forests mixed with scrub vegetation (Chandrasekhar *et al.*, 2003).

Ethno Medicinal Survey

Extensive field surveys and interviews were conducted to gather ethnomedicinal information from 500 respondents of five blocks of district Una, namely, Una, Amb, Gagret, Bangana, and Haroli. A semistructured questionnaire and informal talks were employed to elicit the information through door-to-door survey and frequent visits throughout the district. The respondents were selected randomly, irrespective of their sex, education, and occupation, and subject to their availability and willingness to share their knowledge. The talks were exchanged in the local dialect easily understood by the natives to make it interactive and fruitful. The common plants cited for the anti-diabetic usage were easily identifiable while the others were confirmed from specimens along with their photographs and notable features. Their modes of preparation and administration, dosage, etc., were also recorded. The anti-diabetic plants reported during the study were authenticated from the relevant standard Floras (Hooker, 1872-1897; Collett, 1971; Chowdhery and Wadhwa, 1984) and with the help of voucher specimens available in the herbarium of Department of Botany, Panjab University, Chandigarh.

RESULTS AND DISCUSSION

A total of 500 respondents (259 females and 241 males) selected randomly from diverse educational and occupational profiles were contacted including the homemakers, mid-wives, shopkeepers, farmers, village chiefs, local practitioners, and the "vaidyas." Information of 84 anti-diabetic species along with their

common names, growth habit, useful part(s), availability status, modes of preparation, and administration were documented (Table 1). In previous studies, 46 anti-diabetic species were suggested by 251 respondents (Tag *et al.*, 2012) and 21 species by the 240 natives of a rural district of Assam (Tarak *et al.*, 2011). Out of 58 recorded species in Puduchery as anti-diabetic, 22 are similar to the present study (Dixit and Sudurshan, 2011). Among the 19 anti-diabetic species reported from Hamirpur district, 13 are common with the species of Una district (Kumar *et al.*, 2014). *Clematis virginiana* is a new report from the study area which also finds mention in a recent study from district Mandi of Himachal Pradesh (Sidhu and Thakur, 2015).

The reported species are placed into 42 families (Table 2). Fabaceae is the dominant family represented by 10 species followed by solanaceae (5), cucurbitaceae and poaceae (4 species each). Most of the species were trees (32) followed by herbs (28) (Figure 1). A review of 419 anti-diabetic remedies from 270 angiosperms in India, Pakistan, and Sri Lanka had also suggested fabaceae and cucurbitaceae as the dominant families (Marwat *et al.*, 2014). Fruits (30 species) were the most commonly used part followed by leaves (19 species) and seeds (13 species) as shown in Figure 2. Similar trend in other studies was also recorded (Kadir *et al.*, 2012; Ayyanar and Ignacimuthu, 2011).

Most of the recorded plant species are cultivated (41), wild (32) including edible fruits (30), ornamentals (25), spices (9), etc. Plant products in dried or processed forms were preferred over the fresh materials for preparing the phytoremedies. *Raphanus sativus*, *Lagenaria siceraria*, *Cucumis sativus*, *Lycopersicon esculentum*, *Solanum melongena*, *Momordica charantia*, *M. charantia* var *abbreviata*, *Carica papaya*, *Emblica officinalis*, *Punica granatum*, *Annona squamosa*, *Morus alba*, *Syzygium cumini*, and *Aegle marmelos* were the common vegetables and seasonal fruits taken in diabetes along with household spices. Common spices and herbs from the kitchen garden are a part of diabetic diet in Britain (Vohora *et al.*, 1973). Studies have documented diabetes ameliorating components such as eugenol, curcumin etc. in some spices (Krishnaswamy and Raghuramulu, 1998; Srinivasan, 2005). Another study has reported antidiabetic potential of vegetables like cucurbits and legumes (Tang *et al.*, 2008).

The preparations were made from single species or sometimes polyherbal as well and used in the form of "salads," "soups," vegetables, "churan," "chutney," etc. (Figure 3). Special "chapattis" prepared from a mixed-flour of wheat, soybean, gram and barley were consumed

Table 1: Anti-diabetic plant species recorded from district Una, Himachal Pradesh

Botanical name	CN	GH	Status	PPU	Anti-diabetic use
Annonaceae					
<i>Annona squamosa</i> (L.) L.	Sitaphal	T	Cv	Ft	Ripe fruits are eaten
Apiaceae					
<i>Trachyspermum ammi</i> (L.) Sprague	Ajwain	H	Cv	Sd	Powder or as soaked overnight
Apocynaceae					
<i>Carissa carandas</i> L.	Garna, Garuna	Sh	W	Ft	Eaten ripe
<i>Holarrhena pubescens</i> Wall. ex G. Don	Inderajaun, Keor	T	W	Bk	As powder
<i>Catharanthus roseus</i> (L.) G. Don	Sadabahar	H	Cv	Fl	Fresh flowers are eaten
Asclepiadaceae					
<i>Gymnema sylvestre</i> R.Br.	Gudmar	Cl	Mk	Lf	As powder
Asteraceae					
<i>Eclipta prostrata</i> L.	Kala-bhangra, Bhringraj	H	W	WP	As decoction
<i>Stevia rebaudiana</i> Bert. (Bertoni)	Stevia, Meethi patti	H	Cv	Lf	Eaten fresh, powder or as "tea"
Brassicaceae					
<i>Raphanus sativus</i> L.	Mooli	H	Cv	Tb	Eaten fresh as "salad" or juice
Burseraceae					
<i>Commiphora mukul</i> (Hook. Ex Stocks) Engl.	Guggal	T	Mk	Gum	Powder or soaked
Capparaceae					
<i>Crateva religiosa</i> G. Forst.	Barna	T	Cv/W	Wd	As bowls for storing the water
Caricaceae					
<i>Carica papaya</i> L.	Papita	T	Cv	Ft	Fruits are cooked or eaten ripe
Celastraceae					
<i>Celastrus paniculatus</i> Willd.	Malkangni	Cl	W	Sd	1-2 oil drops in milk daily
Combretaceae					
<i>Terminalia arjuna</i> (Roxb. Ex DC.) Wight & Arn.	Arjun	T	Cv/W	Bk	As powder or decoction
<i>Terminalia bellerica</i> (Gaertn.) Roxb.	Bahera	T	Cv/W	Ft	As powder or "triphala churan" (fruit powder of "harar," "bahera" and "amla")
<i>Terminalia chebula</i> Retz.	Harar	T	Cv	Ft	As powder or "triphala churan"
Convolvulaceae					
<i>Cressa cretica</i> L.	Rudravanti	Sh	Mk	WP	As powder
<i>Porana paniculata</i> Roxb.	Faindal	Cl	W	Lf	Fresh leaves are chewed
Cucurbitaceae					
<i>Cucumis sativus</i> L.	Kheera	Cl	Cv	Ft	As "salad" with black pepper
<i>Lagenaria siceraria</i> (Molina) Standl.	Lauki, Ghiya	Cl	Cv	Ft	Cooked or made into "soups"
<i>Momordica charantia</i> L.	Karela	Cl	Cv	Ft	Taken raw, cooked or as juice
<i>Momordica charantia</i> L. var <i>abbreviata</i> Ser.	Bankarela	Cl	W	Ft	Eaten raw, cooked or as juice
Cyperaceae					
<i>Cyperus rotundus</i> L.	Dila, Motha	H	W	Rt	Taken as juice
Ebenaceae					
<i>Diospyros chloroxylon</i> Roxb.	Kendu, Kinnu	T	W	Ft	Ripe fruits are eaten
Euphorbiaceae					
<i>Euphorbia royleana</i> Boiss.	Danda thor	Sh	W	Ft	Ripe fruits are eaten
<i>Euphorbia thymalooides</i> L.	Nag daun	H	Cv	Lf	5-7 fresh leaves taken daily
<i>Phyllanthus emblica</i> L.	Amla, Aonla	T	Cv/W	Ft, Lx	Fruits as powder or in "triphala churan," latex of the roots taken
Fabaceae					
<i>Acacia catechu</i> (L.f.) Willd.	Khair	T	W	Wd	1 kg of katha (extract of the heartwood) is consumed taking only a pinch as the daily dose
<i>Albizia lebbek</i> (L.) Benth.	Siris, Sirin	T	W	Sd	Ripe seeds are eaten
<i>Butea monosperma</i> (Lam.) Taub.	Palah, Kesu	T	W	Sd	Taken in powder form
<i>Caesalpinia bonduc</i> (L.) Roxb.	Katkaranja, Michkane	Cl	Cv	Sd	2 seeds daily (empty bowels)
<i>Cassia fistula</i> L.	Amaltas, Alis	T	W	Ft	Green unripe legumes are eaten
<i>Cicer arietinum</i> L.	Chana	H	Cv	Sd	Seeds taken roasted or as a mixed flour (wheat, soybean, barley, and chana seeds) for baking "chapattis"
<i>Glycine max</i> (L.) Merr.	Soybean	H	Cv	Sd	As mixed flour for "chapattis"
<i>Pterocarpus marsupium</i> Roxb.	Bijesar	T	Mk	Wd	As powder, the wooden bowls are used for drinking water
<i>Pueraria tuberosa</i> (Willd.) DC.	Salod, Salor	Cl	W	Tb	Fresh tubers are eaten
<i>Trigonella foenum-graecum</i> L.	Methi, Metha	H	Cv	Sd	Seeds are eaten as such, roasted, powder, or as soaked overnight
Gentianaceae					
<i>Swertia chirata</i> (Wall.) C.B. Clarke	Chirayta	H	W/Mk	WP	As decoction or powder

(Contd...)

Table 1: (Continued)

Botanical name	CN	GH	Status	PPU	Anti-diabetic use
Lamiaceae					
<i>Mentha arvensis</i> L.	Pudina	H	Cv	Lf	Fresh or as "chutney" (a thick sauce made by grinding pudina leaves with bulbs of garlic and onion, <i>anardana</i> , ginger, pepper seeds, and black salt)
<i>Ocimum sanctum</i> L.	Ram Tulsi	H	Cv	Lf, WP	Fresh leaves or the plant juice (1 tsp) is taken empty stomach
<i>Pogostemon benghalensis</i> (Burm.f.) Kuntze	Kalibasuti	Sh	W	Lf	Fresh leaves are chewed
Lauraceae					
<i>Cinnamomum tamala</i> (Buch.-Ham.) T. Nees & Eberm.	Tejpatta	T	Cv/Mk	Lf	Leaf powder is taken
<i>Litsea glutinosa</i> (Lour.) C. B. Rob.	Rahan, Rahain	T	W	Bk	Taken as powder with milk
Liliaceae					
<i>Allium sativum</i> L.	Garlic, Lahsun	H	Cv	Bl	2-3 bulblets taken empty bowels daily, cooked, pickled, or as chutney
<i>Allium cepa</i> L.	Onion, Piyaz	H	Cv	Bl, Lf	As chutney from fresh parts
<i>Asparagus racemosus</i> Willd.	Sahanspai, Shatavar	H	Cv/W	Rt	Taken as powder
Lythraceae					
<i>Punica granatum</i> L.	Anar	T	Cv	Ft, Sd	Taken fresh fruit juice, dry seeds (<i>anardana</i>) as "chutney"
Meliaceae					
<i>Azadirachta indica</i> A. Juss.	Neem	T	W	Ft, Lx, Lf	Tender leaves or ripe fruits are eaten, fresh latex from the roots of neem, galgal, and amla (2 tsp each) is mixed and taken daily
<i>Melia azedarach</i> L.	Dek, Darek, Bakain	T	W	Lf	Tender leaves are eaten
Menispermaceae					
<i>Cissampelos pareira</i> L.	Bhatindu, Patindu	Cl	W	Lf	Fresh leaves are eaten
<i>Tinospora cordifolia</i> (Willd.) Miers	Giloy, Glo	Cl	W	St	Eaten fresh, in powder or decoction form
Moraceae					
<i>Ficus religiosa</i> L.	Peepal	T	Cv	Ft	As powder (one tsp daily)
<i>Morus alba</i> L.	Shahtoot, Tut	T	Cv/W	Ft	Ripe fruits are eaten
Moringaceae					
<i>Moringa oleifera</i> Lam.	Suhanjana, Sunjana	T	Cv	Ft	As cooked vegetable or pickled
Musaceae					
<i>Musa paradisiaca</i> L.	Kela	H	Cv	Ft	Cooked or eaten as ripe fruits
Myrtaceae					
<i>Psidium guajava</i> L.	Amrood	T	Cv	Lf	5-7 tender leaves with water
<i>Syzygium cumini</i> (L.) Skeels	Jamun, Jamman	T	Cv/W	Ft, Sd, Bk, Lx	Ripe fruits, seed powder, decoction of bark and fresh latex of roots (2 tsp daily) is useful.
Piperaceae					
<i>Piper nigrum</i> L.	Kali mirch	Cl	Mk	Sd	Eaten ripe seeds or as powder
<i>Piper longum</i> L.	Pipli, Piplamul	Cl	Cv/Mk	Ft	Taken as powder
Poaceae					
<i>Hordeum vulgare</i> L.	Jau	H	Cv	Sd	As mixed-flour for "chapattis"
<i>Saccharum officinarum</i> L.	Ganna	H	Cv	St	Fresh juice or as "jaggery"
<i>Triticum aestivum</i> L.	Gehun, Kanak	H	Cv	Sd	As sprouted and mixed-flour
<i>Zea mays</i> L.	Makki, Chhalli	H	Cv	Sg	As decoction of corn silk
Ranunculaceae					
<i>Clematis virginiana</i> L.	Jhol, Chibru	Cl	W	Lf	Tender leaves are eaten daily
Rhamnaceae					
<i>Ziziphus jujuba</i> Mill.	Ber	Sh	W	Ft	Ripe fruits are eaten
Rosaceae					
<i>Prunus persica</i> (L.) Batsch	Aru, Adu	T	Cv	Lf	Fresh leaves are eaten
Rutaceae					
<i>Aegle marmelos</i> (L.) Correa	Bael, Belpatra	T	Cv/W	Lf, Ft	Leaves of bael, gudmar, and neem are pounded with seeds of jamun (100 g each) and one tsp powder is taken three times daily (with cow milk or curd), fruits eaten ripe or as powder
<i>Citrus limon</i> (L.) Osbeck	Galgal, khatta	T	Cv	Lx	As fresh latex from roots
<i>Murraya koenigii</i> (L.) Spreng.	Gandhla, Kari patta	Sh	W	Lf	5-7 fresh leaves are chewed with pepper seeds (thrice daily)
Sapindaceae					
<i>Sapindus mukorossi</i> Gaertn.	Ritha	T	Cv	Sd	Seed kernels are eaten

(Contd...)

Table 1: (Continued)

Botanical name	CN	GH	Status	PPU	Anti-diabetic use
Sapotaceae					
<i>Mimusops elengi</i> L.	Maulsiri	T	Cv	Rt, Ft	Eaten ripe fruits, drinking water stored in the wooden bowls
Solanaceae					
<i>Lycopersicon esculentum</i> Mill.	Tamatar	H	Cv	Ft	Ripe fruits as "salad"
<i>Physalis minima</i> L.	Bambhola, rasbhari	H	W	Ft	Ripe berries are eaten
<i>Solanum melongena</i> L.	Baingan	H	Cv	Ft	Cooked or as roasted on fire
<i>Withania coagulans</i> (Stocks) Dunal	Paneer dodi	Sh	Mk	Ft	Ripe fruits are eaten
<i>Withania somnifera</i> (L.) Dunal	Ashwagandha	Sh	Cv/W	WP	As decoction
Verbenaceae					
<i>Clerodendrum phlomidis</i> L.f.	Arni	Sh	Cv	Bk	As decoction
<i>Premna latifolia</i> Roxb	Bankar	T	W	Lf, Bk	As powder
<i>Vitex negundo</i> L.	Bana, Nirgundi	T	W	Lf	5-7 tender leaves taken daily
Vitaceae					
<i>Vitis vinifera</i> L.	Angoor	Cl	Cv/Mk	Ft	Eaten fresh or as soaked raisins
Zingiberaceae					
<i>Curcuma longa</i> L.	Haldi	H	Cv	Rz	1/2 tsp powder daily with milk
<i>Zingiber officinale</i> Roscoe	Adrak, Sonth	H	Cv	Rz	As such, as "chutney" or pickle
Zygophyllaceae					
<i>Tribulus terrestris</i> L.	Gokhru, Bhakhra	H	W	Ft	As decoction
Xanthorrhoeaceae					
<i>Aloe vera</i> (L.) Burm. f.	Kwar	H	Cv/W	Gel	Gel of the leaves is used

Rt: Root, Rh: Rhizome, Bl: Bulb, St: Stem, Bk: Bark, Lf: Leaf, Fl: Flower, Ft: Fruit, Sd: Seed, WP: Whole plant, Sg: Stigma, Wd: Wood, Tb: Tuber, tsp.: Teaspoon, CN: Common name, PPU: Plant part used, GH: Growth habit, H: Herb, Sh: Shrub, T: Tree, Cl: Climber, Cv: Cultivated, W: Wild, Mk: Market

Table 2: Family-wise distribution of anti-diabetic species

Family	Number of spp.	Family	Number of spp.	Family	Number of spp.
Annonaceae	1	Ebenaceae	1	Piperaceae	2
Apiaceae	1	Euphorbiaceae	3	Poaceae	4
Apocynaceae	3	Fabaceae	10	Ranunculaceae	1
Asclepiadaceae	1	Gentianaceae	1	Rhamnaceae	1
Asteraceae	2	Lamiaceae	3	Rosaceae	1
Brassicaceae	1	Lauraceae	2	Rutaceae	3
Burseraceae	1	Liliaceae	3	Sapindaceae	1
Capparaceae	1	Lythraceae	1	Sapotaceae	1
Caricaceae	1	Meliaceae	2	Solanaceae	5
Celastraceae	1	Menispermaceae	2	Verbenaceae	3
Combretaceae	3	Moraceae	2	Vitaceae	1
Convolvulaceae	2	Moringaceae	1	Xanthorrhoeaceae	1
Cucurbitaceae	4	Musaceae	1	Zingiberaceae	2
Cyperaceae	1	Myrtaceae	2	Zygophyllaceae	1

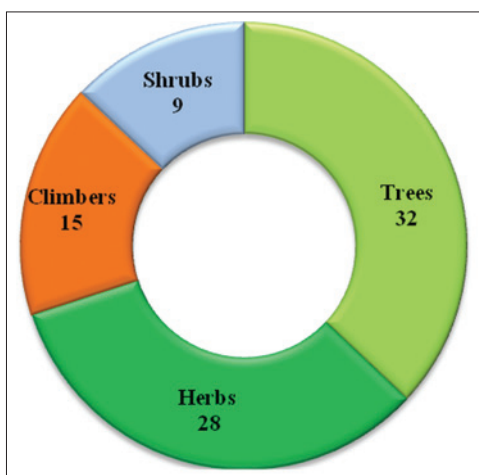


Figure 1: Growth habit of different species

as anti-diabetic and the same had also been mentioned in earlier study. (Ahmad *et al.*, 2009). Water stored overnight in the bowls carved from the heartwood of *Crateva religiosa*, *Pterocarpus marsupium*, *Mimusops elengi* is used to drink in the morning. Jaggery was recommended as a substitute for crystal sugar though in small amounts. These phyto-remedies were usually recommended to be taken empty bowels and with cow milk or curd. The herbal mixtures were reported to be more effective than single plant remedies. A "compound recipe" from 10 anti-diabetic plants had the potential of regenerating insulin secreting cells of pancreas (Wadood *et al.*, 2007).

Some plants such as *Holarrhena pubescens*, *Litsea glutinosa*, *Celastrus paniculatus*, *Swertia chirata*, *Vitex negundo*, *Tribulus*

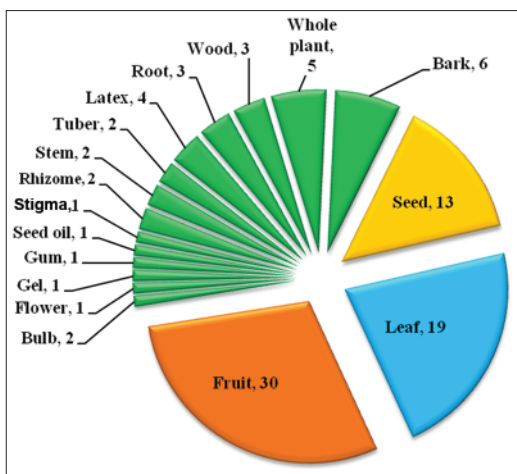


Figure 2: Plant parts used in anti-diabetic remedies

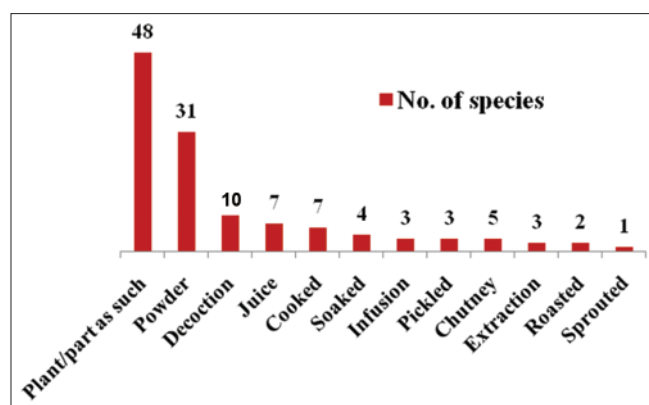


Figure 3: Modes of preparation of remedies

terrestris, and *C. religiosa* are fast vanishing from the wild. *Euphorbia tithymaloides*, *Porana paniculata*, *Pogostemon benghalensis*, *Pueraria tuberosa*, *Premna latifolia*, *L. glutinosa*, and *C. virginiana* are among the less documented plants in the available literature and thus need more attention for conservation and evaluation.

The anti-diabetic plant species have been documented worldwide in different studies (Grover *et al.*, 2002; Bnouham *et al.*, 2006; Sidhu and Sharma, 2013; Marwat *et al.*, 2014; Liu *et al.*, 2016). A review on *M. charantia* has reported some side effects such as hypoglycemic coma and convulsions in children (Basch *et al.*, 2003). A note of caution was also suggested by the respondents to prepare some decoctions. Therefore, a detailed analysis, standardization, and clinical trial of the recorded plant species are an urgent need of the time.

CONCLUSION

A total of 84 species of angiosperms were used by the natives of study area to manage diabetes. Most of the

plants were trees and herbs growing as wild in nature or cultivated as ornamentals, fruits, spices, etc. Fabaceae was the dominant family represented by 10 species. All the plant parts were useful, but fruits and leaves were frequently used, in fresh or processed form, to prepare various home-made remedies for the disease. The polyherbal formulations were reported to be more effective than single plant uses. Plants of *H. pubescens*, *L. glutinosa*, *C. paniculatus*, *V. negundo*, *S. chirata*, etc., are fast depleting species from the wild and thus need to be protected. Some species such as *P. paniculata*, *P. benghalensis*, *P. tuberosa*, *L. glutinosa*, and *C. virginiana* have only few reports about their anti-diabetic efficacy thus can be explored in future studies.

ACKNOWLEDGMENTS

We are thankful to the Chairperson, Department of Botany, Panjab University, Chandigarh, for providing necessary facilities and DST PURSE for financial support to the Department. We are also grateful to the respondents of the study area for sharing their traditional knowledge and for their generous help during the field visits.

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