International Journal of Medicinal Plants Research ISSN: 2169-303X Vol. 2 (1), pp. 198-203, June, 2013.
Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

Tribal way to treat diabetes: Potentials of traditional phytotherapy in the ethnic belts of purulia district, India and socio-economic relevance

Amrita Dey[1] and Abhijit Dey[2*]

[1]Research Scholar, Department of Museology, University of Calcutta, India.
[2] Assistant Professor, Department of Botany, Presidency University (Formerly Presidency College), 86/1, College Street, Kolkata-700073, West Bengal, India.

Accepted 11 March, 2013

Plants have been used by the human beings since time immemorial. Purulia a district located at the western part of the state West Bengal, India is known for its aboriginal elements with diverse socio-economic and cultural backgrounds. In surveys conducted among the tribal villagers, it was found that, a strong ethnobotanical system prevails in the area for the treatment of various ailments of humans and livestock. Diabetes mellitus is not a very common threat to the people residing here but the increasing tendency to westernization and ever changing food habit may contribute to the disease in the near future. The present survey enlists a number of 32 medicinal plants belonging to 18 plant families with potentials to be used as antidiabetics. These plants are used in the treatment of other ailments and the knowledge regarding the antidiabetic principles of certain herbal preparations may be incorporated in the age old tribal practices.

Key words: Diabetes mellitus, ethnobotany, pharmacology, antidiabetic, socio-economic.

INTRODUCTION

Ethnobotany has always provided valuable information regarding human use of botanicals. The age old dependence of man on plants for food, fodder, fiber, fuel and medicine has not only helped human civilization to flourish, but the present day scientific analyses have provided useful tools to evaluate the efficacy of the botanicals. Folkloric use of plants has indicated the medicinal potential of certain herbal formulations. Pharmacological evaluation of medicinal plants has provided useful information on plants used as antibacterial (Dey *et al.,* 2011; Mukherjee *et al.,* 2012), antifungal (Dey and De, 2011b), anti-mycobacterial (Dey and De, 2012c), anti-cancerous (Bhakuni *et al.,* 1976), antioxidative (Dey and De, 2012e), antiophidian (Dey and De, 2012f), anti scorpion venom (Dey *et al.,* 2013), antidiabetic (Patel *et al.,* 2012) and many other properties.

*Corresponding author. E-mail: abhijitbio25@yahoo.com.

Medicinal plants are reported to possess antidiabetic activities (Grover *et al.*, 2002). Botanicals show antidiabetic principles in terms of their antioxidative (Sabu and Kuttan, 2002), α-amylase inhibitory (Kotowaroo *et al.*, 2006), α-glucosidases inhibitory (Onal *et al.*, 2005), anti-hyperglycemic (Alarcon-Aguilara *et al.*, 1998) and hypoglycemic (Ojewole, 2005) properties. Ethnobotanical surveys in search of antidiabetic plants have been carried out at different parts of the globe, such as in Nigeria (Abo *et al.*, 2008; Gbolade, 2009), Morocco (Jouad *et al.*, 2001), Canada (Leduc *et al.*, 2006), Mexico (Hernandez-Galicia *et al.*, 2002), Trinidad and Tobago (Lans, 2006) etc. In India, Sikkim and Darjeeling Himalaya (Chhetri *et al.*, 2005), Assam (Tarak *et al.*, 2011), Arunachal Himalaya (Tag *et al.*, 2012) etc have been surveyed. Earlier, several investigations have been carried out in the district of Purulia in search of medicinal plants used against gastrointestinal disorders (Dey and De, 2012a), snakebite (Dey and De, 2012b) and other ailments and as remedy for pediatric, maternal (Dey and De, 2011a) and veterinary (Dey and De, 2010) ailments. The present work represents a documentation of indigenous flora of

Table 1. Potential anti diabetic medicinal plants as used by the tribals of Purulia district against other disorders

Scientific name	Family	Vernacular name	Reporting area	Anti-diabetic references
Abutilon indicum (L.) Sweet	Malvaceae	*Jhampi*	Saspur	Seetharam *et al.*, 2002
Achyranthes aspera L.	Amaranthaceae	*Chip chirit*	Tandapania	Akhtar and Iqbal, 1991
Aegle marmelos (L.) Corrêa	Rutaceae	*Bel*	Ajodhya	Sabu and Kuttan, 2004; Narendhirakannan and Subramanian, 2010
Andrographis paniculata (Burm. f.) Wall. ex Nees	Acanthaceae	*Mahatita*	Poradi	Zhang and Tan, 2000; Nugroho *et al.*, 2012
Azadirachta indica A. Juss.	Meliaceae	*Nim*	Para	Khosla *et al.*, 2000; Gutierrez *et al.*, 2011
Bombax ceiba L.	Malvaceae	*Simbali*	Puncha	Saleem *et al.*, 1999
Butea monosperma (Lam.) Taub.	Fabaceae	*Murka*	Santuri	Sharma and Garg, 2009, 2012
Calotropis procera (Aiton) W.T. Aiton	Apocynaceae	*Chhota akaon*	Jhalda	Rahmatullah *et al.*, 2009
Carica papaya L.	Caricaceae	*Pipa*	Kashipur	Maniyar and Bhixavatimath, 2012
Cuscuta reflexa Roxb.	Convolvulaceae	*Alak jari*	Pakarnala	Rahmatullah *et al.*, 2009
Datura metel L.	Solanaceae	*Dhatra*	Jhalda	Krishna Murthy *et al.*, 2004
Dolichos biflorus L.	Fabaceae	*Anrsga*	Santuri	Pant *et al.*, 1968
Emblica officinalis Gaertn.	Euphorbiaceae	*Miral*	Sharbarya	Akhtar *et al.*, 2011
Euphorbia hirta L.	Euphorbiaceae	*Ara dudhi*	Puncha	Kumar *et al.*, 2010; Subramanian *et al.*, 2011
Ficus benghalensis L.	Moraceae	*Bor*	Tandapania	Kar *et al.*, 2003
Ficus racemosa L.	Moraceae	*Gular*	Kashipur	Bhaskara *et al.*, 2002; Sophia and Manoharan, 2007
Gymnema sylvestre (Retz.) R. Br. ex Schult.	Apocynaceae	*Merasingi*	Santuri	Yadav *et al.*, 2010; Kang *et al.*, 2012
Hemidesmus indicus (L.) R. Br. ex Schult.	Apocynaceae	*Huring onal*	Puncha	Gayathri and Kannabiran, 2008
Holostemma annularis K. Schum.	Apocynaceae	*Apung*	Dhabani	Reddy *et al.*, 2010
Ichnocarpus frutescens (L.) W.T. Aiton	Apocynaceae	*Piri hore*	Jhalda	Barik *et al.*, 2008; Kumarappan and Mandal, 2008
Ipomoea aquatica Forssk.	Convolvulaceae	*Karmi ara*	Manbazar	Malalavidhane *et al.*, 2000, 2001, 2003
Mangifera indica L.	Anacardiaceae	*Aam*	Jaipur	Ojewole, 2005
Mucuna pruriens (L.) DC.	Fabaceae	*Etka*	Manbazar	Pant *et al.*, 1968; Bhaskar *et al.*, 2008
Neolamarckia cadamba (Roxb.) Bosser	Rubiaceae	*Kadam ba*	Dhabani	Ahmed *et al.*, 2011
Pterocarpus marsupium Roxb.	Fabaceae	*Bija-sal*	Matha	Mukhtar *et al.*, 2005; Dhanabal *et al.*, 2006
Rauvolfia serpentina (L.) Benth. ex Kurz	Apocynaceae	*Chhota chand*	Jhalda	Qureshi *et al.*, 2009
Scoparia dulcis L.	Plantaginaceae	*Koara*	Baliguma	Pari and Latha, 2004, 2005
Solanum xanthocarpum Schrad. & H. Wendl.	Solanaceae	*Bhigibaigan*	Tandapania	Poongothai *et al.*, 2011
Tamarindus indica L.	Fabaceae	*Imla*	Ghatbera	Maiti *et al.*, 2004, 2005
Terminalia belerica Roxb.	Combretaceae	*Bahra*	Santuri	Sabu and Kuttan, 2009
Tinospora cordifolia (Willd.) Miers	Menispermaceae	*Gurchi*	Tandapania	Patel and Mishra, 2011
Zingiber officinale Roscoe	Zingiberaceae	*Ade*	Jhalda	Islam and Choi, 2008; Rani *et al.*, 2012

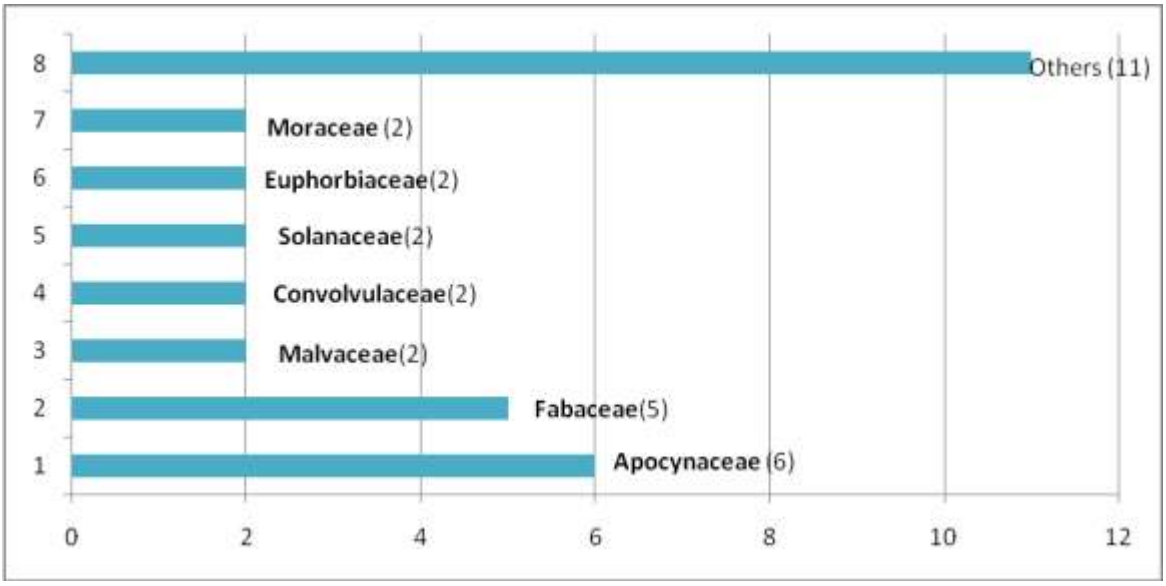

Figure 1. Family wise distribution of potential antidiabetic plants.

the district with potential to be used as antidiabetic plants as indicated by the literature.

MATERIALS AND METHODS

Study area

Purulia, the westernmost district of West Bengal is known for its extreme weather, reduced rainfall, undulated topography and underdeveloped agriculture. The district is located within 22°51' N and 23°42' N and 85°51' E and 86°54' E and covers an area of 6529 sq km (Dey and De, 2011a) and is represented by many hills and hillocks. Strong representation of tribal elements with diverse socio cultural background is another characteristic feature of the district. The main tribal groups residing in the district are Santhal, Oraon, Munda, Birhor, Kharia, Bhumija, Kharwar, Gond, Mal Paharya and Ho (Dey and De, 2011a). They mostly live in close proximity to nature especially in rural villages and dense forests. Due to lack of a developed agricultural system, the rural people mostly depend on forests as their major resource to sustain their livelihood. The authors have noted a strong traditional ethnobotanical knowledge prevailing among the tribals which has been passed through generations with no or slight changes.

Survey

Preliminary surveys were conducted to document the ethnobotanical wealth of the district. The timing was chosen on the basis of flowering of different plants during various seasons throughout the year. During our investigations at different seasons of the year, survey camps were arranged and the informative villagers were selected on the basis of their consent and knowledge and they were designated as informants. Following the selection of 36 traditional healers as informants, standard ethnobotanical procedure was followed as described by Dey and De, 2011a. The informants were taken to the field to verify their ethnomedicinal claims of respective plants and the data was documented accordingly. Common plants were taken for preservation and the rare plants were photographed in their natural habitat. The plants were identified scientifically from the flora of the district and the surrounding areas (Prain, 1903; Paria and Chattopadhyay, 2000, 2005).

RESULTS

A total number of 32 of medicinal plants belonging to 18 plant families as reported by the tribals to have therapeutic value are listed in Table 1 with their scientific name, family, vernacular name and reporting area. The existing scientific databases were searched thoroughly to decipher the pharmacological basis of anti diabetic properties of certain botanicals used by these tribals as remedies of various diseases. Among the plant families, Apocynaceae (6) represents the most prevalent one, followed by Fabaceae (5), Malvaceae, Convolvulaceae, Solanaceae, Euphorbiaceae and Moraceae (2 each) (Figure 1) where the number in the parenthesis indicates the number of reported plants within each family.

DISCUSSION

The results seem to be interesting considering the tribal lifestyle and herbal healing. Diabetes mellitus has been reported as a disease related to lifestyle and obesity (Youssef and McCullough, 2002). Consumption of high caloric diet (Roy and Janal, 2010), hypertension (Hamilton, 1990) and lack of physical exercise (Ansari, 2009) are among the many causes of this present day menace. For the past several years the authors have been associated with the tribal use of medicinal plants in this area and they have found little or no occurrence of diabetes mellitus among them, until recently one or two cases have been reported. Lack of affinity to the high caloric foods due to poverty and physical labor could be the reasons behind the negligible prominence of the disease in the rural areas of the district.

However, the authors have also noted the infiltration of western culture and food habit among the new generations. Urban livelihood is also attracting the young people as a result of which the lifestyle related diseases are likely to appear sooner or later. Moreover, tribal folklore has been practiced since ancient times and diabetes was not prevalent in the past. Therefore, the knowledge which is mostly transferred horizontally from ancestors to the present does not provide a significant knowledge regarding the traditional herbal remedies against diabetes. It was noted by the authors that some of the reported botanicals possess potential antidiabetic activities as supported by the existing literature, and these are used by the tribals to treat other ailments which may be indirectly related to the cure of diabetes. For example, such plants are reported to treat wounds and possess anti-inflammatory and antioxidative properties. Consumption of such plant preparations as monoherbal or polyherbal formulations may have been providing them the antidiabetic properties from ancient times. The importance of such plants as antidiabetic agents must be conveyed to the rural tribal medical practitioners who may add the information to the pre-existing ethnomedicinal wealth practiced by them.

CONCLUSION

Due to high price, side effects and the development of drug resistance in case of synthetic drug use, a large segment of the human population is practicing the use of alternative and complementary methods of remedy and herbal treatments represent one of them. A vast majority of rural people, especially the underprivileged of the developing countries depend on plant based medicine for their regular healthcare. Although, diabetes mellitus is mostly concentrated in the urban areas, reports reveal that the rural people are also facing this danger in the near future. Medicinal plants are reported to possess antidiabetic principles either in crude preparations or as isolated compounds. Awareness among the tribals regarding the possible therapeutic value of certain plants as hypoglycemic agents may serve as an aid to their age long medico-botanical knowledge of using the same plants in the treatment of other diseases.

REFERENCES

Abo KA, Fred-Jaiyesimi AA, Jaiyesimi AE (2008). Ethnobotanical studies of medicinal plants used in the management of Diabetes mellitus in South Western Nigeria. J. Ethnopharmacol. 115: 67-71.

Ahmed F, Rahman S, Ahmed N, Hossain M, Biswas A, Sarkar S, Banna H, Khatun A, Chowdhury MH, Rahmatullah M (2011). Evaluation of *Neolamarckia cadamba* (Roxb.) Bosser leaf extract on glucose tolerance in glucose-induced hyperglycemic mice. Afr. J. Tradit. Complement. Altern. Med. 8: 79-81.

Akhtar MS, Ramzan A, Ali A, Ahmad M (2011). Effect of Amla fruit (*Emblica officinalis* Gaertn.) on blood glucose and lipid profile of normal subjects and type 2 diabetic patients. Int. J. Food Sci. Nutr. 62: 609-616.

Akhtar MS, Iqbal J (1991). Evaluation of the hypoglycaemic effect of *Achyranthes aspera* in normal and alloxan-diabetic rabbits. J. Ethnopharmacol. 31: 49-57.

Alarcon-Aguilara FJ, Roman-Ramos R, Perez-Gutierrez S, Aguilar-Contreras A, Contreras-Weber CC, Flores-Saenz JL (1998). Study of the anti-hyperglycemic effect of plants used as antidiabetics. J. Ethnopharmacol. 61: 101-110.

Ansari RM (2009). Effect of physical activity and obesity on type 2 diabetes in a middle-aged population. J. Environ. Public Health, 195285.

Barik R, Jain S, Qwatra D, Joshi A, Tripathi GS, Goyal R (2008). Antidiabetic activity of aqueous root extract of *Ichnocarpus frutescens* in streptozotocin-nicotinamide induced type-II diabetes in rats. Indian J. Pharmacol. 40: 19-22.

Bhakuni DS, Bittner M, Marticorena C, Silva M, Weldt E, Hoeneisen M (1976). Screening of Chilean plants for anticancer activity. I. Lloydia, 39: 225-243.

Bhaskar A, Vidhya VG, Ramya M (2008). Hypoglycemic effect of *Mucuna pruriens* seed extract on normal and streptozotocin-diabetic rats. Fitoterapia. 79: 539-543.

Dey A, De JN (2010). Ethnoveterinary uses of medicinal plants by the aboriginals of Purulia district, West Bengal, India. Int. J. Bot. 6: 433-440.

Dey A, De JN (2011a). Traditional use of medicinal plants in pediatric and maternal care practiced by the ethnic groups of Purulia district, West Bengal, India. International Journal of Medicinal and Aromatic Plants. 1:189-194

Dey A, De JN (2011b). Antifungal bryophytes: a possible role against human pathogens and in crop protection. Res. J. Bot. 6: 129-140.

Dey A, De JN (2012a). Ethnomedicinal plants used by the tribals of Purulia district, West Bengal, India against gastrointestinal disorders. J. Ethnopharmacol. 143:68-80
Dey A, De JN (2012b). Anti snake venom botanicals used by the ethnic groups of Purulia District, West Bengal, India. J. Herbs, Spices and Med. Plants. 18: 152-165.
Dey A, De JN (2012c). Pharmacology and medicobotany of anti leprotic plants: A Review. Pharmacologia. 3: 291-298.
Dey A, De JN (2012e). Antioxidative potential of Bryophytes: Stress tolerance and commercial perspectives: A Review. Pharmacologia. 3: 151-159.
Dey A, De JN (2012f). Phytoharmacology of antiophidian botanicals: A review. Int. J. Pharmacol. 8: 62-79.
Dey A, Mukherjee S, Das T (2011). *In vitro* Antibacterial activity of n-Hexane fraction of methanolic extract of *Plumeria rubra* L. (Apocynaceae) stem bark. J. Plant Sci. 6: 135-142.
Dey A, De JN (2013). Scorpion Anti-Venom Activity of Botanicals: A Pharmacological Approach. Pakistan journal of Biological Sciences. 16: 201-207.
Dhanabal SP, Kokate CK, Ramanathan M, Kumar EP, Suresh B (2006). Hypoglycaemic activity of *Pterocarpus marsupium* Roxb. Phytother. Res. 20: 4-8.
Gayathri, M., K. Kannabiran, 2008. Hypoglycemic activity of *Hemidesmus indicus* R. Br. on streptozotocin-induced diabetic rats. Int. J. Diabetes Dev. Ctries. 28: 6-10.
Gbolade AA (2009). Inventory of antidiabetic plants in selected districts of Lagos State, Nigeria. J. Ethnopharmacol. 121: 135-139.
Grover JK, Yadav S, Vats V (2002). Medicinal plants of India with anti-diabetic potential. J. Ethnopharmacol. 81: 81-100.
Gutierrez RM, Gómez YG, Guzman MD (2011). Attenuation of nonenzymatic glycation, hyperglycemia, and hyperlipidemia in streptozotocin-induced diabetic rats by chloroform leaf extract of *Azadirachta indica*. Pharmacogn Mag. 7: 254-259.
Hamilton BP (1990). Diabetes mellitus and hypertension. Am. J. Kidney Dis. 16: 20-29.
Hernandez-Galicia E, Aguilar-Contreras A, Aguilar-Santamaria L, Roman-Ramos R, Chavez-Miranda AA, Garcia-Vega LM, Flores-Saenz JL, Alarcon-Aguilar FJ (2002). Studies on hypoglycemic activity of Mexican medicinal plants. Proc. West Pharmacol. Soc. 45: 118-124.
Islam MS, Choi H (2008). Comparative effects of dietary ginger (*Zingiber officinale*) and garlic (*Allium sativum*) investigated in a type 2 diabetes model of rats. J. Med. Food. 11: 152-159.
Jouad H, Haloui M, Rhiouani H, El Hilaly J, Eddouks M (2001). Ethnobotanical survey of medicinal plants used for the treatment of diabetes, cardiac and renal diseases in the North centre region of Morocco (Fez-Boulemane). J. Ethnopharmacol. 77: 175-182.
Kang MH, Lee MS, Choi MK, Min KS, Shibamoto T (2012). Hypoglycemic activity of *Gymnema sylvestre* extracts on oxidative stress and antioxidant status in diabetic rats. J Agric Food Chem. 60: 2517-2524.
Kar A, Choudhary BK, Bandyopadhyay NG (2003). Comparative evaluation of hypoglycaemic activity of some Indian medicinal plants in alloxan diabetic rats. J. Ethnopharmacol. 84: 105-108.
Khosla P, Bhanwra S, Singh J, Seth S, Srivastava RK (2000). A study of hypoglycaemic effects of *Azadirachta indica* (Neem) in normaland alloxan diabetic rabbits. Indian J. Physiol. Pharmacol. 44: 69-74.
Kotowaroo MI Mahomoodally MF, Gurib-Fakim A, Subratty AH (2006). Screening of traditional antidiabetic medicinal plants of Mauritius for possible α-amylase inhibitory effects in vitro. Phytother. Res. 20: 228-231.
Krishna Murthy B, Nammi S, Kota MK, Krishna Rao RV, Koteswara Rao N, Annapurna A (2004). Evaluation of hypoglycemic and antihyperglycemic effects of *Datura metel* (Linn.) seeds in normal and alloxan-induced diabetic rats. J. Ethnopharmacol. 91: 95-98.
Kumar S, Malhotra R, Kumar D (2010). Antidiabetic and Free Radicals Scavenging Potential of *Euphorbia hirta* Flower Extract. Indian J. Pharm. Sci. 72: 533-537.
Kumarappan CT, Mandal SC (2008). Polyphenolic extract of *Ichnocarpus frutescens* attenuates diabetic complications in streptozotocin-treated diabetic rats. Ren. Fail. 30: 307-322.
Lans CA (2006). Ethnomedicines used in Trinidad and Tobago for urinary problems and *Diabetes mellitus*. J. Ethnobiol. Ethnomed. 2: 45.
Leduc C, Coonishish J, Haddad P, Cuerrier A (2006). Plants used by the Cree Nation of Eeyou Istchee (Quebec, Canada) for the treatment of diabetes: A novel approach in quantitative ethnobotany. J. Ethnopharmacol. 105: 55-63.
Maiti R, Jana D, Das UK, Ghosh D (2004). Antidiabetic effect of aqueous extract of seed of *Tamarindus indica* in streptozotocin-induced diabetic rats. J. Ethnopharmacol. 92: 85-91.
Maiti R, Das UK, Ghosh D (2005). Attenuation of hyperglycemia and hyperlipidemia in streptozotocin-induced diabetic rats by aqueous extract of seed of *Tamarindus indica*. Bio Phar Bull. 28: 1172-1176.
Malalavidhane S, Wickramasinghe SM, Jansz ER (2001). An aqueous extract of the green leafy vegetable *Ipomoea aquatica* is as effective as the oral hypoglycaemic drug tolbutamide in reducing the blood sugar levels of Wistar rats. Phytother. Res. 15: 635-637.
Malalavidhane TS, Wickramasinghe SM, Jansz ER (2000). Oral hypoglycaemic activity of *Ipomoea aquatica.* J. Ethnopharmacol. 72: 293-298.
Malalavidhane TS, Wickramasinghe SM, Perera MS, Jansz ER (2003). Oral hypoglycaemic activity of *Ipomoea aquatica* in streptozotocin-induced, diabetic wistar rats and Type II diabetics. Phytother. Res. 17: 1098-1100.
Maniyar Y, Bhixavatimath P (2012). Antihyperglycemic and hypolipidemic activities of aqueous extract of *Carica papaya* Linn. leaves in alloxan-induced diabetic rats. J.

Ayurveda Integr. Med. 3: 70-74.
Mukherjee S, Dey A, Das T (2012). *In vitro* antibacterial activity of n-hexane fraction of methanolic extract of *Alstonia scholaris* L. R.Br. stem bark against some multidrug resistant human pathogenic bacteria. Eur. J. Med. Plants, 2: 1-10.
Mukhtar HM, Ansari SH, Ali M, Bhat ZA, Naved T (2005). Effect of aqueous extract of *Pterocarpus marsupium* wood on alloxan-induced diabetic rats. Pharmazie. 60: 478-479.
Narendhirakannan RT, Subramanian S (2010). Biochemical evaluation of the protective effect of *Aegle marmelos* (L.), Corr. leaf extract on tissue antioxidant defense system and histological changes of pancreatic beta-cells in streptozotocin-induced diabetic rats. Drug Chem. Toxicol. 33: 120-130.
Nugroho AE, Andrie M, Warditiani NK, Siswanto E, Pramono S, Lukitaningsih E (2012). Antidiabetic and antihiperlipidemic effect of *Andrographis paniculata* (Burm. f.) Nees and andrographolide in high-fructose-fat-fed rats. Indian J Pharmacol. 44: 377-381.
Ojewole JA (2005). Antiinflammatory, analgesic and hypoglycemic effects of *Mangifera indica* Linn. (Anacardiaceae) stem-bark aqueous extract. Methods Find. Exp. Clin. Pharmacol. 27: 547-554.
Onal S, Timur S, Okutucu B, Zihnioğlu F (2005). Inhibition of alpha-glucosidase by aqueous extracts of some potent antidiabetic medicinal herbs. Prep. Biochem. Biotechnol. 35: 29-36.
Pant MC, Uddin I, Bhardwaj UR, Tewari RD (1968). Blood sugar and total cholesterol lowering effect of *Glycine soja* (Sieb and Zucc.), *Mucuna pruriens* (D.C.) and *Dolichos biflorus* (Linn.) seed diets in normal fasting albino rats. Indian J. Med. Res. 56: 1808-1812.
Pari L, Latha M (2004). Protective role of *Scoparia dulcis* plant extract on brain antioxidant status and lipidperoxidation in STZ diabetic male Wistar rats. BMC Complement. Altern. Med. 4: 16.
Pari L, Latha M (2005). Antidiabetic effect of *Scoparia dulcis*: effect on lipid peroxidation in streptozotocin diabetes. Gen. Physiol. Biophys. 24: 13-26.
Paria ND, Chattopadhyay SP (2000). Flora of Hazaribagh District, Bihar. Botanical Survey of India., Vol. 1.
Paria ND, Chattopadhyay SP (2005). Flora of Hazaribagh District, Bihar. Botanical Survey of India., Vol. 2.
Patel DK, Kumar R, Laloo D, Hemalatha S (2012). Diabetes mellitus: An overview on its pharmacological aspects and reported medicinal plants having antidiabetic activity. Asian Pac. J. Trop. Biomed. 411-420.
Patel MB, Mishra S (2011). Hypoglycemic activity of alkaloidal fraction of *Tinospora cordifolia*. Phytomedicine. 18: 1045-1052.
Poongothai K, Ponmurugan P, Ahmed KS, Kumar BS, Sheriff SA (2011). Antihyperglycemic and antioxidant effects of *Solanum xanthocarpum* leaves (field grown & in vitro raised) extracts on alloxan induced diabetic rats. Asian Pac. J. Trop. Med. 4: 778-785.
Prain D (1903). Bengal Plants. Botanical Survey of India., Vol. 1-2.
Qureshi, S.A., A. Nawaz, S.K. Udani, B. Azmi, 2009. Hypoglycaemic and hypolipidemic activities of *Rauwolfia serpentina* in alloxan-induced diabetic rats. Int. J. Pharmacol. 5: 323-326.
Rahmatullah M, Sultan S, Toma TT, Lucky SA, Chowdhury MH, Haque WM, Annay EA, Jahan R (2009). Effect of *Cuscuta reflexa* stem and *Calotropis procera* leaf extracts on glucose tolerance in glucose-induced hyperglycemic rats and mice. Afr. J. Tradit. Complement. Altern. Med. 7: 109-112.
Rani MP, Krishna MS, Padmakumari KP, Raghu KG, Sundaresan A (2012). *Zingiber officinale* extract exhibits antidiabetic potential via modulating glucose uptake, protein glycation and inhibiting adipocyte differentiation: an in vitro study. J. Sci. Food Agric. 92: 1948-1955.
Rao, B.R., T. Murugesan, S. Sinha, B.P. Saha, M. Pal, S.C. Mandal, 2002. Glucose lowering efficacy of *Ficus racemosa* bark extract in normal and alloxan diabetic rats. Phytother. Res. 16: 590-592.
Reddy, D.S., I.S. Muchandi, R.A. Srinivasa, H.A. Pradeep, K. RaviKumar, M.S. Rao, M. Ibrahim, 2010. Effect of *Holostemma annularis* on the progression of diabetes induced by a high fructose diet in rats and in diabetic C57BL/6J ob/ob mice. Diabetes Metab. Syndr. Obes. 3: 87-94.
Roy MS, Janal MN (2010). High caloric and sodium intakes as risk factors for progression of retinopathy in type 1 diabetes mellitus. Arch. Ophthalmol. 128: 33-39.
Sabu MC, Kuttan R (2002). Anti-diabetic activity of medicinal plants and its relationship with their antioxidant property. J. Ethnopharmacol. 81: 155-160.
Sabu MC, Kuttan R (2004). Antidiabetic activity of *Aegle marmelos* and its relationship with its antioxidant properties. Indian J. Physiol. Pharmacol. 48: 81-88.
Sabu MC, Kuttan R (2009). Antidiabetic and antioxidant activity of *Terminalia belerica*. Roxb. Indian J. Exp. Biol. 47: 270-275.
Saleem R, Ahmad M, Hussain SA, Qazi AM, Ahmad SI, Qazi MH, Ali M, Faizi S, Akhtar S, Husnain SN (1999). Hypotensive, hypoglycaemic and toxicological studies on the flavonol C-glycoside shamimin from *Bombax ceiba.* Planta Med. 65: 331-334.
Seetharam YN, Chalageri G, Setty SR, Bheemachar (2002). Hypoglycemic activity of *Abutilon indicum* leaf extracts in rats. Fitoterapia. 73: 156-159.
Sharma N, Garg V (2009). Antidiabetic and antioxidant potential of ethanolic extract of *Butea monosperma* leaves in alloxan-induced diabetic mice. Indian J. Biochem .Biophys. 46: 99-105.
Sharma N, Garg V (2012). Antihyperglycemic and antioxidant effect of hydroethanolic extract of *Butea monosperma* bark in diabetic mice. Indian J. Biochem. Biophys. 49: 55-62.
Sophia D, Manoharan S (2007). Hypolipidemic activities of *Ficus racemosa* Linn. bark in alloxan induced diabetic

rats. Afr. J. Tradit. Complement. Altern. Med. 4: 279-288.
Subramanian SP, Bhuvaneshwari S, Prasath GS (2011). Antidiabetic and antioxidant potentials of *Euphorbia hirta* leaves extract studied in streptozotocin-induced experimental diabetes in rats. Gen. Physiol. Biophys. 30: 278-285.
Tag H, Kalita P, Dwivedi P, Das AK, Namsa ND (2012). Herbal medicines used in the treatment of diabetes mellitus in Arunachal Himalaya, northeast, India. J. Ethnopharmacol. 141: 786-795.
Tarak D, Namsa ND, Tangjang S, Arya SC, Rajbonshi B, Samal PK, Mandal M (2011). An inventory of the ethnobotanicals used as anti-diabetic by a rural community of Dhemaji district of Assam, Northeast India. J. Ethnopharmacol. 138(2):345-350.
Yadav M, Lavania A, Tomar R, Prasad GB, Jain S, Yadav H (2010). Complementary and comparative study on hypoglycemic and antihyperglycemic activity of various extracts of *Eugenia jambolana* seed, *Momordica charantia* fruits, *Gymnema sylvestre*, and *Trigonella foenum* graecum seeds in rats. Appl Biochem. Biotechnol. 160: 2388-2400.
Youssef W, McCullough AJ (2002). Diabetes mellitus, obesity, and hepatic steatosis. Semin. Gastrointest. Dis. 13: 17-30.
Zhang XF, Tan BK (2000). Anti-diabetic property of ethanolic extract of *Andrographis paniculata* in streptozotocin-diabetic rats. Acta Pharmacol. Sin. 21: 1157-1164.