Antihypoglycemic Plants from Western Part of Sikkim Himalaya

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ABSTRACT

Present investigation deals with socio-economic documentation of medicinal plants with potent hypoglycemic activity. A tribal community of Sikkim (Lepcha, Rai, Limboo, Bhutia, Gurung, Newar etc.) plays an important role in preservation of ethno-traditional knowledge. West Sikkim is highly diversified in term of therapeutic plants species due to its varied ecological and micro zone altitudinal climatic condition. Total 36 species of medicinal plants are recorded. This comprises total of 26 families, 7 shrubs, 18 herbs, 6trees and 3 climbers. Almost all parts of this plant such as leaf, fruit, seed, bark and root could be used to treat elevated glucose level. Simultaneously, scientific research too shows important role in rejuvenate the traditional knowledge and its therapeutic utilization. Current study helps for upcoming researchers to work on all these anti-diabetic plants and also persuade the young generation over traditional knowledge, preservation and conservation of potent bio-resource of Sikkim Himalaya.

Keywords: Anti-diabetic, Socio-economic, Tribal communities, Medicinal plants, West Sikkim

INTRODUCTION

Ethno-traditional indigenous knowledge is significant because this valuable information was generated after so many trial and errors practiced by ancestors. Also, ethonobotanical information serves as a foundation for new compound with active principles for phytochemical, pharmacognostical, pharmacological and clinical research (Hussain and Hore, 2007). Some of this information is selection of plant, choice of right plant parts, quantities, standardisation of methodology for preparation of medicine products, identification of plants for specific disease treatment etc. However, all the information was generated by different indigenous tribal societies of world. Sikkim is conglomerate of over 20 hill tribes and even more sub tribes (Rai et al., 2000) and each tribe has their own traditional knowledge which was spawned after several experienced and experimental errors by using bio resources present in their habitat. Furthermore, inhabitants of Sikkim are rich in indigenous knowledge on bio-resource and supplemented their food and medicine from wild plants (Subba, 2009).

Diabetes is a systemic metabolic disorder which leads to decrease in both insulin secretion and action (Altan, 2003). Moreover, uncontrolled diabetes leads to cerebrovascular, cardiovascular, nephropathy, neuropathy diseases and also associated with reduced quality of life (Feldman, 1988). No sector and no country of any society are immune to diabetes. The challenge now is its early detection and its effective management. In recent years diabetes has become one of the most and prevalent serious health concerns in both the developed and developing countries (Maiti et al., 2004). In 2007 global survey, Diabetes Atlas published recorded 5.9% of global population prevalence of diabetic disease, the diseased people aged ranged from 20-79 years.

Presently available remedies for diabetes include insulin and various oral antidiabetic agents such as sulfonylureas, biguanides, α-glucosidase inhibitors and glinides (Rao et al., 2010).These remedies of treatment found some disadvantage over traditional medicine system like inadequate supply of drugs, unaffordable cost of treatments, side effects of allopathic drugs. In developing countries these products are expensive and not easily accessible.

Owing to this numerous problems, scientific research has been carried out to develop hypoglycaemic agents from plant materials. In recent years, herbal medicines have started to gain importance as a source for the treatment of diabetes. There is about 1000 plant sp. used as a folk medicine to cure diabetes (Marles and Fransworth, 1995). So, the traditional herbal medicines are mainly used which are obtained from plants, it plays important role in the management of *diabetes mellitus* (Gupta and De, 2012). Herbal products are rich in bioactive compounds such as phenolics, flavonoids, terpenoids, coumarins, and other constituents which show reduction in blood glucose levels (Jung et al., 2006; Ji and Li, 2009). Various species of herbal drugs are described in many popular scientific literatures possessing antidiabetic activity (Valiathan, 1998). Furthermore, these medicinal plants are readily available, environment friendly, low cost, highly effective, and fewer side effects (Rekha, 2005). During last decade 8000 species of wild plants used by tribal and other traditional communities in India for treating health problems has been recorded (Venuopal, 2002; Akerle, 1993).

Globally demand for ethno-traditional medicines are increasing day to day as almost 80% of the human populations in developed communities depends on traditional natural medicines to meet their requirements (Fransworth et al., 1985). The continued commercial exploitation due to craze for herbal globalization of these medicinal plants has resulted in receding the plants population in their natural habitat and increased risk of losing their genetic diversity (Jain and Sastry, 1980). So it is necessary to initiate systematic cultivation of medicinal plants in order to conserve biodiversity, safeguard endangered species and state bio-resources. Ethno-Traditional medicinal knowledge is depleting gradually from generation to generation, present young generation are not tilt on traditional knowledge, and further there are risks of exhaustion of traditional knowledge in future. Therefore this study has designed to focus on the existing knowledge of the medicinal plants which is greatly used for the treatment of diabetes in more accessible and affordable manner for both the urban and rural poor of Sikkim. It also helps in exploration and conservation of medicinal plants and encouraged for upcoming researchers to work on this potential plants.

METHODOLOGY

Study Area

Geographical location of Sikkim lies between 27'5' to 20'9' N latitudes and 87'59' E longitudes areas 7096 sq. Km. The altitudes range from 100 meters to high as 8585 meters, with the timberline, at about 4000 meters in between. Thus, area covers wide range of ecological zones viz. temperate, subtropical, alpine and sub-alpine (Singh et al., 2002). It represents an extremely unique eco-system rich in terms of flora and medicinal plants wealth (Bodeker, 2005).

The West District of Sikkim state (27° 00´-27° 45´ N and 88° 00´ - 88° 30´ E), has a geographical area of 1066 km^2, surrounded by Darjeeling district of West Bengal in the south. The elevation in the district ranges from 300 to 8598 m above m.s.l., consisting of lower, middle and higher hills, alpine and perpetually snow-clad areas; the highest elevation being the mount Kangchendzonga (8598 m). The region possesses highly and numerous diverse wild flora and fauna which includes orchids, rhododendrons, marigolds, magnolias and cherries. The ecological and climatic condition of our study area i.e. West Sikkim is highly approving for several potent therapeutic plant species (Kumari et al., 2010). Areas where studies were carried out are Yoksom, Dentam, Uttarey, Heebermoik, Tashiding, Pelling, Geyzing, Karjay, Chiwa Bhanjang, Soreng, Kaluk, Rinchenpong, Sribadam, Sombaria, Okhrey, Heelay, Barsay etc. (Figure 1).

The data was collected regarding the usage of medicinal plants available in the local area for treating various ailments and especially diabetic diseases and its information was collected directly by contacting the herbal doctors (ayurvedic expert), folk healer and the old aged persons who have knowledge about these medicinal plants in the west district. The present study was carried out in west district during March 2013 to January 2014. The explorative survey of ethno botanical data was collected through interviews, discussion and observations especially to tribal communities like Lepcha, Bhutia, Sherpa, Limboo, Newar, Chettri, Bhaun, Rai, Tamang, Sunwar, and Gurung. Mostly survey was focused on the senior people as they usually have more knowledge about plant and its various uses. All the sample specimens were identified with the

help of available literature (Pradhan and Badola, 2008; Rao et al., 2010) and herbarium was submitted in Department of Science and Technology and Climate Change, Gangtok, Sikkim for future reference.

RESULTS AND DISCUSSION

Present studies revealed 36 different medicinal plant species from west Sikkim used for the treatment of diabetes Table 1. The total of 26 families, 7 shrubs, 18 herbs, 6 trees and 3 climbers are documented. The maximum uses part is rhizome, root and leaves, shoots, bark, fruits, flowers and seeds. The plants are antidiabetic due to presence of hypoglycaemic bio-active compounds such as allicin, ursolic acid, eugenol, polyphenols, lantanoside, catechin, tinosporic acid (Rao et al., 2010). Herbal medicines have been the highly esteemed sources of medicines throughout human history. These medicinal plants having natural therapeutic properties against various diseases and considerable work have been done on these plants to treat *diabetes mellitus*. Every communities have own medicine system for treatment of *diabetes mellitus*. It has been found that the tribal community of west Sikkim is rich in ethno-biological knowledge, they transfer ethno traditional information from one generation to another.

Apart from hypoglycemic property of all these plants, various other therapeutic properties have also been reported in the literature. A paste prepared from dry and fresh rhizomes of *Acornus calamus* is reported to apply externally on skin diseases and on the forehead during fever (Singh et al., 2002). The extract of *Allium sativum* was found to possess Antidiabetic and hypolipidaemic properties (Thomson et al., 2007). Seeds of *Trigonella foenum graecum* also found to have postprandial hypoglycemic activity (Bawadi et al., 2009).

The aqueous extract fruits of *Terminalia cheluba* was found to significantly reduced the elevated blood glucose level without any unfavorable effects on other blood parameters of liver and kidney function (Murali et al., 2007). *Nordostachys jatamansi* is earlier reported to use for the treatment of anxiety, stress, migraine, insomnia and also as potent hypoglycemic agent (Pradhan, 2011).

In west Sikkim most of the folk healers are from Limboo and Lepcha communities. Rai tribal communities do not share their medicinal information to another group. Instead, they transfer that information only to their next generation, as they thought that naming of medicinal plants to other communities lose its effectiveness. This shows that Rai communities are concerned about their ethno traditional knowledge. Lepcha, Rai, Limboo communities have their own methodology for preparation and application of medicine due to their socio-economic structure, ancient traditional knowledge and beliefs. Especially Lepcha follows ethno traditional practices by two folk healers (Bothing and Mun) and mostly believe in worship of nature and natural thing, this behaviour supports the conservation of bio resource. Their livelihood is totally dependent on ecological surroundings and they use simple technology to sustain their life, which seems totally conservative. Present studies/ survey in west Sikkim found that old aged people more than 60 years age recorded to know a lot about wild plant products as compared to younger generation, similar result was recorded by Pandey and Bisaria, 1997.

Table 1 List of anti diabetic plants found in western part of Sikkim Himalaya

Botanical Name / family	Habit / Parts used	Methodology for preparation and application	Citation/ References
Abroma augustaa (L.) Ulatkamal Sterculiaceae	Shrubs / Stem bark and leaf	Stem bark and leaf decoction (10–20ml) taken one time each alternate day in empty stomach for 4–6 week.	Kirtikar and Basu, 1975
Abutilum indicumb (L.) Ghantiphool Malvaceae	Shrub / Stem and Bark	Decoction of stem bark (25-50ml) given two times daily.	Das and Mandal, 2003
Acorus calamus L. Bhojo Araceae	Herb / Rhizomes	Decoction of rhizome taken as herbal tea.	Wu et al., 2009
Aegle marmelous Bael Rutaceae.	Tree / fruits and leaves	The aqueous extract of fruits and leaves	Sabu and Kuttan, 2004
Allium sativum. L. Lasun Liliaceae	Herb/ bulb, leaves almost whole plants	Taken- as a vegetable spices	Rao et al., 2010
Aloe barbadensisc (Mill). Ghew kumara Liliaceae	Herb / Leaf	Fresh leaf pulp (40-50g) taken once a day in empty stomach for 10-12 weeks	Kumar, 2002
Asparagus racemosusa Willd Kurilo Liliaceae	Climbing shrub / Tender shoot	Decoction of tender shoots (25ml) taken once a day for 6-8 weeks.	Kirtikar and Basu, 1975
Boenninghausenia albiflorad (Hook. f.) Reich ex Meissn.Chirbirpatay Rutaceae	Herb / whole plants	The whole plant is crushed without water and the juice (5–10ml) taken one to two times daily for 3–4 week	Polunin and Stainton, 1984
Berberis aristataa DC. Sano chutro Berberidaceae	Shrub / Root and Bark	Root bark extract (5–10ml) taken twice daily (after breakfast and dinner) for 1–2 weeks	Kirtikar and Basu, 1975
Campylandra aurantiacad Baker. Nakima Liliaceae	Herb / Flowers	Flowers are made into curry and taken with staple food two times per week for 4–6 weeks.	Polunin and Stainton, 1984

Cannabis sativa L. Bhang Cannabaceae	Shrub / leaf	Leaf extracts (5–10ml) taken two times daily for 3–4weeks.	Kirtikar and Basu, 1975
Catharanthus roseuse (L.) G. Don. Sada bahar Apocynaceae	Herb / Raw leaf	Raw leafs (1–2) chewed daily for 2 weeks.	Jain, 1994
Calamus rotanga L. Bet Arecaceae	Climbing shrub / Raw fruit	raw fruits (1–2) taken as masticatory two times daily (after breakfast and lunch) for 6–8 weeks	Kirtikar and Basu, 1975
Cinnamomum tamalad (Buch.-Ham.) Nees and Eberm. Sinkauli Lauraceae	Tree / Stem bark.	Decoction of stem bark taken three times daily for 3–4 weeks	Polunin and Stainton, 1984
Cissampelos pareiraa (L.) var. hirsuta (Buch.-Ham ex DC) Forman Batulpatay Familymaceae	Climber / Root bark.	Root bark extract (5–10ml) taken one to two times daily for 2–3 weeks.	Das and Mandal, 2003
Costus specious (Koening) Sm. BetlouriCostaceae.	Herb / Rhizome	Decoction of rhizome (10–20ml) taken two to three times daily for 2–4 weeks.	Das and Mandal, 2003
Ficus racemosa f L. Dumri Moraceae	Tree / Fruit.	Fruits juice (20–25ml) taken two times daily (before meals) for 4–8 weeks.	Jain, 1994
Girardiana heterophyllab Decne. Bhangre sisnu Urticaceae	Shrub/ Root	Root decoction (25–50ml) taken two times daily for 4–8 weeks.	Das and Mandal, 2003
Gynocardia odorataa R. Br. Gantay Flacourtiaceae	Tree / Fruit	Fruit juice (10–15ml) taken one time daily for 2 weeks.	Kirtikar and Basu, 1975
Ipomoea batatusg (L.) Lamk Sagarkhanda Convolvulaceae	Herb / Aerial parts	The juice of the aerial part of the plant (25–30ml) taken two times daily for 3–4 weeks	Chatterjee and Pakrashi, 1991
Litsea cubebag Pers. Siltimmur Lauraceae	Tree / Raw fruit	One raw fruit chewed as masticatory two times daily for 4–6 weeks.	Gurung, 2002

Momordica chrantiaa L. Karela Cucurbitaceae	Climber / Fruit	Fruit extract (25ml) taken two times daily for 12–14 weeks.	Kirtikar and Basu, 1975
Morus alba. L. Kimbu, Mulberry Moraceae	Tree / Leaves, Stem, and Root	Decoction of leaves, stem and roots.	Pradhan, 2011
Nardostachys jatamansia DC. Jatamansi Valerianaceae	Herb / Root	Decoction of rootstock (30–50ml) taken once daily for 2–3 weeks.	Chhetri et al., 2005
Ocimum sanctum. L Tulsi Labiateae	Herb / Leaves	Leaves can be processed into herbal tea	Donga, et al., 2011
Panax pseudoginsengd Wall. Panch patay Araliaceae	Herb / Rhizome	Dried rhizome powder (0.5–1g) taken one time daily with warm milk.	Polunin and Stainton, 1984
Picrorhiza kurrooa Royle ex Benth. Kutki Scrophulariaceae	Herb / Rhizome	Dry rhizome powder (0.5g) taken with two tablespoon of curd and a pinch of pepper power one time daily for 1–2 weeks.	Polunin and Stainton, 1984
Saraca asocae (Roxb.) De Wilde. Asok Caesalpiniaceae	Tree/ Flowers	Uses: Infusion of the dry flower (50–100ml) taken two times daily (before principal meals) for 4–5 weeks	Jain, 1994
Stephania glabrab (Roxb.) Miers Tamarkay Menispermaceae	Climber / Root	Decoction (20–25ml) taken with milk two to three times daily for 1–2 weeks.	Das and Mandal, 2003

Swertia angustifolia Buch.-Ham.ex D. Don. Patlay Chireto Gentianaceae	Herb/ Whole plants	Infusion of whole plant (40–50ml) taken two times daily (before principal meals for 3–4 weeks	Das and Mandal, 2003
Swertia chirayita Buch.-Ham Chireto Gentianaceae	Herb/ Whole plants	Infusion of the whole plant (50–60ml) taken one time daily in empty stomach for 2 weeks	Chhetri et al., 2005
Swertia pedicellatab Ban. Chireto Gentianaceae	Herb / Shoot	Decoction of shoot (20–25ml) taken two times daily (before meals) for 4–6 weeks.	Das and Mondal, 2003
Terminalia sp. T. cheluba Harra Conbretaceae	Herb / Dry fruits	Dry fruits	Murali et al., 2007
Trigonella foenum-graecuma L. Methi Fabaceae	Herb / Seeds	Sprouted seeds mixed with chilly, salt and garlic and ground into a paste. 5–10g of the paste taken with two principal meals daily	Kirtikar and Basu, 1975
Urtica dioca L. Sisnu Urticaceae	Herb / Leaves and Shoots.	Decoction of young leaves and shoots (50–100ml) taken as curry one or two times daily with meals for 4–8 weeks.	Kirtikar and Basu, 1975
Zingiber officinale Rosc. Adua Zingiberaceae	Herb / Rhizomes	Decoction of rhizome (25–50ml) taken as herbal tea with a pinch of salt two to three times daily for 8–12 weeks.	Kirtikar and Basu, 1975

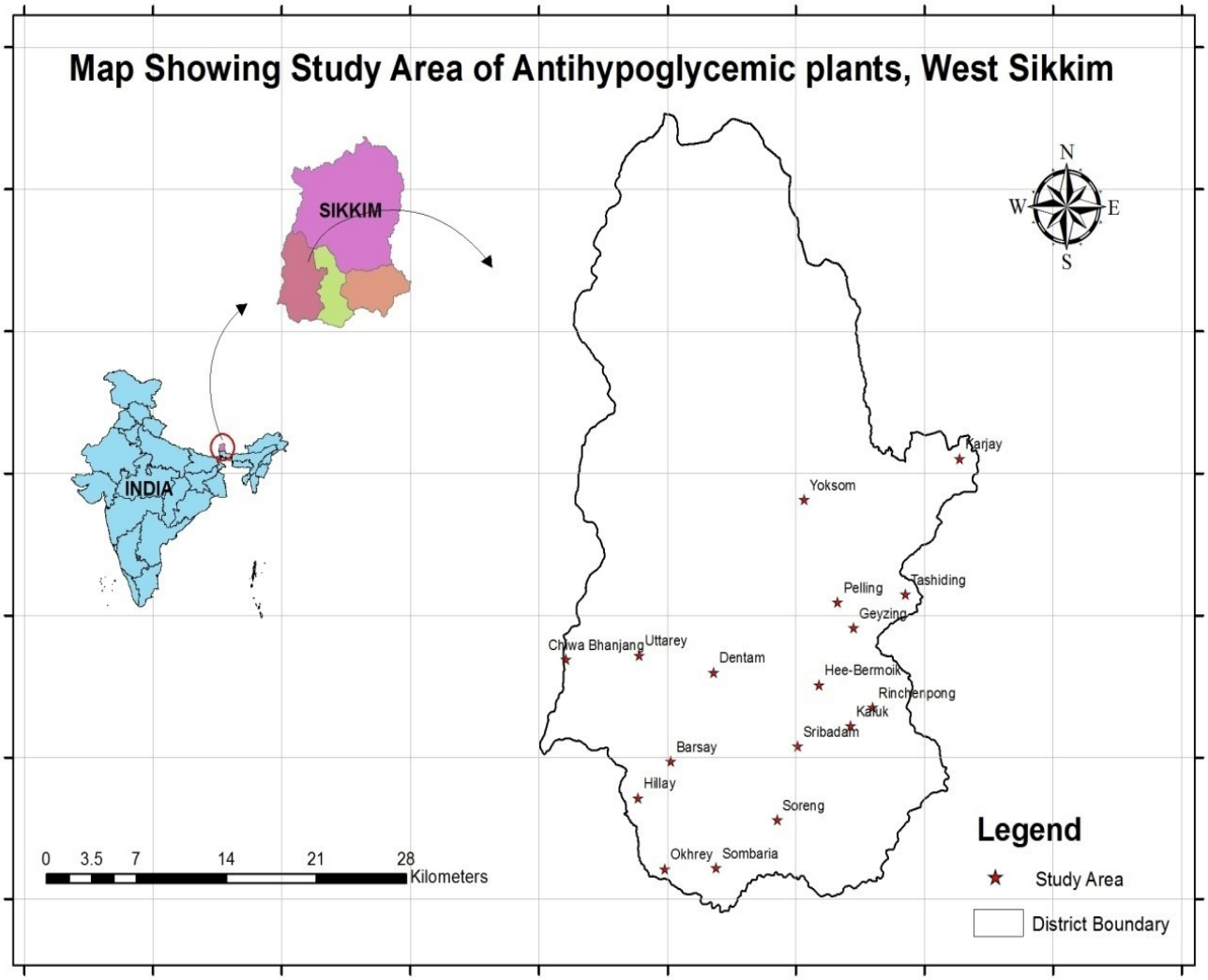

Figure 1. Study area of Antihypoglycemic plants, West Sikkim

CONCLUSION

This paper has presented a list of anti-diabetic plants used in the treatment of *diabetes mellitus*. In which 36 medicinal plants have been used to treat diabetes from western part of Sikkim Himalaya. Almost all parts of this plant such as leaf, fruit, seed, bark and root are used to cure a variety of diseases. This study demonstrated the identification and uses of potent medicinal plants, which are having high therapeutic value and could be used for the treatment diabetes. This documentation also helps to revitalize the local health tradition for primary health care and exploration of medicinal plants in Sikkim Himalaya. All the plants are found to have high hypoglycemic effects. Some bioactive hypoglycaemic agents are already identified and countless plants are still there to be identified. More investigations must be carried out to evaluate the mechanism of action of medicinal plants with Antidiabetic effect. As the pharmacologists are looking forward to develop new drugs from natural sources, development of modern drugs from above plants can be emphasized for the control of various diseases. A systemic research and development work should be undertaken for the development of products for their better economic and therapeutic utilization. Moreover, this study provides good platform for upcoming researchers to work on this Antidiabetic plant and encourages the young generation to tilt over traditional knowledge which was formulated by their ancestors and utilize precisely in future.

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REFERENCES

1. Akerle, O. (1993) Nature's medicinal bounty: do not throw it away. World Health Forum. 14(4), pp.390-5.
2. Altan, V.M. (2003) The pharmacology of diabetic complications. Curr. Med. Chem. 10, pp.1317–1327.
3. Bawadi, H.A., Maghaydah, S.N., Tayyem, R.F., and Tayyem, R.F. (2009) The Postprandial Hypoglycemic Activity of Fenugreek seed & seeds' Extract in Type 2 Diabetics: A Pilot Study.
4. Bodeker, G. (2005) Medicinal plant biodiversity & local health care sustainable use & livelihood development 17th common wealth forest.
5. Chatterjee,A., and Pakrashi, S.C. (1991) The Treatise on the Indian Medicinal Plant, (Council of Scientific and Industrial Research, New Delhi).1, pp.10-103.
6. Chhetri, D.R., Basnet, D., Chiu, P.F., Kalikotay, S., Chhetri, G. et al. (2005) Current status of ethnomedicinal plants in the Darjeeling Himalaya. Curr. Sci. 89(2), pp.264-68.
7. Das, A.P., and Mandal, S. (2003) Some Medicinal Plants of Darjeeling Hills, WWF-India, West Bengal State Office, Kolkata.
8. Donga, J.J., Surani, V.S., Sailor, G.U., Chauhan, S.P., and Seth, A.K. (2011) A systematic review on natural medicine used for the therapy of Diabetes mellitus of some Indian medicinal plants. Int J Pharm Sci. 2(1), pp.98-99.
9. Farnsworth, N.R., Akerele, O., and Bingel, A.S. (1985) Medicinal plants in therapy. Bulletin of world health Organisation. 63, pp.965-981
10. Feldman, J.M. (1988) In Diabetes Mellitus, 9th ed. Indianapolis, Eli Lilly & co. pp.28-42.
11. Gupta, P.D., and De, A. (2012) Diabetes Mellitus and its Herbal Treatment. IJRPBS. 3(2), pp.706-721.
12. Gurung, B. (2002) The Medicinal Plants of Sikkim Himalaya, Maples, Chakung.
13. Hussain, S., and Hore, D.K (2007). Collection & Conservation of Major Medicinal Plants of Darjeeling & Sikkim Himalayas. Indian J Traditional Knowledge. 6(2), pp.352-357.
14. Jain, S.K. (1994) Medicinal Plants, National Book Trust, India, New Delhi.

15. Jain, S.K., and Sastry, A.R.K. (1980) Threatened Plants of India State-of-art Report. Botanic Survey of India, Howrah. pp.1-48.
16. Ji, H.F., Li, X.J., and Zhang, H.Y. (2009) Natural products and drug discovery. EMBO Rep. 10(3), pp. 194–200.
17. Jung, M., Park, M., Lee, H-Ch., Kang, Y., Kang, E.S., and Kim, S.K. (2006) Antidiabetic agents from medicinal plants. Curr. Med. Chem. 13, pp.1203–1218.
18. Kirtikar, K.R. and Basu, B.D. (1975) Vol. 1. New Delhi: Periodical Experts; Glossary of Indian Medicinal plants; p. 338.
19. Kumar, S. (2002) The Medicinal Plants of North-East India. Scientific Publisher (India), Jodhpur.
20. Kumari, P., Joshi, G.C., and Tewari, L.T. (2012) Biodiversity Status, Distribution and Use Pattern of Some Ethno-Medicinal Plants. Int J Conserv Sc. 3 (4), pp.309-318.
21. Kumari,S., Behera, M.D., and Tewari, H.R. (2010) Identification of potential ecotourism sites in West District, Sikkim using geospatial tools. Tropical Ecology. 51(1), pp.75-85.
22. Maiti, R., Jana, D., Das, U.K., and Ghosh, D. (2004) Antidiabetic effect of aqueous extract of seed of Tamarindus indica in streptozotocin induced diabetic rats. J Ethnopharmacol. 92, pp.85-91.
23. Marles, R.J., and Farnsworth, N.R. (1995) Antidiabetic plants and their active constituents. Phytomedicine. 2, pp.137–189.
24. Murali, Y.K., Anand, P., Tandon, V., Singh, R., Chandra, R. et al. (2007) Long- term Effects of Terminalia chebula Retz. on Hyperglycemia and Associated Hyperlipidemia, Tissue Glycogen Content and in Vitro Release of Insulin in Streptozotocin Induced Diabetic Rats.
25. Pandey, A.K., and Bisaria, A.K. (1997) Rational utilization of important medicinal Plants: A tool for conservation. Indian Forester. 124(4), pp.197-206.
26. Polunin, O., and Stainton, A. (1984) Flowers of Himalaya. Oxford University Press, New Delhi.
27. Pradhan, B.K., and Badola, H.K. (2008) Ethnomedicinal Plant use by Lepcha of Dzongu valley, bordering Khangchendzonga Biosphere Reserve, in North Sikkim. India. J Ethnobiol Ethnomed. 4(22), pp.1-18. .
28. Pradhan, S.(2011) Antihyperglycemic effect of various Medicinal Plants of Sikkim Himalayas- A review. Int. J. Res. Phytochem. Pharmacol. 1(13), pp.124-130.
29. Rai, L.K., Prasad, P., and Sharma E. (2000) Conservation threats to some important medicinal plants of the Sikkim Himalaya. Biol Conserv. 93, pp.27-33.
30. Rao, M.U, Sreenivasulu, M., Chengaiah, B., Reddy, K.J., Chetty, C.M (2010) Herbal medicine for Diabetes Mellitus: A Review. Int. J. Pharm Tech Res. 2(3), pp.1883-1892.
31. Rekha, S. (2005) Medicinal plants and primary health care, The role of Gender. Journal of health management. 7(2), pp.277-293.
32. Sabu, M.C., and Kuttan, R. (2004) Antidiabetic activity of Aegle Marmelos and its relationship with its antioxidant properties. Indian J Physiol Pharmacol. 48(1), pp.81-88.
33. Singh, H.B., Prasad, P., and Rai, L.K. (2002) Folk medicinal plants of India. Asian Folk. Stud. 61, pp.295-310.
34. Subba, J.R. (2009) Indigenous Knowledge on bio-resources management for livelihood of the people of Sikkim. Indian J Traditional Knowledge. 8(1), pp.56-64.
35. Thomson, M., Al-Amin, Z.M., Al-Qattan, K.K., Shaban, L.H. and Muslim A. (2007) Antidiabetic & hypolipidaemic properties of garlic (Allium sativum) in streptozotocin induced diabetic rat.
36. Valiathan, M.S. (1998) Healing plants. Curr. Sci. 75, pp.1122–1126.
37. Venugopal, S.n. (2002) A report on simple formulations for primary health care uses based on Ayurveda for commercially important plant spices of Andhra Pradesh. FRLHT. pp 2-38.
38. Wu, Hao-Shu, Zhu, Di-Feng, Zhou, Chang-Xin, Feng, Chu-Rui, Lou, Yi-Jia et al. (2009) Insulin sensitizing activity of ethyl acetate fraction of Acorus calamus L. in vitro and in vivo, J Ethnopharmacol. 123(2), pp.288-292.