Antihyperglycemic effect of various medicinal plants of sikkim himalayas -
A review
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ABSTRACT
Diabetes is a metabolism disorder majorly seen in Sikkimese population due to hereditary, lifestyle, and environment. Among the ethno medicinal plants of Sikkim various plants have potential as antidiabetic (Chettri et al., 2005). Some of the antidiabetic medicinal plants found in Sikkim are Aegle marmelos, Azadirachta indica, Aloe barbadensis, Asparagus racemous, Berberis aristala, Catahranthus roseus, Cordycep sinensis, Costus sp., Nar-
dostachts jatamansi, Ocimum sanctum, Panax pseudoginseng, Picorrizae kurrao, Sweritia chirita, Trigonella
feocum, and Morus alba distributed in lower, middle and upper hilly region having different elevation range. Various research and preclinical studies done on the animals have shown that the part of these medicinal plants such as seeds, roots, leaf, stems have active phytochemicals that are responsible for hypoglycemic activity either by lowering of blood glucose levels, increasing insulin secretion, or increasing glucose tolerance.

Keywords: Stevioside; rebaudioside-A; photostability; diterpenoid glycosides; 1H and 13C NMR spectral data; chemical studies

INTRODUCTION
Sikkim is a small state located in the North eastern part of India, with 27° 04' 46" to 28° 07' 48" Latitude North and 88° 00' 55" to 88° 55' 25" Longitude East in the Himalayan range with a total geographical area of 7096 sq. km. It is rich in biodiversity of flora and fauna including various medicinal plants for treating various health complication.

Diabetes and its related complications have remained major health problems among Indians due to various reasons like hereditary, stress, environment or lifestyle (Pullaiah et al., 2003). Herbal treatment, having high therapeutic effect with minimum side effect complications and cost effectiveness has gained popularity for treating various health problems. Sikkim has various medicinal plants with antidiabetic potential.

The various part such as seeds, roots, leaf, stems plants contain active secondary metabolites that are responsible for reducing blood sugar level, increasing insulin secretion proven by various preclinical and clinical studies. Hence it can be cultivated in large scale, collected, processed into dried crude form, standardised and purified phytochemical extracts. Various methods of herbal extraction process can be done like tincture, decoction, maceration, solvent extraction etc., and phytochemical analysis can be done, documented and further formulated into antidiabetic nutraceuticals, powders, capsules, crude extract etc., thus increasing the chances of commercialization in Sikkim and opening various opportunities for employment.

METHODOLOGY
Information were collected regarding the potential herbs commonly found in Sikkim from Department of Forest Environment and W/L management, (State Medicinal Plant Board, Sericulture dept), Department of Science and Technology and further interacted with the concerned person from the following Depts. Reference from various Books on Medicinal plants Of Sikkim,
MEDICINAL PLANTS OF SIKKIM WITH HYPOGLYCEMIC POTENTIAL

_Aegle marmelos_ (Bael)

_Aegle Marmelos_ (Bael) from Rutaceae family is a tree found in Lower Hill of Sikkim Himalayas and is widely used traditional medicinal plant for treating various disease like constipation and having antimicrobial, antifungal (Sarada Jyothi K et al., 2010, Pallav Maity et al., 2009). Recently it has been reported to have anti-hyperglycemic effect. Various studies on the aqueous extract of fruit and leaves of the plant was effective in reducing blood sugar level in alloxan induced rat (Sabu and Ramadasan et al., 2004). It decreases blood glucose level by improving glucose tolerance. It contains a phytochemical called sitosterol that lowers the blood cholesterol. It was found to be as effective as insulin in the restoration of blood glucose and body weight to normal levels on hyperglycemic state (Seema et al., 1996). _Aegle marmelos_ leaf extract has been reported to regenerate damaged pancreatic beta cells in diabetic rats (Das et al., 1996). It helps in Improvement of digestion and reduction of blood sugar and urea (Donga et al., 2011). Hence it can be used in powder form for the hypoglycemic effect. The seed of the plant can also be used for treating the deficiency of memory caused in streptozotocin induced diabetes in rats. (Amir Farshchi et al., 2010). Methanol extract of the leaves of the plant has shown effective antidiabetic effect. (Sevugan Arumugam et al., 2008). Alcoholic extracts of the plant as hypoglycemic has been studied.

_Aloe barbadensis_ (Ghiukmari)

_Aloe barbadensis_ from the family Liliaceae commonly known as Aloe vera is the herb found in lower Himalayan region and seen as household herb in Sikkim. Various formulation of cosmeceuticals, neutraceuticals, herbal drug, health drink for treating piles, beautifying agent, stomach ailments, gastrointestinal problems, skin diseases, constipation are available. It is also effective for treating inflammation and has high wound healing property and antihyperglycemic property (Hormann et al., 1994, Peter Arethron, 1996). Aloe vera gel helps in secretion of insulin thus increasing the insulin level and lowering the blood glucose level hence useful for treating type 2 diabetes. In diabetic induced rats fed with A. vera, the fasting plasma glucose levels were reduced to normal and body weight was found to be increased. (Ayasha Noor et al., 2008). The Aloe vera gel and its phytoesters like lophenol, 24- methyllophenol, 24-ethyl-lophenol, cycloarctanol and 24-methylene-cycloarctanol have shown ability to reduce blood glucose level (Eriko Misawa et al., 2008, Miyuki Tanaka et al., 2006). Processed Aloe vera appeared to lower blood glucose levels by decreasing insulin resistance (Kwanghee Kim et al., 2009).

_Aspasgus racemosus_ (Kurilo)

_Aspasgus racemosus_ from the family Liliaceae is a climber shrub consumed as vegetable in most part of the world . In Sikkim Himalayas it is commonly found in middle and lower region. It has been used as a effective medicinal plant globally and are used as antioxidants,treating gastric disorder,immunomodulatory, immunostimulants, anti-inflammatory, antihypertoxic, antibiotic, antioxytocic, and reproductives agents,Jaundice(R.K Goyal et al., 2003)

The solvent extract of the dried root of _Aspasgus racemosus_ have shown in increase in insulin secretion.Reduction in blood glucose level was seen in a streptozotocin induced diabetic rats (Raghavan govdarajan et al., 2004).Studies on different solvents were found to be highly effective in stimulating insulin secretion in perfused rat pancreas. ( J M A Hannan et al.,2007).Alcoholic extract of root of A. racemosus was found to have slight diuretic effect in rats and hypoglycemic effect in rabbits(R K Goyal et al.,2003).Various studies on roots of A. racemosus for its hypoglycemic effect has been done.

_Azadirachta indica_ (Neempati)

_Azadirachta indica_ (Neem )from the family Meliaceae is well known traditional medicinal tree found all over India found in lower and middle region of Sikkim. It is used as antimicrobial, antiseptic, moisturizer for various skin disorder , astringent, tonic, antiulcer, antioxytocic, antiinflammatory (Nudrat .Z et al.,2000) E. Atawodi et al., 2009). Various research has also been done on its antihyperglycemic effect of _A.indica_. Preclinical studies done on rats have shown that the _A.indica_ leaf extract can block the action of epinephrine induced hyperglycemia that causes reduction in utilization of glucose.Thus showing anti-hyperglycemic activity(R.R. Chattopadhya,1996). ). Oral dose of _A. indica_ leaf extract can also help in preventing various complications caused due to diabetes such as cardiovascular diseases due to alteration in serum lipid as it reduces the serum lipid thus preventing the complications caused due to diabetes mellitus . (R.R. Chattopadhya., et al. Many studies have indicated that oral administration of Neem decreases the insulin requirement in Type 1 diabetes (Pillai et al., 1981). Seed of neem has also shown effective hypoglycemic activity. Various research and clinical studies have shown that neem leaf extracts and seed oil help to reduce the insulin requirement thus helping to lower the blood glucose levels. Hence it can be processed into capsule powder or tablet form or oil.

The decoction of the leaves or the juice from the leaves has shown effective hypoglycemic effect.
**Berberis aristata (Chutro)**

*Berberis aristata* (chutro) from the family Berberidaceae is a shrub, commonly a edible plant. *B. aristata* is folklore medicine used in the treatment of diabetes in India, Sikkim and Darjeeling. (Bhupesh Chander Semwal *et al.*, 2009) It is traditionally used as antimicrobial (M. Shahid *et al.*, 2008), antiperiodic, antidiarrhoeal skin diseases gastro-irritant, anticoagulants, antipyretic, hypotensive. The stem extract are known to show hypoglycemic activity. The hypoglycemic activity of methanol extract of the stem of *Berberis aristata* was seen on normal and diabetic rat. The presence of alkaloids, glycosides, carbohydrates, bitter principles and Saponins has been implicated in the Antidiabetic activities (Nitin Kumar *et al.*, 2010). The methanolic extract of *Berberis aristata* has blood glucose lowering potential in diabetic induced rats and exhibit an antioxidant property as well(J.K Gupta *et al.*, 2009). The solvent extract of the powder have shown hypoglycemic activity. (Bhupesh Chander Semwal *et al.*, 2009).

**Catharanthus roseus (Sadabahar )**

*Catharanthus roseus* from the family Apocynaceae is found commonly in lower hilly region of Sikkim Himalayas. The extracts of *C. roseus* is commonly used for the treatment of malaria, leukaemia, wasp stings, sore throat, eye irritation, infections astringent, diuretic and expectorant (Damilare, 2010).It is also a potential hypoglycemic herb. The leaf juice is known to show hypoglycemic activity when preclinical studies were done on diabetes induced rats by enhancing insulin secretion from the beta cell and thus lowering the blood glucose level(Srinivas etal, 2003). The dichloromethane extract of leaf showed hyperglycaemic activity in alloxan induced diabetic rat (M, Jayanthi *et al.*, 2010). Traditionally the decoction of the leaf and root of the plant is used for treatment of diabetes. Hence the fresh leaves can be dried and further extracted by solvent extraction, soxhlet extraction for the release of the active phytochemical which can reduce the blood glucose and show anti hyperglycaemic activity.

**Cordyceps sinensis (Yarchargumba)**

*Cordyceps sinensis* and *Cordyceps militaris* from the family Clavicципataceae commonly known as summer grass winter worm is found in North Sikkim above 2000 meter where parameters required are low temperature, low oxygen and high altitude. It is known to treat various health complications like aging, cancer, fatigue, heart and lungs and liver ailments and diabetes. Various preclinical studies on animals and clinical trials on humans have shown that it has potential to regulate blood sugar metabolism. It can improve the insulin sensitivity and thus improve blood glucose metabolism. The polysaccharide of *C.sinensis* and *C.militaris* shows hypoglycemic activity when induced on animals.CSP-1, the polysaccharide from cordyceps causes lowering of blood glucose level in diabetic animals. The hypoglycemic activity is due to increase in insulin level which may be due to induced insulin release (S.P. Li *et al.*, 2006)

The other secondary metabolites of *Cordyceps* *sp* are cordycepin and cordycepic acid and these active components also play important role in lowering the blood glucose level.

**Costus sp. (Bet laure)**

*Costus sp.* from the family Costaceae grows on tropical to temperate region. It is used for the treatment of various disease like fever, bronchitis,anemia, rheumatism(Annexure II, state of environment,2007). Rhizome from the plant is also used traditionally for treatment of diabetes in north eastern part of Himalayas. The rhizome is cooked and eaten local people eat the leaves for curing the diabetes. (Merina Benny, 2004) Study of crude extract of *Costus speciosus* rhizomes lowered the plasma glucose in STZ-induced diabetic rats which may be due to increase in secretion of insulin from B-cells of Langerhans. Preclinical studies have shown that it helps in lowering the glucose level by improving the insulin secretion when the crude extract of the plant was administered to STZ induced diabetic rats. According to (Pitchai Daisy *et al.*, 2008) The solvent extract of the rhizome of the costus sp. is effective in decreasing the serum glucose level and normalizing other biochemical parameters. Hence it effective in showing hypoglycemic effect. The root of *Costus* sp also shows anti hyperglycemic effect in alloxan induced diabetes rats. The phytochemical responsible for hypoglycemic effect is sesquiterpene known as Eremarthin which can cause the insulin release from the Beta cells. Eremarthin isolated from the hexane extract of *C. speciosus* root was studied for anti diabetic activity (J.Eliza *et al.*, 2009)

**Momordica charantia (Karela)**

*Momordica charantia* from the family Cucurbitaceae. It is widely cultivated in India and Himalayan range as well. It has been extensively used as a folk medicine for treatment of diabetes. The fruit of the plant has hypoglycemic activity. Several compounds contained in bitter melon are known to account for its ability to lower the levels of sugar in the blood. It’s also rich in micronutrients which are required for prevention of complications of diabetes. The polypeptide isolated from the seed shows hypoglycemic activity on humans (Khanna and Jain, *et al.*, 1981). The solvent extract of the dried fruit powder shows effective hypoglycemic activity (Singh *et al.*, 2000). The unique fruits of this plant have been shown to produce a hypoglycemic effect in experimental models following oral administration (Sharma *et al.*, 1960; Akhtar *et al.*, 1981; Srivastava et al., 1987; Day *et al.*, 1990; Pugazhenthhi *et al.*, 1995). Aqueous extract of the *Momordica charantia* showed more hypoglycemic activity than solvent extract when
administered on alloxan induced diabetes on rats (Jaspreet Virdi et al., 2003)

It is possible that the mechanism of action is that bitter gourd makes the receptors of target cells (like muscles and fat tissues) more sensitive to insulin, and therefore, the cells increase their absorption of glucose. At least three different groups of constituents in the bitter gourd appeared to have hypoglycemic, blood sugar lowering, actions of potential benefit in diabetes mellitus. It is believed that these include a mixture of steroidal saponins known as charantin, insulin-like peptides, and alkaloids. The bitter melon is believed to improve glucose tolerance in Type II diabetes. Active constituents are believed to be oleanolic acid glycosides and Momordins which prevent absorption of sugar (Mitra and Bhattacharya, 2006).

**Morus alba (Mulberry)**

*Morus alba* is less commonly found medicinal plant in Sikkim and initiative for the cultivation has been taken in west Sikkim. It is effective as antioxidant and anti-diabetic, antifatigue, antibacterial (Wei Li et al., 2009, Fang Wang et al., 2008). It is known to treat hypoglycaemia as it contains the active phytochemical in leaves, stem and roots that are responsible for lowering the blood glucose level. The secondary metabolites are 1-deoxynojirimycin found in leaves and shoot part of plant and Moran 20K, found in roots. 1-DNJ is the derivative of imino sugar or azasugar with potential alpha glycosidase inhibition activity (Kiyo-taka Nakagawa et al., 2008). The mechanism for the hypoglycemic activity is it binds with alpha-glycosidase preventing carbohydrate to bind with this enzyme (showing competitive inhibition). Hence reducing the breakdown of carbohydrate to glucose and thereby slowing down the entry of sugar (glucose) into the blood circulation. The metabolites compete with the carbohydrate for the active site of enzyme. Hence reducing the breakdown of carbohydrate to glucose and thereby slowing down the entry of sugar (glucose) into the blood circulation. Thus regulating the blood glucose level (Mitchell Mudra et al., 2007).

**Nardostachys jatamansi (Jatamansi )**

*Nardostachys jatamansi* is a perennial herb from the Alpine Himalayas, at an altitude of 11000-17000 meters and is cultivated in areas ranging from Punjab to Sikkim and Bhutan. It is used for the treatment for anxiety, etc. hepatoprotective (Shakir Ali et al., 2000) antimicrobial (V. Prashanth Kumar et al., 2006), antioxidant (N Lyle et al., 2009) Essential oil of *Nardostachys jatamansi* is also used for treating tension, stress, migraine and insomnia. Currently research has been done on its potential as hypoglycemic plant. The solvent extract of the plant has shown effective hypoglycemic activity. NJE provided resistance to pancreatic β-cell damage from cytokine or streptozotocin treatment. The β-cell protective effect of NJE is mediated by suppressing NF-κB activation (Mi-Young Song et al., 2010).

**Ocimum sanctum (Tulsi)**

*Ocimum sanctum* (Tulsi) is from the family Labiatae commonly found in India as well as lower hilly region of Sikkim. It is a potential herb as anti-microbial, antihypertensive, anti-diabetic, antifatigue, antibacterial, antiallergic, antihypertensive, Malarial fever, Skin disease, bronchitis (P. Prakash et al., 2004). The leaf extract of *Ocimum sanctum* showed reduction in blood glucose level. It shows a coencisol lowering activities (Donga et al., 2011). Protect against radiation (Uma Devi et al., 1999). The alcoholic extract of the leaves of the plant has shown antihyperglycemic activity. The basil leaves improve the B cell function and enhance insulin secretion (Agrawal et al., 1996). The 70% ethanolic extract of the leaves of *Ocimum sanctum* suppress the blood glucose levels in normal glucose fed hyperglycemic, insulin treated and diabetic rats as compared to control (Chattopadhyay et al., 1993). Since it is used for the treatment of various diseases including diabetes it can be processed into herbal teas, capsules etc.

**Panax pseudoginseng (Panch patay)**

*Panax pseudoginseng* is a herb from Araliaceae family a perennial rhizomatous herb growing in conifer rhododendron forests of Eastern Himalaya above (Shiva K. Sharma et al., 2010) around 8000ft in Sikkim Himalayas. It is anti-obese, anti-cancer, anti-diabetic, anti-oxidant, antistress (Se Na Yun et al., 2004; Jong Dae Park et al., 2005) Asian ginseng is commonly used by the traditional practitioners of Chinese medicine, to treat diabetes. The aqueous and the ethanol extract of the root and berry have shown effective hypoglycemic activity. When administered in streptozotocin induced rat, the mechanism seen is stimulation of secretion of insulin from the cells of pancreas and increase in the number of insulin receptor thus improving the insulin sensitivity, lowering the blood glucose level and body weight and increasing activity of glucokinase. (Donga et al., 2011; Hong Xiang et al., 2009). There is various component present in Ginseng but the active component responsible is a saponin called ginsenoside (a group of saponin with triterpinoind structure) that stimulates the insulin secretion and increase the sensitivity of insulin (Park et al., 2008; Chang-yong Yang et al., 2010). Various preclinical studies done on rats have shown anti hyperglycaemic activity when administered on diabetes induced rat.

**Picrorhiza kurroa (Kutki)**

*Picrorhiza kurroa* (Kutki) belongs to the family Scrophulariaceae is a herb mostly found in Himalayan range between 9000-15000 ft, a highly valued medicinal plant with great potential as antioxidant (D. Raja-prabhu et al., 2007) hepatoprotective, antibacterial, antiviral, immune system stimulating herb, root of the
plant can reduce cholesterol and improve blood circulation. Currently various research has been done on *Picrorhiza kurrooa* as hypoglycemic plant. It controls the release of glycogen from liver thereby decreasing the insulin load. Liver is the store house of glucose. *Picrorhiza Kurrooa Royle* regulates the release of glucose from the liver by controlling glycogen synthesis and glycogenolysis thereby reducing the requirement of insulin. The treatment with the aqueous and methanol extract of *P. kurrooa* rhizomes, diabetic pancreas showed considerable improvement in β-cell density. The number of insulin granules and β-cells population was significantly high in the treated groups of rats. The islet size was also larger. This may be an indication of the regeneration and rejuvenation of β-cells leading to increase in insulin production and secretion (Shivkumar Chauhan *et al.*, 2008). The decoction or tincture of the leaves, seed are effective to show hypoglycemic activity.

**Swertia chirayita (chireto)**

*Swertia chirayita* is the plant from the family Gentianaceae commonly found in western Himalayas range from Kashmir to Sikkim. It is distributed between 5000-7000 ft. It is used as anti-inflammatory, laxative, antibacterial, antifungal, cardiotonic, diuretic, hepatoprotective, antioxidant, antituberculosis, treatment of jaundice, (Huiling Yang *et al.*, 2004) The bitterness, antihelmintic, hypoglycemic and antipyretic properties are attributed to amarogentin (most bitter compound isolated till date sweenchir, swertiamarin and other active principles of the herb (P. Joshi *et al.*, 2005). Preclinical studies of the ethanolic extract of the plant on the diabetes induced rats resulted in lowering of blood glucose level. Leaves and the whole plant contains active principle like ophelic acid, sweenchir and chiratin have shown hypoglycemic activity (Saxena *et al.*, 1991). (A.M Saxena *et al.*, 2007) The methanolic extract of the plant is known to show hypoglycemic activity. It is also known to control the symptoms caused by diabetes.

**Trigonella foenum-graecum (Methi)**

*Trigonella foenum-graecum* (Fenugreek) from the family Fabaceae is a crop plant that is used as both an herb and a spice (seed). It is used in various treatments like baldness, cancer, elevated cholesterol levels, inflammations, microbial and fungal infections, and stomach ulcers. Currently preclinical and clinical studies on the herb have indicated its anti-diabetic properties. The fibre-rich fraction of fenugreek seeds can help in lowering blood sugar levels in people with diabetes. The seeds of *Trigonella foenum graecum* are reported to possess hypoglycemic properties in animal and human subjects (Shani *et al.*, Sharma *et al.*, 1990). The water extract of the methanol extractive-free residue of the seed powder, which contains almost exclusively the soluble dietary fraction of *Trigonella foenum graecum*, showed significant hypoglycemic activity at different prandial states (Ali *et al.*, 1995; 1990). The whole powder, its methanol extract, and the residue remaining after methanol extraction have significant hypoglycemic effects when fed simultaneously with glucose. (J.M.A. Hannan *et al.*, 2003) The ethanol extract showed significant activity against the diabetic state induced by alloxan but the intensity of hypoglycemic effect varied from dose to dose. Phytochemical group tests were also accomplished and presence of alkaloids, steroids and carbohydrates were recognized in the extract. (Asmeta Mowla *et al.*, 2009). The possible mechanism of action of extracts could be correlated with the remisnecfent effect of the reference anti diabetic drug glimepiride that promotes insulin secretion by closure of K⁺-ATP channels, membrane depolarization and stimulation of Ca²⁺ influx, an initial key step in insulin secretion.

**Terminalia sp. T.chebula (Harra), T.bellerica (Borra)**

*Terminalia* sp. belongs to the family Combretaceae, *Terminalia chebula* and *Terminalia bellerica* are hypoglycemic plant. *T.chebula* known as Harra in Sikkim, commonly seen sold in local market. It is effective as antioxidant (M C Sabu *et al.*, 2008, antimicrobial, antiulcer and anti diabetic and treating other health problems like constipation. The various solvent extract and the aqueous extract of *T.chebula* has shown antidiabetic activity when administered on diabetes induced rats. It caused the regeneration of Beta cells of pancreas thus showing anti-diabetic affect. The aqueous extract of the plant has shown the antihyperglycemic activity. The water extract of *T. chebula* dried fruit has good potential of being good drug for the treatment of diabetes mellitus (Y. K. Murali *et al.*, 2004). The ethanolic extract of the fruit is effective in regulating the blood glucose level in streptozotocin induced rats by increasing the insulin secretion. (G. Perisamy *et al.*, 2006). Various research is going on for identification and isolation of the active component responsible for the hypoglycemcic activity. Preclinical studies has shown that when the extract of *T.bellerica* was fed to alloxan induced diabetic animal, it resulted in lowering of glucose level serum glucose level. (M.C Sabu *et al.*, 2008)

**Utric. Sp. (Sishnu)**

*Utrica* sp. from the family Urticaceae is commonly found in Himalaya region distributed in all part of Sikkim most commonly found is *U.dioica, U.pariviflora*. It is taken as edible vegetable for treating various diseases like high blood pressure, diabetes, digestion, helps lactation, promotes menstruation, anti-inflammatory cleanses blood. All part of the plant has medicinal value such as leaves, stems roots, flowers. Various researches have been done on *Utrica sp.* as hypoglycemic plant. The active component of *Utrica dioica* was found to increase the insulin content of blood sera in normal and streptozotocin diabetic rats that were injected intraperitoneally (i.p.) with the active ingredient of the extract. The aqueous extract of *Urtica dioica* leaves (Stinging Nettle) could enhance the
secretagogue function of Islets of Langerhans (Bijan Farzami et al., 2003). The aqueous extract of leaves of Urtica parviflora has good hypoglycemic and anti-hyperglycemic effect and the primary action being inhibition of intestinal glucose absorption (Sangeeta Pilkhwal Sah et al., 2010). The aqueous extract of the leaves showed fall in blood glucose level. The phytochemical of U.parviflora constitute of saponins,glycosides ,,alkaloids,flavonoids,and polysaccharides that increase the insulin hence decrease the blood glucose level. The aqueous extract of U.parviflora possess significant hypoglycemic activity which may be attributed to, in part by reduction of intestinal glucose absorption by the chemical constituents (Sangeeta Pilkhwal Sah et al., 2010)

**DISCUSSION**

Sikkim is rich in various medicinal plants that have high potential in treating diabetes. But the only source of most of these medicinal plant is from the wild resource and there is a risk of over exploitation by collectors or traditional practitioners. Hence initiative should be taken for the cultivation of these valuable medicinal plants in large scale so that the supply balance is sustained and there is no over exploitation of such endangered plants and adequate herbal raw material is available for further processing and formulation of anti diabetic product. Sikkim being declared as organic state, its medicinal plants has more value as it is not polluted by harmful pesticides or insecticides. Initiative should not be limited to conservation of Biodiversity but proper initiative should be taken for systematic propagation of herbs and aromatic plants and standardise the propagation method and parameters required for the propagation of the each medicinal plants. Hence large scale cultivation can be done in various nurseries, herbal gardens or by distributing high quality seeds to farmers for disease free plants and providing. Training should be provided on various aspects like sustainable production of this medicinal plant like propagation methods, cultivation techniques harvesting methods so that further collection and processing of the raw material can be done without over exploitation.

Among these plants some plants are commonly found, some comes under endangered species and some have been recently been introduced in Sikkim. Due to its great potential for antihyperglycemic effect it can be cultivated in large scale , collected ,phytochemical analysis of the active component can be done and further the plants can be processed into various dried crude form ,purified phytochemical extract , or formulated into herbal product such as nutraceuticals, herbal teas, capsules powders etc., Thus increasing the chances of commercialization in Sikkim. Comparison of the active components can be done by phytochemical analysis and further standardisation can be done. Various research institutes and departments should come together to make it successful.

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