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Polyherbal formulations based on Indian medicinal plants as antidiabetic phytotherapeutics

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Abstract

In spite of all the advances in therapeutics, diabetes still remains a major cause of morbidity and mortality in the world. Herbal formulations are becoming popular now days particularly in the treatment of Type 2 diabetes. Though there are various approaches to reduce the ill effects of diabetes and its secondary complications, herbal formulations are preferred due to lesser side effect and low cost. This review focuses on the potential of different polyherbal formulation in the treatment of diabetes and also reviews their pharmacological investigations.

Key words: Polyherbal, formulation, antidiabetic activity, medicinal plants, Type 2 diabetes, ayurvedic

Introduction

Diabetes is a heterogeneous metabolic disorder characterized by altered carbohydrate, lipid, and protein metabolism which causes hyperglycemia resulting from insufficient insulin secretion, insulin action or both (Joseph, 2011; Mutalik 2003). It is one of the refractory diseases identified by Indian Council of Medical Rearch for which an alternative medicine is a need for the treatment. Diabetes mellitus has become a growing problem in the contemporary world (Piyush *et al* 2006). India has today become the diabetic capital of the world with over 20 million diabetes and this number is likely to increase to 57 million by 2025 (Cook *et al*,2008). This astronomic increase in the prevalence of diabetes has made diabetes a major public health challenge for India and is become important human ailment afflicting many from various walks of life in different countries and once again the whole world being looked upon Ayurvedic the oldest healing system of medicine for the treatment of diabetes (Joseph, 2011). Although there are many synthetic medicines developed for patients, but it is the fact that it has never been reported that someone had recovered totally from diabetes (Zhengh *et al*, 2004). .The modern oral hypoglycemic agents produce undesirable and side effects. Thus in the recent years considerable attention has been directed towards the antidiabetic potential

of medicinal plants and their herbal formulation in the management of disease. Here we enlisting (table 1) some of the medicinal plants with potential antidiabetic activities reported with their possible mode of action

Table 2. Medicinal plants used for the treatment of diabetes.

Plant name	Part Used	Possible mechanism of action	References
Aegle marmelos	Leaf	Increases utilization of glucose; either by direct stimulation of glucose uptake or via the mediation of enhanced insulin secretion and has potent antioxidant activity, which may account for the hypoglycemic potential	Sachdewa *et al*, 2001
Allium cepa	Bulb	Lowers blood glucose level and has potent antioxidant activity, which may account for the hypoglycemic potential	Augusti,1973
Allium sativum	Whole plant	Increased the insulin like activity of plasma	Jain *et al*,1975
Aloe vera	Whole plant	Maintains glucose homeostasis by controlling the carbohydrate metabolizing enzymes	Rajasekaran *et al*,2004; Okyar *et a*l,2001
Artemisia pallens	Aerial part	Inhibits glucose re-absorption or increase in peripheral glucose utilization	Subramoniam *et a*l,1996
Annona squamosa	Leaf	Lowers blood glucose level	Gupta *et a*l,2005
Andrographis paniculata	Whole Plant	Prevents glucose absorption from gut	Yu BC *et al*,2003
Azadirachta india	Leaf	Reduce blood glucose level by regeneration of β cells	Chatopadhyay *et a*l,1996
Biophytum sensitivum	Whole plant leaf	Stimulates pancreatic beta cells to release insulin.	Puri *et a*l,1998
Beta vulgaris	Root	Lowers blood glucose level	Yoshikawa *e*t *a*l,1996
Brassica juncea	Whole plant	Increases the concentration of hepatic glycogen and glycogenesis and suppressed the activity of glycogen phosphorylase and gluconeogenic enzymes, lead to reduction in glycogenolysis and gluconeogenesis	Khan *et al*,1995
Boerhavia diffusa	Leaf	Increases plasma insulin levels and improves glucose tolerance, produced significant antioxidant activity	Satheesh *et al*, 2004

Cassia auriculata	Flower	Increased utilization of glucose through increased glycolysis	Abesundara *et al*,2004; Latha *et al*,2003
Caesalpinia bonducella	Seed	Increases the release of insulin from pancreatic cells	Sharma *et al*,1997
Catharanthus roseus	Leaf	Increases metabolism of glucose	Singh *et al*,2001
Cajanus cajan	Leaf and stem twigs	It lowers plasma glucose level	Esposito *et al*,1991
Citrullus colocynthis	Seed	The oral administration of plant extract reduced the plasma level of AST and LDH significantly.	Al-Ghaithi *et al*,1995
Coccinia indica	Leaves	Suppresses glucose synthesis, through depression of the key gluconeogenic enzymes glucose-6-phosphatase and fructose-1,6-bisphosphatase and enhances glucose oxidation by shunt pathway through activation of its principal enzyme glucose-6-phosphate dehydrogenase	Kamble *et al*,1994; Shibib *et al*,1993
Casearia esculenta	Root	Exhibits significant reduction in blood glucose level, a decrease in the activities of glucose-6-phosphatase and fructose-1,6-bishosphatase and an increase in the activity of liver hexokinase, resulting in potent hypoglycemic activity	Prakasam *et al*,2002
Camellia sinensis	Leaves	Epigallocatechin gallate, present in tea increases insulin activity and prevent oxidative damages, responsible for the hypoglycemic activity	Gomes *et al*,1994
Enicostemma littorale	Leaves	Decrease glycosylated Hb & glucose 6 phosphatase	Srinivasan *et al*,2005; Maroo *et al* 2002
Eugenia jambolana	Seed powder	It exhibits normoglycemia and better glucose tolerance.	Ravi *et a*l,2004
Eucalyptus globulus	Leaves	Increase insulin secretion from clonal pancreatic beta line (BRIN-BD 11)	Gray *et al*,1998
Ficus bengalensis	Bark	Inhibits insulin degradative processes	Kumar *et al*,1989

Gymnema sylvestre	Leaves	Lowers plasma glucose level	Ghalap *et al*,1998
Hibiscus rosa sinensis	Whole Plant Leaf and Flower	Stimulates insulin secretion from pancreatic beta cells and increases utilization of glucose, either by direct stimulation of glucose uptake.	Sachdewa *et al*, 2001b.
Mangifera indica L	Leaf	Possibly act through the intestinal reduction of glucose as well as pancreatic and extra pancreatic mechanism	Aderibigbe *et al*,1999
Morus indica L	Leaf	Acts by increasing glucose uptake	Andallu *et al*,2002
Murraya koeingii	Leaf	Increases glycogenesis and decreases glycogenolysis and gluconeogenesis	Khan *et al*,1995
Momordica charantia	Fruit	Reduce blood glucose level	Chen F *et al*,1995
Ocimum sanctum	Leaf	Its powdered leaf has produced potent hypoglycaemic and hypolipidemic effect in normal and diabetic rats	Vats *et al*,2004a
Salacia reticulata	Whole plant	Inhibits alpha-glucosidase activity	Jayawardena *et al*,2005
Swertia chirayita	Whole plant	Stimulates insulin release from islets of Langerhans by depleting aldehyde-fuchsin stained beta-granules and immunostained insulin	Saxena *et a*l,1993;Saxena *et al*,1991
Syzygium cumini	Seed	Decrease blood glucose level and also inhibit alpha glucosidase enzyme.	Pandey *et al*,2002
Scoparia dulcis	Leaves	Decrease glycosylated Hb & Inc. total Hb, Insulin-secretagogue activity	Pari *et al*,2002
Trigonella foenum graceum	Seed	Decrease blood glucose concentration	Ajabnoor *et al*,1998; Onal *et al*,2005
Vinca rosea	Whole plant	Alpha glucosidase inhibitors	Ghosh *et al*, 2001
Withania somnifera	Leaves	Beta cell rejuvenation, regeneration, stimulation	Andallu *et al*,2000
Zingiber officinale	Leaves	Decrease blood glucose level.	Akhani *et al*,2004

Major formulations used in Ayurveda are based on herbs used as decoctions, infusion, tinctures and powders. Drug formulation in Ayurveda (As mention in Ayurvedic treatise like Charaka Samhita, Sushruta Samhita) is based on two principles: (a). Use as single drug, and (b). Use of more than two drugs. When two or more herbs are used in formulation they are known as polyherbal formulation. Sometimes herbs are combined with mineral preparation.

The concept of polyherbalism is peculiar to Ayurveda although it is difficult to explain in term of modern parameter. Sarandghar Samhita highlights the concept of synergism behind polyherbal formulations. Ayurveda has fundamental aspects for drug formulation. The herbs are selected according to disease other herbs are used to prevent side effect arising from chief herb. It is evident that there are many herbal formulations of varying potency since these preparation act by different mechanism, it is theoretically possible that different combination of these extract will do better job in reducing blood glucose. In the traditional system of plant medicine it is usual to use plant formulation and combined extract of plant are used as a drug of choice rather than individual ones (Kumar, 2010)], to get the benefit of synergism and to find suitable antidiabetic and antioxid-ant combination therapy. Here we focuses on potential of different polyherbal formulation that have been confirmed by scientific investigation, which appear to be most effective relatively nontoxic and have substantial documentation of efficacy.

Dihar

A polyherbal formulation containing eight different herbs *Syzygium cumini, Momordica charantia, Emblica officinalis, Gymnema sylvestre, Enicostemm, Azadirachta indiaca, Tinospora cordifolia and Curcuma longa* (Patel *et al*2009). Literatures revealed that combination of these eight herbs shows effective Anti-hyperglycemic activity in Strptozotocin (STZ,45 mg/kg iv single dose) induced type 1 diabetic rats. Treatment with Dihar (100 mg/kg) for 6 weeks produced decrease in STZ induced serum glucose and lipid levels and increases insulin levels as compared to control. Dihar produced significant decrease in serum creatinine urea level and lipid peroxidation in diabetic rats. Administration of Dihar to diabetic rats significantly increased the activity of antioxidant enzyme (Patel *et al* 2009).

Diabet

A polyherbal formulation containing *Curcuma longa*, *Coscinium fenestratum*, *Strychnos potatorum*, *Phyllanthus reticulatus*. *Tamarindus indica*, *Tribulus terrestris* and containing marketed for diabetes was investigated for its glucose tolerance and antidiabetic activity in alloxan induced diabetic rats. The glucose tolerance test and hypoglycemic studies carried out in normal rats at a dose of 500mg/kg. The product showed its effectiveness at a dose of 500 mg/kg but does not hypoglycemic effect (Patel *et al*, 2009).

Diasol

A polyherbal antidiabetic formulation containing plant extracts of *Eugenia jambolana, Foenum graceum, Terminalia chebula, Quercus, infectoria, Cuminum cyminum, Taraxacum officinale, Emblica officinalis, Gymnea sylvestre, Phyllanthus nerui and Enicostemma littorale* (www.ssbherbs.com; Babuji.et al. 2010) Previous investigation showed Diasol prod-

uced 63.4 % reduction of blood glucose level in a dose of 125 and 250 mg/kg b.w i.p and proved to be effective antidiabetic polyherbal formulation(Babuji. *et al*2010).

Dianex

A polyherbal formulation was screened for antidiabetic activity in rats and it has been reported in literatures that Dianex produce significant hypoglycemic activity in both normal and diabetic mice. It was administered orally in different doses of 100, 250 and 500 mg/kg bw up to 6 weeks. Research concluded that the continuous administration of Dianex up to 6 weeks showed it to be effective in long term treatment (Mutalik. *et al*. 2010).

DRF/AY/5001

An indigenous polyherbal formulation (containing *Gymnema sylvestre, Syzygium cumini, Pterocarpus marsupium, Momordica charantia, Emblica officinalis, Terminalia* belirica, Terminalia chebula and Shudh shilajit) developed by Dabur Research foundation Gaziabad, elicit hypoglycemic/antidiabetic effect in both normal and experimentally induced hyperglycemic rats.DRF/AY/5001 inhibited significantly the hyperglycemia induced by epinephrine. It showed significant reduction in blood glucose level at 1-3 hr with single dose treatment in alloxan induced diabetes rats and 15 days treatment of rats with 600 mg/kg of Drf/ Ay/5001 was similar to that of Glibenclamide.DRF/AY/5001 gave nearly comaparable result with that of synthetic drug Glibenclamide (Mandlik *et al*, 2008).

Diashis

A study was conducted on polyherbal formulation composed of eight medicinal plants for the management of streptozotocin (STZ)-induced diabetes in rats. As oxidative stress is one of the consequences of diabetes,(Wright and Bacon ,2006) the activities of hepatic antioxidant enzymes and metabolic enzymes were evaluated. The study revealed that treatment with 'Diashis' in STZ-induced diabetic rats resulted in a significant recovery in the activities of hepatic hexokinase, glucose-6-phosphate dehydrogenase, and glucose-6-phosphatase along with correction in the levels of fasting blood glucose, glycated hemoglobin, and liver and skeletal muscle glycogen. The oxidative stress status in the liver was corrected by 'Diashis' which was highlighted by the recovery in the activities of catalase, peroxidase, and glutathione-S-transferase along with the correction in the quantity of thiobarbituric acid-reactive substances and conjugated diene. 'Diashis' was not found to have any metabolic toxicity (Bera *et al*, 2010).

Diabrid

A herbal based antidiabetic formulation for maturity onset diabetic patients was clinically evaluated in 60 diabetic patients for six months. The clinical studies revealed that Diabrid was well tolerated in high doses and was found to be a potential antidiabetic drug in mild and moderate diabetic cases (180-280 mg/dl). The blood sugar level was controlled within 2-8 week depending upon initial blood sugar level. No side effect was observed. The hypoglycemic activity was dose dependent and gradual. The drug also maintained the body weight and blood pressure of diabetic patients. No deleterious effect was observed on kidney and liver (Quadri *et al*, 2006).

Diakyur

A ployherbal formulation (composed of *Cassia javanica,Cassia auriculata, Salacia reticulate, Gymnema sylvestre, Mucuna pruriens, Syzygium jambolaum,Terminalia arjuna*), scientifically proved to be a potential antidiabetic formulation in previous studies. Report indicated that Diakyur has shown significant hypoglycemic activity as well as antilipid peroxidative activity so that it can be used as an adjuvant along with allopathic treatment of medicine to treat diabetes as well as to delay the late complications of diabetes (Joshi *et al*, 2007).Literature studies concluded that Diakyur at a dose of 1600 mg/kg p.o is safe for long term treatment in diabetic condition (Chandra *et al* 2007).

Diasulin

A polyherbal formulation containing *Cassia auriculata, Coccinia indica, Curcuma longa, Emblica officinalis, Gymnema sylvestre, Momordica charantia, Scoparia dulcis, Syzygium cumini, Tinospora cordifolia, Trigonella foenum graecum* Previous Investigation suggest that controls the blood glucose level by increasing glycolysis and decreasing gluconeogenesis with a lower demand of pancreatic insulin than in untreated rats. This is possible, because it regulates the activities of hepatic glucose metabolic enzymes (Pari and Saravanan, 2004). Diasulin also resulted in significant decrease in tissue lipids and lipid peroxide formation (Ramalingam and Pari, 2005).

Diabecon

A polyherbal formulation containing *Gymnema sylvestre, Pterocarpus marsupium, Glycyrrhiza glabra, Casearia esculenta, Syzygium cumini, Asparagus racemosus, Boerhavia diffusa, Sphaeranthus indicus, Tinospora cordifolia, Swertia chirata, Tribulus terrestris, Phyllanthus amarus, Gmelina arborea, Gossypium herbaceum, Berberis aristata, Aloe vera,* Triphala, *Commiphora wightii*, shilajeet, *Momordica charantia, Piper nigrum, Ocimum sanctum, Abutilon indicum, Curcuma longa, Rumex maritimus* is reported to increase peripheral utilization of glucose, increase hepatic and muscle glucagon contents, promote B cells repair and regeneration and increase c peptide level. It has antioxidant properties and protects B cells from oxidative stress. It exerts insulin like action by reducing the glycated haemoglobin levels, normalizing the microalbuminurea and modulating the lipid profile. It minimizes long term diabetic complications (www.himalayahealthcare.com,. www.diabecon.com),.Previous Studies also revealed that Diabecon is a safe drug to prevent complications such as retinopathy in diabetic patients. Diabecon resolved retinal and vitreal haemorrhages and its subsequent prevention. It also enhanced the absorption of hard and soft exudates by anti-inflammatory properties Studies concluded that Diabecon can be used as an adjuvant with conventional treatment in NIDDM and IDDM patients.

Dia-Care:

A herbal formulation containing Sanjeevan Mool; Himej, Jambu beej, Kadu, Namejav, Neem chal is claimed to be effective for both Type 1, Type 2 diabetes within 90 days of treatment and cures within 18 months. Persons taking insulin will eventually be liberated from the dependence on it. The whole treatment completes in 6 phases, each phase

being of 90 days. Approx. 5 grams (1 tea spoon) powder is mixed with 1/2 glass of water, stirred properly, kept overnight and filtered. The filtrate is taken in the morning on empty stomach. To the remaining medicine fresh water is added and kept for the whole day and is consumed half an hour before dinner. The taste of the drug is very bitter. It is a pure herbal formula without any side effects (Kant *et a*l.2002).

Diabetes-Daily Care

Diabetes-Daily Care containing Alpha Lipoic Acid, Cinnamon 4% Extract, Chromax, Vanadium, Fenugreek 50% extract, *Gymnema sylvestre* 25% extract, Momordica 7% extract, Licorice Root 20% extract is a Unique, Natural Formula, which effectively and safely Improves Sugar Metabolism (Modak et al ,2007; www.yourhealthsupply.com/diabetes-daily-care.com/medbroadcast.com/sanofi-aventisca.com).

Diabecure

A formulation containing *Juglans regia, Berberis vulgaris, Erytherea centaurium*, Millefolium, Taraxacum effective in lowering the blood sugar level (Modak *et al,* 2007).

Diabeta

A formulation containing *Gymnema sylvestre, Vinca rosea* (Periwinkle), *Curcuma longa* (Turmeric), *Azadirachta indica* (Neem), *Pterocarpus marsupium* (Kino Tree), *Momordica chara*ntia (Bitter Gourd), *Syzygiumcumini* (Black Plum), *Acacia arabica* (Black Babhul), *Tinospora cordifolia , Zingiber officinale* (Ginger) available in the capsule form is an anti-diabetic with combination of proven anti-diabetic fortified with potent immunomodulators, antihyperlipidemics, anti-stress and hepatoprotective of plant origin. The formulation of Diabeta is based on ancient ayurvedic references, further corroborated through modern research and clinical trials. Diabeta acts on different sites in differing ways to effectively control factors and pathways leading to diabetes mellitus. It attacks the various factors, which precipitate the diabetic condition, and corrects the degenerative complications, which result because of diabetes. Diabeta is safe and effective in managing Diabetes Mellitus as a single agent supplement to synthetic anti-diabetic drugs. Diabeta helps overcome resistance to oral hypoglycemic drugs when used as adjuvant to cases of uncontrolled diabetes. Diabeta confers a sense of well-being in patients and promotes symptomatic relief of complaints like weakness giddiness, pain in legs, body ache, polyuria and pruritis (Modak et al ,2007;. www.diabetes-daily-care.com/medbroadcast.com).

ESF/AY/500

A polyherbal formulation intended to be used for diabetic patients has been screened for antioxidant activity and composed of eight medicinal plants, namely *Aerva lanata, Aegle marmelos, Ficus benghalensis, Catharanthus roseus, Bambusa arundinaceae, Salacia reticulata and Szygium cumini* and '*Eruca sativa'* the ethanolic extract of ESF/AY/500 exhibited significant antioxidant activity showing increased levels of superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GPx), and reduced glutathione(GSH) and decreased level of lipid peroxidation (Sajeeth *et al* ,2010).

EFPTT/09

A polyherbal formulation containing five ingredients of herbal origin that is used in medicine to treat diabetes. Literature revealed that EFPTT/09 elicits hypoglycemic and antidiabetic effect in both normal and alloxan induced diabetes rats. It also elicited a significant antioxidant effect in diabetic rats by its ability to inhibit lipid peroxiodation and elevate the enzymatic antioxidant in pancreatic tissue.It has been found that at a dose of 600 mg/kg the hypoglycemic effect of EFPTT/09 nearly comparable to that of glibenclamide (5 mg/kg.). (Yoganandam and Bimlendu, 2010).

5EPHF

Lanjhiyana et al developed new polyherbal formulation (5EPHF) consisting of five medicinal plant extracts viz., *Aegle marmelos, Murraya koenigii, Aloe vera, Pongamia pinnata and Elaeodendron glaucum*. Research showed that treatment with 5EPHF at dose 200 mg/kg to diabetic rats resulted in significant reduction of serum glucose, glycosylated haemoglobin, total cholesterol, triglyceride, low density lipoprotein, creatinine and urea whereas significant increased level of insulin and high density lipoprotein was observed. The formulation treatment significantly inhibited lipid peroxidation and elevates the level of antioxidant enzymes in alloxanized rats (.Lanjhiyana *et al* 2007).

Glyoherb

A polyherbal formulation was evaluated for its antihyperglycemic, antihyperlipidemic and antioxidant effects against normal and streptozotocin-induced diabetic rats. 'Glyoherb' sugar control granules possess potential antidiabetic activity as it lowers serum glucose levels and increases glucose tolerance in STZ-induced type 1 diabetic rats. This polyherbal formulation also possess significant antihyperlipidemic activity as it lowers serum cholesterol and triglyceride levels. 'Glyoherb' did not exert any toxic effects in STZ-induced impaired kidney and liver functions. It was rather found to be improving kidney and liver functions. In addition, 'Glyoherb' possesses potential antioxidant activity as it decreases lipid peroxidation and enhances antioxidant status in diabetic rats. The antidiabetic activity of 'Glyoherb' may be attributed to its antioxidant properties also. Thus previous research concluded that 'Glyoherb' may be regarded as a promising natural and safe remedy for the prevention or delay of diabetic complications (Thakkar and Patel, 2007).

Karmin Plus

An indeginous polyherbal formulation containing *Momordica charantia, Azadirachta indica, Picrorrhiza kurroa, Ocimum sanctum and Zinziber officinale* was evaluated for antidiabetic activity by Banger et al and it was found that product showed effectiveness at two dose levels at 200 mg/kg and 400 mg/kg b.w for antidiabetic activity(Om Prakash *et al* 2009).

Okudiabet

Studies on formulation containing *stachytarpheta angustifolia, Alstonia congensis bark* and *Xylopia acthiopica* fruits extract showed that polyherbal formulation was effective in decreasing plasma glucose levels in the diabetic rats and proved to have a better plasma

glucose lowering effect that glibenclamide and also having good reducing effect on Cardiovascular system.The high LD 50 value (16.5g/kg) indicates that formulation could be safe for use (Ogbonnia *et al*, 2010).

SMK001

Literatures revealed that SMK001 is a potential antidiabetic polyherbal formulation. Kim Jong Dae et al investigated the therapeutic anti-diabetic effect of SMK001, a poly herbal formula was was evaluated in the streptozotocin (STZ; 60 mg/kg, single intraperitoneal injection) induced diabetic rats. Result showed that SMK001 significantly reduces the blood and urine glucose level and it shows more favouable effect at a dose of 100mg/kg compared to that of Glibenclamide 5mg/kg (Kim Jong Dae et al, 2006).

PM021:

Herbal formula consists of two herbal components, Mori Folium and Aurantii Fructus, is routinely used to treat diabetes in Korea. Jong Hoon Kim investigated the antidiabetic effect of PM021 on the type II diabetic Otsuka Long–Evans Tokushima Fatty (OLETF) rats. The results showed that PM021 significantly prevented increases in body weight, blood glucose, and urine and food intake that resulted from the induction of obesity and diabetes. PM021 also improved glucose tolerance in OLETO rats. However, PM021 had no effect on LETO rats, a control group of OLETF rats. Taken together, these findings indicate that PM021 has distinct anti-diabetic effects without any adverse effects or toxicities (Jong-Hoon Kim,).

An indigenous herbal formulation containing Methi, Black sesame seed, Katha safeed, Neem leaves, Karela were evaluated for hypoglycemic activity on adult wistar albino rats using normo glycemic, glucose loaded and alloxan induced hyperglycemic rats. Research proved that this formulation showed promising results that is comparable to that of reference standard glibemclamide. However the exact biological active constituent responsible for hypoglycemic effect has not been reported (Khan *et al*, 2011).

In the recent years there is a great interest towards Ayurvedic forms of medication not only for diabetes but also for other disease like arthritis and cancer as the danger and shortcoming of modern medicine have started getting more apparent, majority of Ayurvedic formulation are prepared from herb and many herbal formulation are in market and are immensely used by diabetic patients on the advice of physicians.

Conclusion

The above-mentioned formulations have been considered for their possible hypoglycaemic actions and the researchers have carried out some preliminary investigations. Scientific validation of several Indian plant species has proved the efficacy of the botanicals in reduceng the sugar level Thus many different plants have been used individually or in formulations for treatment of diabetes and its complications. One of the major problems with this herbal formulation is that the active ingredients are not well defined. It is important to know the active component and their molecular interaction, which will help to analyze therapeutic

efficacy of the product and also to standardize the product. Efforts are now being made to investigate mechanism of action of some of these plants using model systems.

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