World Journal of Translational Medicine

Online Submissions: http://www.wjgnet.com/esps/
bpgoffice@wjgnet.com
doi:10.5528/wjtm.v2.i3.74

World J Transl Med 2013 December 12; 2(3): 74-81
ISSN 2220-6132 (online)

BRIEF ARTICLE

"Diabegon", a safe and effective polyherbal therapy for type 2 diabetes mellitus

Sunil Mahajan, Nita Singh, Senthil K Subramanian, Pratibha Chauhan, Sonali Saxena, HM Goswamy, GBKS Prasad, Prakash S Bisen

Sunil Mahajan, Nita Singh, Senthil K Subramanian, Pratibha Chauhan, Sonali Saxena, HM Goswamy, GBKS Prasad, School of Studies in Biochemistry, Jiwaji University, Gwalior 474011, India
Prakash S Bisen, School of Studies in Biotechnology, Jiwaji University, Gwalior 474011, India
Author contributions: Mahajan S, Singh N and Chauhan P were involved in the experimental work; Subramanian SK and Saxena S were associated with the registration, follow up and collection of blood specimens, *etc.*; Goswamy HM contributed to supervision of the drugs administered; Prasad GBKS and Bisen PS were associated with the study design, execution and manuscript preparation.
Supported by AYUSH, New Delhi, India, No. F.NO. Z.31014/02/2009/EMR-CCARS; and M/S Deendayal Aushadhi Pvt. Ltd. Gwalior, India
Correspondence to: Prakash S Bisen, Professor, School of Studies in Biotechnology, Jiwaji University, Mahalgaon, Gwalior 474 011, India. psbisen@gmail.com
Telephone: +91-751-2462500 Fax: +91-751-4043850
Received: August 25, 2013 Revised: October 21, 2013
Accepted: November 20, 2013
Published online: December 12, 2013

Abstract

AIM: To investigate the antihyperglycemic, antihyperlipidemic and antioxidant functions of a polyherbal formulation, "Diabegon", in human subjects with type 2 diabetes mellitus.

METHODS: A total of 33 human subjects with type 2 diabetes mellitus were recruited for the study and all anthropological and biochemical parameters were recorded at the time of registration. The subjects were given hot water extract obtained from 10 gm of "Diabegon" powder, "Diabegon kwath", on an empty stomach everyday in the morning under personal supervision for 6 mo. The therapeutic functions of the "Diabegon kwath" was assessed by monitoring the blood glucose levels at monthly intervals and glycosylated hemoglobin, lipid profile and biomarkers of oxidative stress, liver and kidney function markers at three monthly intervals in the study subjects.

RESULTS: Daily administration of hot water extract of "Diabegon" regularly for 6 mo resulted in significant reductions of blood glucose and glycosylated hemoglobin levels. There was also a significant increase in high density lipoprotein cholesterol levels with concomitant decreases in total cholesterol, triglycerides, low density lipoprotein cholesterol and very low density lipoprotein. A significant improvement in glycosuria and proteinuria was also observed. Also, the subjects exhibited a significant improvement in enzymatic and nonenzymatic biochemical markers of oxidative stress. The kidney and liver functions remained normal and in fact improved in many subjects.

CONCLUSION: The study which is first of its kind, advocates "Diabegon kwath" as a safe and effective Ayurvedic therapy for the treatment of human type 2 diabetes mellitus and further placebo controlled trial may substantiate the therapeutic efficacy of the formulation.

Key words: Type 2 diabetes mellitus; Diabegon kwath; Polyherbal formulation; Oxidative stress; Blood glucose; Lipids; Antiglycemic; Antihyperlipidemic; Antioxidant; antidiabetic therapies

Core tip: The study evaluated antiglycemic, antihyperlipidemic and antioxidant functions of a polyherbal formulation designated "Diabegon kwath" in type 2 diabetic subjects with varying degrees of hyperglycemia and found that the formulation serves as an effective alternative to conventional antidiabetic therapies.

Mahajan S, Singh N, Subramanian SK, Chauhan P, Saxena S, Goswamy HM, Prasad GBKS, Bisen PS. "Diabegon", a safe and effective polyherbal therapy for type 2 diabetes mellitus. *World J Transl Med* 2013; 2(3): 74-81 Available from: URL: http://www.wjgnet.com/2220-6132/full/v2/i3/74.htm DOI: http://dx.doi.org/10.5528/wjtm.v2.i3.74

INTRODUCTION

Type 2 diabetes mellitus is one of the most common global metabolic disorders and is characterized by abnormalities of carbohydrate and lipid metabolisms, mainly resulting either from defects in insulin secretion and/or insulin action, or adipocyte functioning[1]. Although the disease manifests in the form of hyperglycemia, the cause can vary, ranging from disturbance in insulin secretion, insulin action, insulin resistance, glucose production and glucose uptake, interplay among different metabolic pathways, hormones, *etc.* Type Ⅱ diabetic patients often exhibit increased low density lipoprotein (LDL) and decreased high density lipoprotein (HDL) cholesterol levels and hypertension, as well as altered platelet function[2]. Due to such varied etiology, not a single agent or molecule has so far been unequivocally accepted as the antidiabetic drug. There is a broad range of glucose and lipid-lowering (metformin, sulfonylureas, insulin, statins) drugs which although are successful to some extent, careful consideration must be given when selecting the appropriate glucose and lipid-lowering therapy. The conventional antidiabetic therapies are reported to be associated with many side effects, such as hypoglycemia, lactic acid intoxication and gastrointestinal upset[3], in diabetic subjects. Statins are very widely used during dyslipidemia and there are reports in experimental models that statin therapy may exhibit an adverse effect on glucose homeostasis[4].

Indigenous systems of medicine based on traditional wisdom have thrived through the ages and are practiced by a large population all over the globe for the management of diabetes. A large number of plants have proved their efficacy in the management of hyperglycemia, hyperlipidemia, oxidative stress and the inflammatory response[5-7]. Scientific validation of many of the plant-based antidiabetic medicines has been done[8-10] and the bioactive principles identified and characterized[11,12]. The antihyperglycemic effect of several plant extracts and herbal formulations that are used as antidiabetic remedies has been confirmed[13,14]. Plant drugs are frequently considered to be less toxic and free from side effects than synthetic ones[15]. Combined extracts of herbs are used as the drug of choice rather than individual plant extracts. Herbal formulations[16] were shown to exhibit antidiabetic, antioxidant effects in animal models as well as in diabetic subjects[17,18]. The phytochemical based formulations consist of multiple herbs and are therefore liable to produce a large number of metabolites that may act on multiple targets in the body. Although the phytochemical formulations have been widely used for many years, systematic scientific evidence and proof of efficacy are generally lacking compared with synthesized chemical medicines. Diabegon powder, a plant based formulation consisting of a mixture of about 10 herbs, *Gymnema sylvestre* (*Gurmar*), *Eugenia jambolana* (*Jamun seed*), *Emblica officianale* (*Amla*), *Curcuma longa* (*Haldi*), *Pterocarpus marsupium* (*Vijaysaar*), *Terminalia chebula* (*Harad*), *Cassia fistula* (*Amaltas*), *Picrorhiza kurroa* (*Kutki*), *Swertia charita* (*Chiraita*) and *Terminalia Bellerica* (*Behada*), was validated in this study for its therapeutic potential in human type Ⅱ diabetes mellitus.

MATERIALS AND METHODS

Subjects

A total of 33 type Ⅱ diabetic subjects attending a weekend diabetes clinic run by the School of Studies in Biochemistry, Jiwaji University, India were randomly selected for the study after giving informed written consent. The following criteria were employed for selecting the subjects for the study.

Inclusion criteria

1. Non-insulin dependent diabetics diagnosed as per the criteria of World Health Organization;
2. Both genders between the ages of 30-65 years;
3. Body Mass Index range between 18.5 and 30;
4. Participants who understood the benefits of the study and signed a written informed consent.

Exclusion criteria

1. Presently using other blood glucose level controlling agents;
2. Daily intake of alcoholic beverages;
3. Smokers consuming more than 1 pack/d;
4. Patients diagnosed as type Ⅰ and type Ⅱ diabetes mellitus (insulin requiring stage);
5. Patients with ketosis, diabetes related complications, hepatic or renal disease, pancreatitis, cardiac problems, uncontrolled hypertension, malnutrition and severe immune deficiency.

The subjects had the objectives, nature of drugs, rationale and duration of therapy to be administered explained to them in the local language. They were asked to avoid a carbohydrate rich diet and regular walking for about 4-5 km during the course of therapy was advocated. Anthropometric measurements like weight, height and waist were recorded at monthly intervals. The patients were kept exclusively on "Diabegon therapy" and did not take any other kind of oral antihyperglycemic or lipid lowering drugs during the study period.

Drug, doses and duration

The drug administered is purely a polyherbal formulation consisting of *Gymnema sylvestre* (*Gurmar*), *Eugenia jambolana* (*Jamun seed*), *Emblica officianale* (*Amla*), *Curcuma longa* (*Haldi*), *Pterocarpus marsupium* (*Vijaysaar*), *Terminalia chebula* (*Harad*), *Cassia fistula* (*Amaltas*), *Picrorhiza kurroa* (*Kutki*), *Swertia charita* (*Chiraita*) and *Terminalia bellerica* (*Behada*)

Table 1 Effect of 6 mo polyherbal therapy on hyperglycemia

Biochemical parameter	Variations at 3 monthly intervals following polyherbal therapy			
	0 d	3 mo	6 mo	Mean change
Fasting plasma glucose (mg/dL)	159.54 ± 7.74	130.08 ± 6.58[b]	131.02 ± 3.63[b]	(↓ 17.8%)
Postprandial glucose (mg/dL)	248.30 ± 11.82	196.48 ± 11.23[b]	183.54 ± 10.54[b]	(↓ 26.0%)
HbA1c (%)	7.22 ± 0.14	6.65 ± 0.14[b]	6.41 ± 0.11[b]	(↓ 11.2%)

Data are expressed as mean ± SEM; [b]$P < 0.001$ compared to 0[th] d levels.

Table 2 Effect of 6 mo polyherbal therapy on lipidemia

Biochemical parameter	Variations at 3 monthly intervals following polyherbal therapy			
	0 d	3 mo	6 mo	Mean change
Total cholestero (mg/dL)	162.08 ± 6.00	144.84 ± 5.20[b]	146.8 ± 4.70[a]	(↓ 9.4%)
Triglyceride (mg/dL)	140.81 ± 6.88	126.74 ± 6.88	122.3 ± 4.50[a]	(↓ 13.1%)
HDL cholesterol (mg/dL)	34.38 ± 1.37	35.28 ± 1.04	37.9 ± 1.20[a]	(↑ 9.8%)
LDL cholesterol	99.33 ± 5.61	84.21 ± 5.21[b]	81.98 ± 4.84[a]	(↓ 17.4%)
VLDL (mg/dL)	28.16 ± 1.37	25.35 ± 1.37	23.71 ± 1.13[a]	(↓ 15.8%)

Data are expressed as mean ± SEM; [a]$P < 0.05$, [b]$P < 0.001$ compared to 0[th] d levels. HDL: High density lipoprotein; LDL: Low density lipoprotein; VLDL: Very low density lipoprotein.

and was provided by M/S Deendayal Aushadhi Pvt. Ltd., India. Each subject had 50 mL of fresh hot water extract derived from 10 gm of "Diabegon" powder soaked overnight in water administered daily on an empty stomach and therapy continued for six months without any break under the supervision of an Ayurvedic physician. The study design was approved by the Institutional Human Ethics Committee of Jiwaji University.

Biochemical parameters

The fasting and postprandial plasma glucose measurements were determined at monthly intervals, while the glycosylated hemoglobin, antioxidant parameters such as super oxide dismutase, catalase, glutathione (GSH), Thiobarbituric Acid Reactive Substances (TBARS) and lipid profile, functional markers of kidney and liver function were monitored at baseline, at the middle (3 mo) and at the end (6 mo) of the therapy.

Fasting and postprandial plasma glucose was estimated by the Glucose oxidase/Peroxidase method[19]. Glycosylated hemoglobin (HbA1c) was estimated by the ion exchange resin method[20]. Estimation of plasma total cholesterol by the Cholesterol oxidase - Phenol-aminophenazone (CHOD-PAP) method[21], triglyceride by the GPO-PAP method[22], HDL by the Polyethylene glycol/ Cholesterol oxidase-Phenol-aminophenazone Polyethylene glycol/CHOD-PAP method[23], LDL and VLDL were calculated by the Friedewald formula, urea by the modified Berthelot method[24], uric acid by the uricase/PAP method[25], creatinine by modified Jaffe's kinetic method[26], serum glutamate pyruvate transaminase (SGPT or alanine transaminase) and serum glutamate oxaloacetate transaminase (SGOT or AST) by the modified International Federation of Clinical Chemistry method[27] and bilirubin[28] was assayed using standard kits from Crest Biosystems, Goa (India). Superoxide dismutase and catalase activities were assayed by Winterbourn *et al*[29] and by Sinha *et al*[30] respectively. Estimation of reduced GSH and TBARS was done by the method of Ellman[31] and Ohkawa *et al*[32] respectively, and protein was estimated by the method of Lowry *et al*[33], estimation of urinary sugar by Benedict's method[34] and urinary protein by the sulfosalicylic method[35].

Ethical clearance

The study protocol was duly approved by the Institutional Human Ethics Committee (JU/IHEC/2013-A/10).

Statistical analysis

Statistical analysis was done by a paired *t* test (Sigma stat 3.5).

RESULTS

Effect of polyherbal therapy on blood glucose levels

Table 1 shows the fasting and postprandial blood glucose levels at 3 monthly intervals following polyherbal therapy. A significant decrease ($P < 0.001$) was recorded in both fasting and postprandial glucose levels (17.8% and 26% respectively) and glycosylated hemoglobin (11.2%) at the end of six months therapy.

Effect of polyherbal therapy on lipidemia

Table 2 shows the results of the lipid profile. Total cholesterol, triglycerides, LDL and VLDL significantly decreased by 9.4%, 13.1%, 17.4%, 15.8% respectively ($P < 0.05$). HDL cholesterol significantly increased from 34.38 ± 1.37 to 37.78 ± 1.26 ($P < 0.05$) at the end of the therapy.

Effect of polyherbal therapy on biomarkers of oxidative stress

Significant ($P < 0.05$), improvements in GSH level (from 2.29 ± 0.26 to 3.03 ± 0.12 mg/dL), SOD activity (from 0.47 ± 0.07 to 0.74 ± 0.04 μmol/L min^{-1} per mg protein), catalase activity (from 4.19 ± 0.37 to 6.07 ± 0.23 μmol/L min^{-1} per milligram protein) and levels of TBARS (from 486.62 ± 29.82 to 442.26 ± 21.44 (moles of Malondialdehyde/mL of blood) were recorded at the end of polyherbal therapy (Table 3).

Effect of polyherbal therapy on biomarkers of toxicity

The effect of polyherbal therapy on kidney function was monitored by estimating urea, creatinine and uric acid levels in plasma at various intervals during the course of therapy. The data presented in Table 4 showed significant reductions in uric acid (from 5.35 ± 0.21 to 4.80 ± 0.97 mg/dL) and creatinine (from 0.78 ± 0.04 to 0.60 ± 0.02 mg/dL) and there was no significant change in the level

Table 3 Effect of 6 mo polyherbal therapy on biomarkers of oxidative stress

Biochemical parameter	Variations at 3 monthly intervals following polyherbal therapy			
	0 d	3 mo	6 mo	Mean change
GSH (mg/mL)	2.29 ± 0.26	2.74 ± 0.14	3.03 ± 0.12[a]	(↑ 32.3%)
SOD (μmol/L·min^{-1} per milligram protein)	0.47 ± 0.07	0.58 ± 0.03	0.74 ± 0.04[a]	(↑ 57.4%)
Catalase (μmol/L·min^{-1} per milligram protein)	4.19 ± 0.37	4.70 ± 0.27	6.07 ± 0.23[b]	(↑ 44.8%)
TBARS (*n* moles of MDA/mL of blood)	486.62 ± 29.82	455.11 ± 21.81[a]	442.26 ± 21.44[a]	(↓ 9.1%)

Data are expressed as mean ± SEM; [a]$P < 0.05$ compared to 0[th] d levels. GSH: Glutathione; SOD: Superoxide dismutase; TBARS: Thiobarbituric acid reactive substances; MDA: Malondialdehyde.

Table 4 Effect of 6 mo polyherbal therapy on biochemical markers of kidney function

Biochemical parameter	Variations at 3 monthly intervals following polyherbal therapy			
	0 d	3 mo	6 mo	Mean change
Urea (mg/dL)	26.31 ± 0.97	26.45 ± 0.90	25.48 ± 0.87	(↓ 3.1%)
Uric acid (mg/dL)	5.35 ± 0.21	5.36 ± 0.16	4.80 ± 0.97[a]	(↓ 10.2%)
Creatinine (mg/dL)	0.78 ± 0.04	0.76 ± 0.02	0.60 ± 0.02[b]	(↓ 23.0%)

Data are expressed as mean ± SEM; [a]$P < 0.05$, [b]$P < 0.001$ compared to 0[th] d levels.

of urea.

Significant variations in enzyme markers of liver, namely SGOT (from 24.00 ± 3.04 to 21.49 ± 1.67 IU/L) and SGPT (from 25.33 ± 3.27 to 21.83 ± 64 IU/L), were recorded (Table 5). There was no change in the level of bilirubin.

Effect of polyherbal therapy on hypertension and body mass index

Table 6 shows variations in systolic blood pressure (130.40 ± 2.27 to 126.12 to 2.41 mmHg), diastolic blood pressure (81.06 ± 1.14 to 77.90 ± 1.35 mmHg) and body mass index (from 25.75 ± 0.57 to 24.85 ± 0.50 kg/m^2).

Effect of polyherbal therapy on glycosuria and proteinuria

There were significant reductions in urinary sugar (64%) and urinary protein levels (60%) (Table 7) following polyherbal therapy.

DISCUSSION

The majority of the formulations used in Ayurveda are based on herbs and used as decoctions, infusion, tinctures and powders. The decoction of polyherbal formulation used in the present study (named "Diabegon kwath" in Ayurvedic terminology) contained hot water extract of powdered plant parts of *Gymnema sylvestre* (*Gurmar*), *Eugenia jambolana* (*Jamun seed*), *Emblica officianale* (*Amla*), *Curcuma longa* (*Haldi*), *Pterocarpus marsupium* (*Vijaysaar*), *Terminalia chebula* (*Harad*) *Cassia fistula* (*Amaltas*), *Picrorhiza kurroa* (*Kutki*), *Swertia charita* (*Chiraita*) and *Terminalia bellerica* (*Behada*) in varying amounts. Administration of "Diabegon kwath" over a period of 6 months to type Ⅱ diabetic subjects with varying degrees of hyperglycemia and hyperlipidemia resulted in significant alleviation of these metabolic abnormalities. Marked improvements in glucose homeostasis, as evident from significant changes in glycosylated hemoglobin and blood glucose levels, and lipid profile, as evident from elevations in HDL choles-

Table 5 Effect of 6 mo polyherbal therapy on biochemical markers of liver function

Biochemical parameter	Variations at 3 monthly intervals following polyherbal therapy			
	0 d	3 mo	6 mo	Mean change
Total bilirubin (mg/dL)	0.98 ± 0.05	0.91 ± 0.06	0.97 ± 0.04	(↓ 1.0%)
SGOT (IU/L)	24.00 ± 3.04	21.70 ± 2.04[a]	21.49 ± 1.67[a]	(↓ 10.4%)
SGPT (IU/L)	25.33 ± 3.27	22.70 ± 2.24[a]	21.83 ± 1.64[a]	(↓ 13.8%)

Data are expressed as mean ± SEM; [a]$P < 0.05$ compared to 0[th] d levels. SGOT: Serum glutamate oxaloacetate transaminase; SGPT: serum glutamate pyruvate transaminase.

Table 6 Effect of 6 mo polyherbal therapy on blood pressure and anthropometry

	Variations at 3 monthly intervals following polyherbal therapy			
	0 d	3 mo	6 mo	Mean change
Systolic blood pressure (mmHg)	130.40 ± 2.27	125.15 ± 2.09[a]	126.12 ± 2.41[a]	(↓ 3.2%)
Diastolic blood pressure (mmHg)	81.06 ± 1.14	78.97 ± 1.23	77.90 ± 1.35	(↓ 3.8%)
Body mass index (kg/m^2)	25.75 ± 0.57	25.19 ± 0.56[b]	24.85 ± 0.50[b]	(↓ 3.4%)

Data are expressed as mean ± SEM; [a]$P < 0.05$, [b]$P < 0.001$ compared to 0[th] d levels.

Table 7 Effect of 6 mo polyherbal therapy on glycosuria and proteinuria

Parameter	Variations at 3 monthly intervals following polyherbal therapy			
	0 d	3 mo	6 mo	Mean change
Urinary sugar (gm/dL)	0.74 ± 0.10	0.34 ± 0.06[b]	0.27 ± 0.06[b]	(↓ 63.5%)
Urinary protein (mg/dL)	63.33 ± 16.68	43.63 ± 15.15	25.45 ± 6.50[a]	(↓ 59.8%)

Data are expressed as mean ± SEM; [a]$P < 0.05$, [b]$P < 0.001$ compared to 0[th] d levels.

terol with concomitant decreases in other lipids, were observed. One of the major ingredients of the polyherbal preparation studied is *Gynmnema Sylvestre* which is reported to promote insulin secretion, probably by regeneration of pancreatic beta cells[36]. *In vitro* trials on experimental models with *Gynmnema Sylvestre* have proved that this herbal drug increases insulin release by increasing the cell permeability[37]. The *G. sylvestre* is reported to inhibit absorption of glucose from intestine. The leaves of *G. sylvestre* contain gymnemic acid and the atomic arrangement of gymnemic acid molecules is similar to that of glucose molecules. Gymnemic acid molecules fill the receptor location in the absorptive external layers of the intestine, thereby preventing the sugar molecules absorption by the intestine, which ultimately results in low blood sugar level[38]. *Pterocarpus marsupium* is effective in reducing levels of blood glucose and glycosylated hemoglobin in type 2 diabetic patients[39]. Alcoholic extract of *Picrorrhiza kurroa* (75 mg extract/kg) reduced serum glucose that was at a maximum 2 h after the dose. It also showed an antihyperglycemic effect in alloxanized diabetic rats. Serum glucose decreased by 43% and 60% with 75 and 150 mg/kg of the extracts, respectively. Antioxidant activity is also described in the literature[40]. Hexane fraction of *Swertia chirayita* at 250 mg/kg, *po* to normal rats significantly reduced blood sugar and increased plasma insulin without influencing hepatic glycogen content. However, when administered for 28 d, it significantly increased hepatic glycogen content in conjunction with other effects, probably by releasing insulin[41]. Decoction of stem bark of *Cassia fistula Linn.* improved glucose tolerance, significantly inhibited the glucose absorption from the small intestine and provoked glycogen accumulation in liver and skeletal muscle[42,43]. *Terminalia chebula* exhibited *in vitro* antioxidant and free radical-scavenging activities[44]. The antihyperglycemic effect of *T. chebula* is due to its ability to restore the functions of pancreatic tissues by causing an increase in insulin output, inhibiting the intestinal absorption of glucose or facilitating the metabolites in insulin dependent processes. In India, decoction of kernels of *Eugenia jambolana* is used as household remedy for diabetes. The antihyperglycemic effect of aqueous and alcoholic extract as well as lyophilized powder showed a reduction in blood glucose level[45]. Hence, treatment with herbal drugs has an effect on protecting β-cells and smoothing out fluctuation in glucose levels[46,47].

Studies were conducted earlier with polyherbal formulations with varying contents and compositions for their antihyperglycemic potential. A polyherbal formulation, Dihar[18], containing eight different herbs, *Syzygium cumini*, *Momordica charantia, Emblica officinalis*, *Gymnema sylvestre*, *Enicostemm*, *Azadirachta indiaca*, *Tinospora cordifolia and Curcuma longa*[18], showed effective antihyperglycemic activity in streptozotocin (STZ, 45 mg/kg *iv* single dose) induced diabetes in rats. A polyherbal formulation, termed DRF/AY/5001, containing *Gymnema sylvestre*, *Syzygium cumini*, *Pterocarpus marsupium*, *Momordica charantia*, *Emblica officinalis*, *Terminalia belirica*, *Terminalia chebula* and *Shudh shilajit*, showed an antihyperglycemic effect similar to Glibanclamide[48]. Similarly, a polyherbal formulation, namely "Diabecon", 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* and *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 exhibited antioxidant properties and protected β-cells from oxidative stress. "Glyoherb" granules were shown to possess potential antidiabetic activity, lowered serum glucose levels and increased glucose tolerance in STZ-induced type 1 diabetic rats. This polyherbal formulation also possesses significant antihyperlipidemic activity as it lowered serum cholesterol and triglyceride levels. "Glyoherb" did not exert any toxic effects in STZ-induced impaired kidney and liver functions. It was found rather to improve kidney and liver functions. In addition, "Glyoherb" possesses potential antioxidant activity as it decreases lipid peroxidation and enhances antioxidant status in diabetic rats[49,50] and it was reported that the treatment with *Coccinia cordifolia* extract of newly detected type 2 diabetic patients for 90 d results in a 16% decrease in fasting blood glucose level and 18% in PP blood glucose level. Several studies of medicinal plants claimed to have a significant reduction in blood glucose level but in the present study, HbA1C percentage was significantly decreased in type Ⅱ diabetes subjects after 6 mo of treatment, suggesting that there is a reduction of generalized glycosylation of proteins in circulation. A significant reduction in glycosuria and proteinuria was observed in type Ⅱ diabetic subjects on "Diabegon kwath" therapy.

Oxidative stress plays a major role in the pathogenesis of both types of diabetes mellitus. Free radical production caused by hyperglycemia may occur by at least three different routes: nonenzymatic glycation[51], auto-oxidation of glucose and intracellular activation of the polyol pathway[52,53]. High levels of free radicals and simultaneously declined antioxidant enzyme levels lead to cell damage, inactivation of enzymes and lipid peroxidation. The "Diabegon kwath" in the present study also exhibited potent antioxidant activity, as evident from restoration of the activities of antioxidant enzymatic activities studied. The *Emblica officinalis* which is a rich source of vitamin C has been reported to reduce lipidemia and free radical production in experimental animals, considered to be the most important causative factors for diabetes-related complications. The *E. officinalis* and its enriched tannoids delay diabetic cataract in rats[54]. The lipid levels, such as cholesterol and triglycerides, in serum and liver were markedly elevated in aged control rats, while they were significantly decreased by the administration of amla[55]. There is an increased quest to obtain natural antioxidants

with broad spectrum actions. The herbal formulation used in the present study shows significant improvement in markers of oxidative stress, besides antihyperglycemic and antihyperlipidemic functions. Furthermore, oral administration of "Diabegon kwath" daily for 6 mo had no adverse effects, either on kidney or liver functions and in fact a marked improvement in functioning of these vital organs was noticed.

In conclusion, the present study with "Diabegon kwath" in type Ⅱ diabetic subjects with varying degrees of hyperglycemia, hyperlipidemia and oxidative stress proved that the formulation serves as an effective alternative to conventional antidiabetic therapies. Furthermore, the formulation was found to improve liver and kidney functions and may be regarded as a promising natural and safe remedy for the prevention of diabetic complications. This is the first long term study with any polyherbal formulation in human type Ⅱ diabetes mellitus.

ACKNOWLEDGMENTS

We thank Deendayal Aushadhi Pvt. Ltd., Gwalior (M.P.) for the supply of the polyherbal formulation and the financial support from AYUSH, New Delhi, is duly acknowledged. We are grateful to all the human subjects who volunteered to participate in the study. Our profound thanks are due to Dr. Mohit Tiwari, Dr. Sheetal Gupta of M/S Deendayal Aushadhi Pvt. Ltd., Gwalior, Sri Dinesh Borole, other colleagues of the laboratory and students for their unreserved support in conducting this study.

COMMENTS

Background

Type 2 diabetes is a multifaceted lifelong disorder and can lead to micro and macrovascular complications when left unchecked. The oral hypoglycemic agents available for the treatment of type II diabetes mellitus are reported to exhibit undesired side effects in a considerable number of subjects, even under euglycemic conditions. Polyherbal preparations are shown to function as potential antihyperglycemic agents.

Research frontiers

Polyherbal based Ayurvedic formulations are in regular use in southeastern countries as drug supplements for the treatment of type II diabetes mellitus. Scientific validation of such preparations and their safety evaluations are major concerns to biomedical scientists working on indigenous systems of medicine.

Innovations and breakthroughs

Several short term studies in experimental models revealed antidiabetic potentials of many polyherbal based formulations and very few herbal drug preparations have succeeded in human trials. This is the first ever long term open study validating an antidiabetic Ayurvedic formulation in human type II diabetes mellitus. The study not only evaluated the efficacy of the Ayurvedic polyherbal formulation but also addressed the safety concerns in human subjects.

Applications

The study revealed that "Diabegon kwath" functions as an effective alternative antidiabetic drug formulation which can safely be advocated for treatment of human type 2 diabetes mellitus.

Terminology

"Diabegon kwath" is a hot water extract of defined plant/herb parts.

Peer review

The study is interesting and not well known in the majority of countries. This is a long term study about the efficacy of "Diabegon kwath", a polyherbal formulation with diverse therapeutic functions. The formulation acts on glucose metabolism, lipids and functions as an antioxidant and the results of the study are significant.

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