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Management of Type 2 Diabetes Mellitus by Lifestyle, Diet and Medicinal Plants

[1]N. Haque, [1]U. Salma, [2]T.R. Nurunnabi, [3]M.J. Uddin, [2]M.F.K. Jahangir, [2]S.M.Z. Islam and [2]M. Kamruzzaman
[1]Department of RDDR, Modern Herbal Group, Dhaka-1217, Bangladesh
[2]Biotechnology and Genetic Engineering Discipline, Khulna University, Khulna-9208, Bangladesh
[3]Department of Chemistry, Primeasia University, HBR Tower, 9 Banani, Dhaka-1213, Bangladesh

Abstract: Globally, the prevalence of chronic, noncommunicable diseases is increasing at an alarming rate and diabetes is one of them. If diabetes is not controlled then a lot of complication like coronary artery disease, cerebrovascular disease, peripheral vascular disease, retinopathy, nephropathy and neuropathy arise in diabetic patients and causes morbidity and/or mortality. Diabetes is increasing at an epidemic form and in near future the largest increases will take place in the regions dominated by developing economies. So, it will be a great social and economical burden to developing countries as well as the developed. But if we be aware about our diet and lifestyle and take proper medication we may prevent and reduce the prevalence of diabetes. Oral medicine plays an important role in management of diabetes. But most of the oral drugs are costly and have a lot of side effects. For this it is also necessary to take medicines with fewer or no side effects. And antidiabetic medicinal plants may play an important role in this case. In this article we have tried to describe how diet and lifestyle with using medicinal plants may help to prevent or maintain diabetes and help to reduce the mortality and morbidity due to diabetes or complication related to it.

Key words: Hypoglycemic, insulin resistance, diabetes mellitus, glycemic index

INTRODUCTION

Diabetes Mellitus (DM) can be found in almost every population in the world and epidemiological evidence suggests that, without effective prevention and control programmes, diabetes will likely continue to increase globally. Type 1 diabetes usually accounts for only a minority of the total burden of diabetes in a population but is increasing in incidence in both poor and rich countries. Type 2 diabetes constitutes about 85% to 95% of all diabetes in high-income countries and may account for an even higher percentage in low and middle-income countries. Type 2 diabetes is now a common and serious global health problem, which, for most countries, has evolved in association with rapid cultural and social changes, ageing populations, increasing urbanization, dietary changes, reduced physical activity and other unhealthy lifestyle and behavioral patterns (International Diabetes Federation, 2006).

Nowadays type 2 DM is one of the major public health concerns in both developing and developed countries in the Asian-Pacific region. It has become epidemic in a number of countries, particularly in newly industrialized nations. The direct and indirect social and economic costs of treating diabetes and its complications have the potential to cripple the countries' healthcare budgets. In recent times, a new dimension has been added with the increasing appearance of type 2 diabetes in adolescents and even children (Asian-Pacific Type 2 Diabetes Policy Group, 2005).

Diabetes has recently been described as the perfect epidemic (Lau, 2001) is rapidly emerging as a global health care problem that threatens to reach pandemic levels by 2030. It is estimated that approximately 285 million people worldwide, or 6.6% adult have diabetes, 70% of whom live in low- and middle-income countries. This number is expected to increase by more than 50% in the next 20 years if preventive programmes are not put in place. By 2030, some 438 million people, or 7.8% of the adult population, are projected to have diabetes. The largest increases will take place in the regions dominated by developing economies (International Diabetes Federation, 2009).

Regardless of the type of diabetes, patients are required to control their blood glucose levels with medications and/or by adhering to an exercise program and a dietary plan. Insulin therapy by injection is given to those with type 1 DM and to some patients with type

Corresponding Author: Nazmul Haque, Senior Scientific Officer, Department of RDDR, Modern Herbal Group, 2, Shahid Tajuddin Ahmed Sarani, Moghbazar, Dhaka-1217, Bangladesh Tel: +88-01816-310499

2 DM. Patients with type 2 DM are usually placed on a restricted diet and are instructed to exercise, the purpose of which primarily is weight control. If diet and exercise fail to lower and stabilize blood glucose levels, oral anti-diabetic medication is prescribed. In some cases, insulin injections are necessary. Oral anti-diabetic agents exert their effects by various mechanisms: (1) stimulating beta cells in the pancreas to produce more insulin (sulfonylureas and meglitinides), (2) increasing the sensitivity of muscles and other tissues to insulin (thiazolidinediones), (3) decreasing gluconeogenesis by the liver (biguanides) and (4) delaying the absorption of carbohydrates from the gastrointestinal tract (alpha-glucosidase). These treatments are associated with adverse effects and some may produce toxic effects (e.g., thiazolidinediones may cause liver toxicity) (Dey *et al*., 2002).

Most of the oral therapeutic anti-diabetic agents are costly having with a lot of side effects. Moreover, it is very tough to the lower or middle income people to take costly anti-diabetic medication. As blood glucose monitoring is an essential task for patients suffering from diabetes; thus, beside diet and exercise any change caused by inexpensive herbal products to blood glucose levels without having any or fewer side effects may alter the amount of medication needed to control blood glucose.

CAUSES OF TYPE 2 DIABETES MELLITUS

There are a lot of causes (less insulin secretion by pancreas, insulin resistance etc.) and risk factors (age, obesity, ethnicity, strong family history of type 2 diabetes etc.) that are directly related to the pathogenesis of type 2 DM. Beside the risk factors the relation between lifestyle and diet habit with prevalence of type 2 DM has been proved by several articles (Asian-Pacific Type 2 Diabetes Policy Group, 2005).

In the past two decades, the rates of obesity have tripled in developing countries that have been adopting a Western lifestyle involving decreased physical activity and over consumption of cheap, energy-dense food (Hossain *et al*., 2007). The upsurge in obesity is closely linked to the increase in the prevalence of type 2 DM. About 90% of type 2 DM is attributable to excess weight (Hossain *et al*., 2007). Like developing countries over the last decade, profound changes in the quality, quantity and source of food consumed in many developed countries combined with a decrease in levels of physical activity have led to an increase in the prevalence of diabetes and its complications (Yach *et al*., 2006). Furthermore, some manifestations of Peripheral Diabetic Neuropathy (PDN) and cardiovascular disease in overweight and obese subjects develop at the stage of Impaired Glucose Tolerance (IGT) (Sumner *et al*., 2003; Reindel *et al*., 2004; Pittenger *et al*., 2005).

Several researches also showed the relation with the high fat diet, obesity and insulin resistance (Thounaojam *et al*., 2010). It is generally agreed that insulin resistance is an invariable accompaniment of obesity but that normoglycemia is maintained by compensatory hyperinsulinemia until the pancreatic β cells become unable to meet the increased demand for insulin, at which point type 2 DM begins. The mechanism by which β cells become unable to meet rising insulin demand has never been elucidated, primarily because of the unavailability of human pancreatic islets for appropriate study. However, post-mortem studies in patients with type 2 DM indicate that the β cell mass is reduced (Rahier *et al*., 1983). Some animal studies implicate fat deposition in islets as the cause of the β cell decompensation, so-called lipotoxicity (Lee *et al*., 1994). Excess fat in β cells and other nonadipocytes in this form of obesity is ascribed to the high plasma levels of Free Fatty Acids (FFAs) (Lee *et al*., 1994), coupled with a greatly enhanced capacity for lipogenesis (Lee *et al*., 1997). There is compelling *in vitro* evidence that the modest 5- to 10-fold increase in islet fat content that occurs *in vivo* in the prediabetic phase of the disease causes the compensatory β cell hyperplasia and hyperinsulinemia; a further increase in islet fat to ~50 times normal reverses the foregoing compensatory changes and causes β cell dysfunction, a reduction in the number of β cells and diabetes (Milburn *et al*., 1995; Hirose *et al*., 1996).

DIET AND LIFESTYLE TO PREVENT AND MANAGE TYPE 2 DIABETES MELLITUS

Type 2 diabetes mellitus is a common disease with substantial associated morbidity and mortality (Harris *et al*., 1998). Most adverse diabetes outcomes are a result of vascular complications, both at a macrovascular level (coronary artery disease, cerebrovascular disease, or peripheral vascular disease) and a microvascular level (retinopathy, nephropathy, or neuropathy) (UK Prospective Diabetes Study Group, 1998). Macrovascular complications are more common; up to 80% of patients with type 2 diabetes will develop or die of macrovascular disease (Wingard *et al*., 1993; Meigs *et al*., 1997) and the costs associated with macrovascular disease are an order of magnitude greater than those associated with microvascular disease (American Diabetes Association, 1998).

Because diabetes is defined by blood glucose levels, much of the attention in diabetes care focuses on the management of hyperglycemia. This has been magnified by the causal link between hyperglycemia and microvascular outcomes (Diabetes Control and Complications Trial Research Group, 1993). However, while some observational evidence suggests that level of glycemia is a risk factor for macrovascular disease (Laakso, 1996), experimental studies to date have not clearly shown a causal relationship between improved glycemic control and reductions in serious cardiovascular outcomes (Diabetes Control and Complications Trial Research Group, 1993). Given these results and the epidemiologic characteristics of diabetes complications, it would seem more logical to focus diabetes care on prevention of macrovascular complications rather than on glucose control and microvascular complications (Vijan and Hayward, 2003).

For this to prevent and maintain diabetes first we have to concentrate ourselves on diet and physical activities. Two landmark studies have confirmed that attainment of glycemic control as close to normal as possible is necessary for prevention of long term complications in both type 1 (Diabetes Control and Complications Trial Research Group, 1993) and type 2 (Ohkubo *et al*., 1995) diabetes and this requires an intensive approach to management. Nutrition is of utmost importance in intensive management and has often been described as the cornerstone of diabetes care (Kalergis *et al*., 2005). The main focus in the nutritional management of diabetes is to improve glycemic control by balancing food intake with endogenous and /or exogenous insulin levels. Historically, there have been several attempts to control the glycemic response to food, particularly carbohydrate-containing foods, including use of very low carbohydrate and starvation diets, artificial sweeteners and pharmacological preparations such as fast acting insulin and inhibitors of carbohydrate absorption (Kalergis *et al*., 2005). One way to classify the glycemic response of various carbohydrate-containing foods is Glycemic Index (GI). This term was first coined by Jenkins to describe the extent that blood glucose rises after a test food in comparison to a reference food, usually white bread (Jenkins *et al*., 1984).

Beside proper diet physical exercise is also necessary to maintain blood glucose level and to prevent type 2 diabetes related complications, such as nephropathy, retinopathy, arteriosclerotic heart disease and peripheral neuropathy, which most often result from the prolonged exposure to hyperglycemia (Kahn, 1995). Several animal studies have been showed the effect of physical exercise on maintenance of glucose level by improve glucose uptake through various mechanisms (Phillips *et al*., 1996; Ivy, 1997; Wojtaszweski *et al*., 1997; Heled *et al*., 2002).

MEDICINAL PLANTS TO PREVENT AND MANAGE TYPE 2 DIABETES MELLITUS

Oral anti-diabetic drugs are usually taken when diet and exercise failed to maintain hyperglycemia. Oral anti-diabetic agents are used to stimulate beta cells in the pancreas to produce more insulin (sulfonylureas and meglitinides), increase the sensitivity of muscles and other tissues to insulin (thiazolidinediones), decrease gluconeogenesis by the liver (biguamides), delay the absorption of carbohydrates from the gastrointestinal tract (alpha-glucosidase), treat hyperlipidemia and hyperinsulimea.

But presently, there is growing interest in herbal remedies due to the side effects associated with the oral hypoglycemic agents (therapeutic agent) for the treatment of diabetes mellitus (Day, 1998; Grover *et al*., 2002). In recent years, herbal medicines have started to gain importance as a source of hypoglycemic agents. Marles and Farnsworth (1995) estimated that more than 1000 plant species are being used as folk medicine for diabetes. Biological actions of the plant products used as alternative medicines to treat diabetes are related to their chemical composition. Herbal products or plant products are rich in phenolic compounds, flavonoids, terpenoids, coumarins and other constituents which show reduction in blood glucose levels (Jung *et al*., 2006; Hong-Fang *et al*., 2009). Several species of herbal drugs have been described in the scientific and popular literature as having antidiabetic activity (Valiathan, 1998). Several investigators reported anti-diabetic properties of various herbs not only in rats (Shanmugasundaram *et al*., 1990; Okabayashi *et al*., 1990) but also in humans (Hirata *et al*., 1992). Some of these showed the mechanisms by which medicinal plants produce anti-diabetic effects include: recovery of beta cells (Shanmugasundaram *et al*., 1990), inhibition of glucose absorption (Hirata *et al*., 1992), stimulation of insulin release (Sugihara *et al*., 2000) and increased glucose tolerance (Kar *et al*., 1999). Furthermore, the lipid lowering properties have been described (Shigematsu *et al*., 2001). Due to their perceived effectiveness, fewer side effects in clinical experience and relatively low costs, herbal drugs are now being prescribed widely by so many health practitioners (Verspohl, 2002). In the following paragraphs we describe the effect and mechanism of medicinal plants in maintenance of DM.

Ginseng (*Panax ginseng*): Several species are members of the Panax genus (Araliaceae family). These species include *Panax quinquefolius* (the American ginseng), *Panax japonicus* (the Japanese ginseng) and *Panax ginseng* (the Asian or Korean ginseng) (Ernst, 2002). Traditionally, the roots of the ginseng plant are used medicinally. Herbs in the Panax species contain ginsenosides that are unique to Panax. Ginsenosides are sapogenins (steroidal saponins) with a backbone chemical structure of either danmarane-type tetracyclic triterpene or oleananetype pentacyclic triterpene (Shibata, 2001). In addition to the ginsenosides, *P ginseng* contains at least 14 different glycans, known as panaxans (Konno *et al*., 1985; Oshima *et al*., 1985). Components in *P ginseng* alter blood glucose concentration by different mechanisms. Sever animal studies showed that the aqueous extract of ginseng root has the capability of producing hypoglycemia in both glucose-loaded healthy animals and in animals with experimentally induced diabetes, but not in healthy animals. This extract altered blood glucose levels by stimulating the biosynthesis of insulin by the pancreas and inducing the production of a glucose transporter in the liver (Waki *et al*., 1982; Ohnishi *et al*., 1996). The glycans in ginseng root also produce hypoglycemic effects in both normal animals and in those with experimentally induced diabetes (Ng and Yeung, 1985). The polysaccharides in ginseng lower blood glucose levels either by decreasing glucose production by the liver or by increasing the glucose use by tissues (Yang *et al*., 1990). Likewise, the polypeptides reduce blood glucose concentrations via their effect on adrenergic receptors (Wang *et al*., 1990).

Fenugreek (*Trigonella foenum-graecum*): The seeds of *Trigonella foenum-graecum* Linn. (Fabaceae) are traditionally used for their tonic, carminative, glucose-lowering functions and in the management of gastrointestinal ulcers (Zia *et al*., 2001). Several animal studies showed that the aqueous and alcoholic extracts of the seeds, as well as the seeds themselves, have a hypoglycemic effect when given orally (Raju *et al*., 2001; Puri *et al*., 2002; Yadav *et al*., 2008). Another animal study showed the hypoglycemic effect of the alcoholic extract of fenugreek in both healthy and diabetic rats, but the diabetic rats experienced a more pronounced decrease in blood glucose (Vats *et al*., 2002). Beside animal studies in a placebo-controlled clinical trial the hypoglycemic effect of hydro-alcoholic fenugreek seed extract has been proved in insulin resistant patients with type 2 DM (fasting glucose <200 mg dL^{-1}). In this trial one group received 1 g per day of hydro-alcoholic fenugreek seed extract for two consecutive months (12 patients) and another a placebo with dietary control and exercise (13 patients). All patients were insulin resistant. There was no statistical difference between the two groups with respect to fasting blood glucose levels or the two-hour post-glucose tolerance test at the end of the two-month treatment; however, a decrease in insulin secretion by the pancreas as well as improved sensitivity to insulin was observed after the fenugreek treatment but not with placebo (Gupta *et al*., 2001). In another study it has been showed that the patients with type 1 DM who received fenugreek seed powder in two divided doses (50 g each) with their lunch and dinner for 10 days experienced a significant reduction in their fasting blood glucose levels and a 54% reduction in 24 h urinary glucose secretion (Sharma *et al*., 1990). It appears that fenugreek can reduce blood glucose levels in patients with type 1 or type 2 DM, although its effect is less pronounced in patients with more severe diabetes. The effect of fenugreek on blood sugar in healthy individuals does not seem to be of importance. Clinicians counseling diabetic patients should be aware of this potential interaction between fenugreek and antidiabetic drugs (Al-Achi, 2005).

Bitter Melon (*Momordica charantia*): *Momordica charantia* Descourt. (Cucurbitaceae) is a complex plant medicine that has a remarkably long history of use, both as a food and as a medicine. In Asia and South America, this herb is widely used in folk medicine to treat diabetes. Several experimental animal studies support its effect on lowering blood glucose levels in both healthy and diabetic animals (Vikrant *et al*., 2001; Virdi *et al*., 2003). A clinical trial showed the effect of bitter melon juice that significantly improved glucose tolerance and the fried melon also improved glucose tolerance. Serum insulin levels did not increase, suggesting that bitter melon may have influenced hepatic or peripheral glucose disposal directly. This is doubly important because any agents that stimulate insulin release (so-called insulin secretagogues) may worsen insulin resistance in patients with NIDDM and accelerate beta-cell loss in patients with IDDM. Glycosylated hemoglobin also decreased in the patients suggesting an extrapancreatic action (Leatherdale *et al*., 1981).

In bitter melon there is a protein that is structurally and pharmacologically similar to bovine insulin (Baldwa *et al*., 1977). It is often referred to as v-insulin and research is ongoing to determine if this type of insulin may be suitable for patients who do not tolerate, or for philosophical reasons prefer not to use, animal sourced insulin. In a small study, 9 patients (6 with juvenile onset, 1 maturity onset and 2 asymptomatic IDDM) were given v-insulin subcutaneously. Five healthy and 5 patients with overt diabetes served as controls and were given a placebo injection. A hypoglycemic effect in the treatment group was observed that started 30-60 min after injection but peaked after 4-12 h (compared to 2-3 h for regular insulin) (Baldwa *et al*., 1977). In another study, subcutaneous v-protein produced a hypoglycemic effect in a small controlled study (n = 19) of juvenile and maturity onset IDDM. One juvenile patient who suffered side-effects when on bovine insulin (swelling, stomach pain and bouts of hypoglycemia) was maintained on v-protein for 5 months without experiencing any adverse effects (Khanna *et al*., 1981).

Gymnema (*Gymnema sylvestre*): G. sylvestre R. Br. (Asclepiadaceae) leaves contain triterpene saponins belonging to oleanane and dammarene classes. Oleanane saponins are gymnemic acids and gymnemasaponins, while dammarene saponins are gymnemasides. Besides this, other plant constituents are flavones, anthraquinones, hentri-acontane, pentatriacontane, α and β-chlorophylls, phytin, resins, dquercitol, tartaric acid, formic acid, butyric acid, lupeol, β-amyrin related glycosides and stigmasterol. The plant extract also tests positive for alkaloids. Leaves of this species yield acidic glycosides and anthroquinones and their derivatives (Dateo and Long, 1973).

Gymnemic acids have antidiabetic, antisweetener and anti-inflammatory activities. The antidiabetic array of molecules has been identified as a group of closely related gymnemic acids after it was successfully isolated and purified from the leaves of *G. sylvestre* (Liu *et al*., 1992). *G. sylvestre* leaves have been found to cause hypoglycemia in laboratory animals and have found a use in herbal medicine to help treat adult onset diabetes mellitus (NIDDM) (Shanmugasundaram *et al*., 1990; Okabayashi *et al*., 1990; Hirata *et al*., 1992).

The mechanisms by which *G. sylvestre* produce antidiabetic effects include: recovery of beta cells (Shanmugasundaram *et al*., 1990), inhibition of glucose absorption (Hirata *et al*., 1992; Shimizu *et al*., 1997), stimulation of insulin release (Sugihara *et al*., 2000) and increased glucose tolerance (Kar *et al*., 1999). Furthermore, the lipid lowering properties have been described (Wang *et al*., 1990; Shigematsu *et al*., 2001). However, it must be considered that all these studies were performed using a mixture of glycosides (Shimizu *et al*., 1997), a fraction denominated *G. sylvestre* (Shanmugasundaram *et al*., 1990; Okabayashi *et al*., 1990), alcoholic extract of leaves (Kar *et al*., 2003) and gymnemic acid (Hirata *et al*., 1992; Sugihara *et al*., 2000).

Banaba (*Lagerstroemia speciosa*): *Lagerstroemia speciosa* L. Pers. (Lythraceae), commonly known as banaba in the Philippines is a tropical flowering tree used as a folk medicine for the treatment of a myriad of diseases (De Padua *et al*., 1997). In the Philippines, the tea made from the leaves of *L. speciosa* has been used as a beverage for the treatment and prevention of diabetes mellitus (Quisumbing, 1978). Kakuda *et al*. (1996) studied banaba's antidiabetic activity by preparing water and methanol extracts of the plant. After feeding the extracts to hereditary type 2 diabetic KK-Ay/Ta Jcl mice, they found that food containing either 5% of water extract (BE) or 3% of methanol extract was effective in reducing blood glucose and insulin levels ($p<0.05$) (Kakuda *et al*., 1996). In a second study it has been demonstrated that the extract possesses an anti-adipogenic activity by reducing weight gain on parametrial adipose tissue in female diabetic KKAY mice (Suzuki *et al*., 1999). Other *in vitro* studies using 3T3- L1 showed that the extract exhibits activities that stimulated both glucose transport and inhibited adipocyte differentiation (Liu *et al*., 2001; Bai *et al*., 2008). In rat adipocyte, leaves of *L. speciosa* increased the rate of glucose uptake and decreased the isoproterenol-induced glycerol release (Hayashi *et al*., 2002).

Tanquilut *et al*. (2009) showed the first physiological evidence that *L. speciosa* possesses anti-hyperglycemic effect in alloxan-induced diabetic mice that may offer a valuable therapeutic measure in the treatment of diabetes mellitus (Tanquilut *et al*., 2009). Moreover, clinical use of *L. speciosa* in diabetic patients has also been shown to suppress glucose level in a dose-dependent manner (Judy *et al*., 2003).

Holy basil (*Ocimum sanctum*): *Ocimum sanctum* Linn. (Labiatae) commonly known as Holy Basil. Different parts of this plant have been claimed to be valuable in a wide spectrum of diseases. Here the antidiabetic properties of *O. sanctum* are our main concern. The anti-diabetic properties of *O. sanctum* have been evaluated in several experimental animal models and very few studies on human are available. One animal study showed administration of fresh *O. sanctum* leaves (1 and 2 g day^{-1}) for four weeks exerted significant hypoglycaemic and uricosuric effects on fasting glucose and 24 h urine samples in experimental adult albino rabbits (Sarkar *et al*., 1990). Some other animal studies showed the hypoglycemic effect of different types of *O. sanctum* leaf extract in experimental rats with diabetes mellitus induced by alloxan (Giri *et al*., 1987) or by glucose and/or streptozotocin (Chattopadhyay, 1993; Chandra *et al*., 2008). *O. sanctum* also showed hypoglycaemic activity along with other herbal formulations. Dry *O. sanctum* leaf powder when fed at 1% of total diet for 30 days to the rats with diabetes induced by alloxan, fasting blood sugar, uronic acid, total amino acids, total cholesterol, triglyceride, phospholipids and total lipids reduced significantly (Rai *et al.*, 1997a). Similarly, methanolic extract of *O. sanctum* when given to experimental animals at a dose of 200 mg kg^{-1}, bw for 30 days, the activities of glucokinase and hexokinase was increased significantly (Vats *et al.*, 2004). It was also found that feeding of 200 mg kg^{-1}, body weight aqueous extract of whole *O. sanctum* plant for 60 days significantly delayed insulin resistance in fructose fed experimental mice (Reddy *et al.*, 2008). The alcoholic extract and other organic solvent fraction's extract has been found to stimulate insulin secretion from perfused rat pancreas, isolated islets and clonal pancreatic β-cells. The proposed mechanism of action for the secretion of insulin is that, *O. sanctum* extract is able to stimulate adenylate cyclase/ cAMP or the phosphatidylinositol or direct effect on exocytosis that induce mobilization of intracellular Ca^{++} as well as promoting Ca^{++} entry (Hannan *et al.*, 2006).

In one of the initial randomized controlled clinical trails, anti-diabetic properties have been studied in 40 noninsulin dependent diabetes mellitus (NIDDM) patients. It was observed that taking dried *O. sanctum* leaf powder made from 2.5 g fresh leaves per day orally on empty stomach could reduce the fasting glucose level up to 21 mg dL^{-1} and postprandial blood glucose by 15.8 mg dL^{-1} (Agrawal *et al.*, 1996). In another trial on 27 NIDDM patients, it was observed that supplementation of *O. sanctum* powder along with hypoglycaemic drugs for one month could significantly decrease the blood glucose, glycosylated proteins, total amino acids, uronic acid, triglycerides, Low Density Lipoprotein (LDL) and very Low Density Lipoprotein (VLDL), compared to control group on similar hypoglycaemic drugs. However, there was no significant change in High Density Lipoprotein (HDL) level (Rai *et al.*, 1997b).

Periwinkle (*Catharanthus roseus*): *Catharanthus roseus* Linn. (Apocyanaceae) is known with various names (Madagascar periwinkle; *Vinca rosea*; *Lochnera rosea*) in all over the world. Water decoction of the leaves and/or the whole plant is used as household remedy for diabetes in several countries (Don, 1999). Several animal studies showed the antidiabetic activity of various types organic extracts of *C. roseus* (Swanston-Flatt *et al.*, 1989; Chattopadhyay *et al.*, 1991; Singh *et al.*, 2001). As water decoction or fresh juice of leaves are used traditionally as antidiabetic, some animal studies also done with the juice of fresh leaves. In two animal studies researchers showed the hypoglycemic effect of the juice of fresh leaves of *C. roseus* in streptozotocin-induced (Ahmed *et al.*, 2007) and alloxen induced (Nammi *et al.*, 2003) diabetic animals. Moreover, the hypoglycemic effect of the powder of *C. roseus* leaves has also been proved clinically (Banakar *et al.*, 2007).

Ivy Gourd (*Coccinia indica*): *Coccina indica* Wight and Am. has been used since ancient times as an antidiabetic drug by physicians who practice the Indian system of medicine known as Ayurveda. For this some researchers concentrate themselves to proof the antidiabetic effect of this plant. One animal study showed hypoglycemic effect of 95% ethanol extract of the leaves of *C. indica*. This effect was due in part to the inhibition of the key gluconeogenic enzyme glucose-6-phosphatase (Hossain *et al.*, 1992). In another animal study showed that the oral administration of the isolated pectin from the fruit of the *C. indica* at a dose of 200 mg/100 g BW/day produced a reduction in glycaemia and an increase in liver glycogen. Glycogen synthetase activity was significantly increased. Incorporation of labeled glucose into hepatic glycogen was also found to be higher. A significant reduction in phosphorylase activity was noted in the pectin-administered groups (Kumar *et al.*, 1993).

Garlic (*Allium sativum* L.) and Onion (*Allium cepa* L.): These two herbs are extensively used in many ethnic cuisines. Both garlic and onion belong to the genus *Allium* of the family Liliaceae. Garlic and onion have been shown to produce significant decreases in blood glucose concentrations in experimental animals. Healthy Wistar adult male rats showed significant decreases in blood glucose levels after they were fed a one-month diet containing 2% (wt/wt) garlic (Ahmed and Sharma, 1997). In healthy rabbits, the maximum glucose concentration following a subcutaneous glucose tolerance test was lower after oral treatment with garlic or onion (Roman-Ramos *et al.*, 1995). Components in garlic and onion, S-allyl cysteine sulfoxide in garlic and S-Methyl Cysteine Sulfoxide (SMCS) in onion, were shown to cause the glucose-lowering effect seen in diabetic animals (Sheela *et al.*, 1995; Kumari *et al.*, 1995; Augusti and Sheela, 1996). SMCS was shown to improve the use of glucose as a result of an increase in insulin secretion by the pancreas (Kumari and Augusti, 2002).

DISCUSSION

Around 100 years ago infectious diseases, like cholera, small pox, TB, typhoid, malaria and so on, were the main causes of mortality. With the subsequent developments in medical science these infectious diseases are less of a problem. In the mean time chronic, noncommunicable diseases and complications have surpassed infectious diseases as the main cause of death and disability. Among the noncommunicable diseases diabetes is increasing at an alarming rate. If diabetes is not controlled then a lot of complication like coronary artery disease, cerebrovascular disease, peripheral vascular disease, retinopathy, nephropathy and neuropathy arise in diabetic patients and causes morbidity and/or mortality (Wingard *et al*., 1993; Meigs *et al*., 1997; UK Prospective Diabetes Study Group, 1998). By analyzing the recently collected data it is estimated that in near future more than 1.2% increase (from 6.6 to 7.8%) in prevalence of diabetes will take place worldwide. Moreover, the largest increases will take place in the regions dominated by developing economies (International Diabetes Federation, 2009). So, it will be a great social and economical burden to developing countries as well as the developed.

We always say that prevention is better than cure. The role of diet in maintenance and prevention of diabetes has been supported by several studies (Kalergis *et al*., 2005; Ghattas *et al*., 2008). For this, it is necessary for us to be aware about our diet and lifestyle that play a vital role in prevalence of diabetes and diabetes related morbidity and mortality (Yach *et al*., 2006; Haque and Nargis, 2010). We should take calorie restricted, well planned low-fat and/or low carbohydrate diet and have to increase physical activities to prevent or manage diabetes. Besides changing diet habit and lifestyle the patient should take oral herbal preparations as these are with fewer side effects (Verspohl, 2002).

With the development of modern technology a lot of animal and clinical trials on antidiabetic properties of medicinal plants have been conducted. In this study we included few of them. Among these herbs the antidiabetic properties of *Trigonella foenum-graecum* (Sharma *et al*., 1990; Gupta *et al*., 2001; Yadav *et al*., 2008), *Momordica charantia* (Leatherdale *et al*., 1981), *Gymnema sylvestre* (Hirata *et al*., 1992), *Lagerstroemia speciosa* (Judy *et al*., 2003), *Ocimum sanctum* (Agrawal *et al*., 1996; Rai *et al*., 1997a), *Catharanthus roseus* (Banakar *et al*., 2007) have been proved by both animal and clinical trials. Moreover, through animal studies researchers are trying to prove the antidiabetic properties of traditionally used plants and their usefulness in the ethnotherapy of type 2 diabetes (Sugiwati *et al*., 2006; Eseyin *et al*., 2007; Palsamy and Malathi, 2007; Anthony and Adebimpe, 2009; Anreddy *et al*., 2010; Radhika *et al*., 2010). On the other hand, the preparations of herbal antidiabetic medicine are cheap and economically feasible to low or middle income people also. So, it might play a significant role in prevention and maintenance of diabetes.

As maintenance of blood sugar level and reduction of morbidity and mortality due to diabetes is our main concern so beside proper diet and exercise we should take safer herbal preparation and should encourage the researchers to find out more effective antidiabetic herbal plants to reduce the economic burden of a country.

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