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RESEARCH ARTICLE

Antihyperglycemic Effect of Aqueous Leaf Extract of *Mimusops elengi* against Streptozotocin-Induced Diabetic Male Albino Rat

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ABSTRACT

Objective: The present study was hypothesized to evaluate the antihyperglycemic effect of aqueous leaf extract of *Mimusops elengi* on streptozotocin (STZ)-induced diabetic animals. **Materials and Methods:** Antidiabetic activity of *M. elengi* leaf extract at a dosage of 250 mg/kg body weight was evaluated. **Results:** The activity levels of glucose, triglycerides, total cholesterol, and serum glutamic pyruvic transaminase were significantly elevated in STZ-induced diabetic animals when compared to that of normal animals. After supplemented with aqueous leaf extract of *M. elengi*, animals group recorded significant lower blood glucose level. **Conclusion:** The aqueous leaf extract of *M. elengi* has been potent antidiabetic effect in male albino rat.

Keywords: Cholesterol, diabetes mellitus, medicinal plant, *Mimusops elengi*

INTRODUCTION

Diabetes mellitus (DM), long considered a disease of minor significance to world health, is now taking its place as one of the main threats to human health in the 21st century.[1] It is the most common non-communicable disease worldwide and the 4–5th leading cause of death in developed countries.[2] The global figure of people with diabetes is set to rise from the current estimate of 150 million to 220 million in 2010 and 300 million in 2025.[3] Developing countries such as India have had the maximum increases in the last few years. The current prevalence of type 2 diabetes is 2.4% in the rural population and 11.6% in the urban population of India. It has been suggested that diabetes is the third leading causes of death due to high incidence of morbidity and mortality after cancer and cardiovascular disorder. However, their use is being restricted by cost, limited pharmacokinetic properties, secondary failure rates, and accompanying side effects.[4] The WHO recommendation on alternative treatment for DM has lead increased investigations on hypoglycemic agents from medicinal plants. Natural products have been a source of medicinal treatment for thousands of years, and plant-based systems continue to play an essential role in primary health care of over 80% of developed and developing countries of the world.[5] Many indigenous Indian medicinal plants have been found to be useful to successfully manage diabetes.[6,7] *Mimusops elengi* Linn. (family Sapotaceae) commonly known as Magizhamboo (in Tamil name) and is found all over the world. The tree is of great significance to the Hindus and the dried twigs of the tree are used for different Yajnas and religious rituals. Many report revealed that in the ancient Indian civilization, the fruits were a staple diet of the sages, hermits, and people.[8] It has a long history of being used in Indian traditional medicine.[9] The bark is used as a gargle for odontopathy, ulitis, and ulemorrhagia.[10] *M. elengi* having various kinds of biological and pharmacological activities. It possesses activities such as antibacterial,[11] antifungal,[12] and cytotoxicity activities.[13] Thus, it is prudent in the current context to look for new

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and efficacious approaches from the vast reserves of phytotherapy. In the study, folklore medicinal plant has been selected for the antihyperglycemic effect. The present study was carried out in rats to test the efficacy of aqueous leaf extract of *M. elengi* on serum insulin, hyperglycemia, and serum lipid profile changes associated with diabetes.

MATERIALS AND METHODS

Plant material

A total of six species of Indian traditional plants (*M. elengi*, *Pongamia pinnata*, *Andrographis paniculata*, *Mimosa pudica*, *Coccinia grandis*, and *Solanum surattense*) were collected in and around Vellore District, Tamil Nadu, India. After preliminary screening of the six plants, the crude extract of *M. elengi* was found to have strong antidiabetic activity against streptozotocin (STZ)-induced diabetic rats. The fresh leaves of *M. elengi* were collected from in and around Vellore District, Tamil Nadu, India. The fresh leaves were cleaned and shade dried under room temperature. The plant specimen was authenticated and voucher specimen was deposited in our college.

Extract preparation

100 g powdered leaf of the plant were taken and mixed with 500 mL of distilled water and magnetically stirred in a container overnight at room temperature. The residue was removed by filtration and the aqueous extracts were concentrated under vacuum to get solid yield of 10%. The plant extract was administered to animals in aqueous solution.

Animals

Adult male albino rats of Wistar strain weighing around 180–190 g were purchased from Tamil Nadu Veterinary and Animal Sciences University, Chennai, India. The animals were kept in polypropylene cages (three in each cage) at an ambient temperature of 25±2°C and 55–65% relative humidity. A 12 ± 1 h light and dark schedule was maintained in the animal house until the animals were acclimatized to the laboratory conditions. They were fed with commercially available rat chow (Hindustan Lever Ltd., Mumbai, India) and had free access to water. The experiments were designed and conducted in accordance with the institutional guidelines.

STZ-induced diabetic animal

Freshly prepared solution of STZ (Sigma, USA), 35 mg/kg body weight in 0.1 M of cold citrate buffer pH 4.5,[14,15] was introduced into the overnight fasted animals by a single intraperitoneal injection. The control rat was injected with saline. The animals were considered diabetic if the blood glucose level values were >250 mg/dL on the 3rd day after STZ injection.

Experimental design

Rats administered with saline for 21 days. Group-I: Normal. Group-II: Rats administered with STZ (55 mg/kg body weight) intraperitoneally. Group-III: Oral administration of *M. elengi* leaf extract (250 mg/kg body weight) in STZ-induced rats from the 8th to 21st day.

Preparation of serum, plasma, and tissue homogenate

After the experimental period, animals were sacrificed by cervical decapitation. Blood was collected and centrifuged for serum separation. For plasma, blood was collected with anticoagulant and centrifuged at 2000 rpm for 20 min.

Biochemical analysis

The biochemical estimation was carried out in our laboratory using the following methods. Serum total cholesterol (TC),[16] triglycerides (TGs),[17] low-density lipoprotein (LDL), high-density lipoprotein (HDL), and very LDL (VLDL).[18]

Statistical analysis

The values were expressed in mean ± standard deviation. The statistical analysis was carried out using one-way ANOVA in standard Statistical Package for the Social Sciences.

RESULTS

In the present research, the STZ-induced Group-II animals, the level of the blood glucose was found to have increased significantly when compared to the levels in Group-I normal animals [Figure 1]. After administration of the leaf extract of *M. elengi* 250 mg/kg body wt., the increased levels of blood glucose were found to have decreased significantly when compared to the levels in diabetic-induced control groups [Figure 1]. The levels of insulin were tested in normal, diabetic-induced control, and plant extract-treated groups. The plant extract was administrated to diabetic-induced groups in the dosage of 250 mg/kg body wt. STZ was induced into Group II animals, the level of insulin was decreased significantly when compared to that of normal groups [Figure 1]. After administration of the *M. elengi* plant extract 250 mg/kg body wt. (Group-III), the decreased levels of the insulin were increased significantly when compared to the levels in STZ-induced control animals (Group-II) [Figure 1].

The lipid profile such as TC, TG, HDL, LDL, and VLDL was also estimated in normal, diabetic-induced control, and plant extract-treated groups. The STZ was induced in Group II animals, the levels of lipid profile such as TC, TG, LDL, and VLDL were significantly increased when compared to the levels in normal groups [Figure 2], whereas HDL level of diabetes-induced groups (Group-II) was decreased significantly when compared to the levels in normal groups (Group-I). After administration of *M. elengi* (250 mg/kg body wt.,) (Group-III), the increased levels of the lipid profile such as TC, TG, VDL, and VLDL were decreased significantly when compared to the levels in diabetic-induced control groups. The level of HDL was increased in plant-treated group when compared to the levels in diabetic-induced control groups [Figure 2].

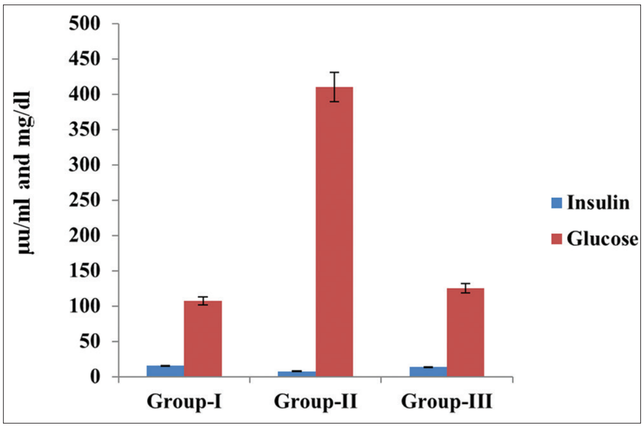

Figure 1: Effects of aqueous leaf extract of *Mimusops elengi* on diabetes-induced groups: Levels of serum insulin (µu/ml) and blood glucose (mg/dl)

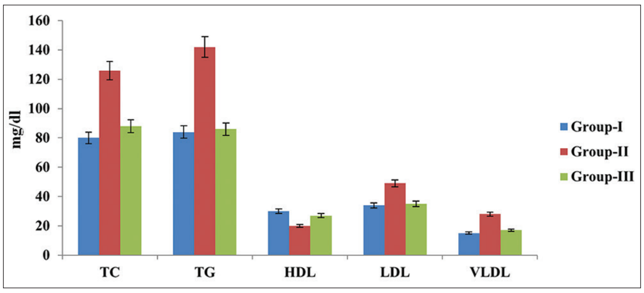

Figure 2: Effect of aqueous leaf extract of *Mimusops elengi* on the cholesterol, triglycerides, high-density lipoprotein, low-density lipoprotein, and very low-density lipoprotein levels

DISCUSSION

STZ produces reactive oxygen species in the body which cause pancreatic injury and could be responsible for depleted insulin levels and thereby augmented levels of blood glucose in the present study. Similar studies and observation were made elsewhere.[19] Lipids are transported in the form of lipoproteins between the various tissues and organs for utilization and storage. Since lipids are insoluble in water, the problem of transport in the aqueous blood plasma is solved by associating with non-polar lipids (phospholipids and cholesterol) and proteins to make water miscible lipoproteins. There are four major groups of plasma lipoproteins, namely (1) chylomicrons derived from intestinal absorption of triacylglycerol and other lipids, (2) VLDL (VLDL or pre-β-proteins) derived from the liver for the export of triacylglycerol, (3) LDL (LDL or α-lipoproteins) representing the final stages in the catabolism of VLDL, and (4) HDL (HDL or lipoproteins) involved in VLDL and chylomicrons metabolism and also cholesterol transport. In the present study revealed that the aqueous leaf extract of *M. elengi* exerts hypoglycemic effects in STZ-induced diabetic rats by indicating that the extract ameliorates kidney function and lowers blood glucose of diabetic rats. The findings are of considerable importance because they contextualize the hypoglycemic and hypolipidemic effects of *M. elengi* in the management of diabetes. This is clinically relevant considering the prevalence of accelerated progression of microvascular (retinopathy and nephropathy) and macrovascular (atherosclerotic) complications in diabetic patients.[20] Macrovascular diseases account for the majority of deaths in Type 2 diabetic patients, and the presence of hypertension is associated with 4–5-fold increase in mortality.[21,22] In the present study, the hypoglycemic activity of the crude extract of *M. elengi* was evaluated in normal, hyperglycemic, and STZ-induced diabetic rats. A single oral administration with the crude extract of *M. elengi* caused a significant decrease in serum glucose levels in normal rats. Moreover, these doses of the crude extract produced the maximum glucose lowering in 250 mg/kg body wt. treated groups when compared to the levels in diabetic-induced animals.

The reduction in the serum insulin levels in the STZ-treated rats might be attributed to the reduced secretion of the hormone which might be due to the damage of the beta cells of endocrine pancreas. The STZ selectively destroys the pancreatic cells and induced hyperglycemia. In diabetes, the increased blood sugar levels might be due to either insulin resistance of the body cells or decreased secretion of insulin from beta cells manifest in the decreased serum insulin levels.[23] After administration of the aqueous leaf extract of *M. elengi* to the STZ-induced diabetic animal revealed augmented serum insulin levels. This increment of serum insulin levels might be due to elevated secretion of the hormone, which might reflect the probable "repair" of the damaged beta cells of the endocrine of the pancreas. The lipoprotein levels in the STZ-induced diabetic rats of the present study showed a significant alter in lipoprotein metabolism. The serum TC content increased significantly in diabetic animals. The elevated hypertriglyceridemia was increased in the synthesis of triglyceride-rich lipoprotein particles very-low-density lipoprotein (VLDL) in liver diminished catabolism in diabetic rats. Since insulin has a potent inhibitory effect on lipolysis in adipocytes, insulin deficiency is associated with excess lipolysis and increased influx of free fatty acids to the liver.[24] The increased levels of LDL and VLDL in the diabetic animals might be due to overproduction of LDL and VLDL by the liver due to the stimulation of hepatic triglyceride synthesis as a result of free fatty acid influx. The HDL was significantly reduced in the diabetic rats which indicate a positive risk factor for atherosclerosis.[25] The levels of serum TC, TGs, LDL, and VLDL were significantly reduced in the plant extract-treated diabetic animals. This might be due to the reduced hepatic triglyceride synthesis and/or reduced lipolysis that might be due to the increased serum insulin levels, in the extract-treated animals. The HDL was significantly increased in the extract-treated animals indicating a reversed atherogenic risk. A reduced atherogenic index (TC/HDL) was recorded in the plant extract fed animals.

CONCLUSION

In the present study suggests that the aqueous leaf extract had synergetic hypoglycemic effect revealed by elevated serum insulin levels, depleted serum lipid levels, and, therefore, attributed to therapeutic value of the aqueous leaf extract of *M. elengi* to combat the diabetic condition in rats. This research studies will be more useful for diabetic people or pharmaceutical companies.

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