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HYPOGLYCEMIC AND HYPOLIPIDEMIC ACTIVITIES OF *VITEX AGNUS-CASTUS* EXTRACT IN STREPTOZOTOCIN INDUCED DIABETIC RAT

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ABSTRACT

The aim of present study was to investigate the hypoglycemic and hypolipidemic activities of Vitex agnus-castus extract on normal and streptozotocin-diabetic rats. Experimental diabetes was induced by intraperitonal injection of streptozotocin (STZ) in a single dose of 50 mg/kg. Oral administration of methanolic extract of Vitex agnus-castus 200 mg/kg body wt was given orally for 45 days. Experimental results showed that, streptozotocin significantly elevated the blood sugar level whereas treatment with methanolic extract of Vitex agnus-castus (200 mg/kg body wt.) depressed the streptozotocin induced high blood sugar level and also it shows the marked changes in the level of Insulin, Hemoglobin, Glycosylated hemoglobin, cholesterol and triglycerides. This study strongly suggests that the methanolic extract of Vitex agnus-castus attributed its prominent hypoglycemic activity on experimental diabetic rats through suppression of gluconeogenesis and stimulation of glucose oxidation using the pentose phosphate pathway.

KEYWORDS : *Vitex agnus-castus, diabetes mellitus, VACExt and streptozotocin.*

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INTRODUCTION

Diabetes mellitus is characterized by hyperglycemia together with biochemical alterations of glucose and lipid metabolism (Arky, 1982). Liver is an insulin dependent tissue, which plays a pivotal role in glucose and lipid homeostasis and is severely affected during diabetes (Seifter and England, 1982). Decreased glycolysis, impeded glycogenesis and increased gluconeogenesis are some of the changes of glucose metabolism in the diabetic liver (Baquer, 1998). During diabetes a profound alteration in the concentration and composition of lipid occurs (Sochor *et al.,* 1985).

Insulin has many actions within the central nervous system (CNS), including reduction of food intake, body weight and interacting in predictable ways with other controllers of meal size (McGowan *et al.,* 1990). On the other hand, its anabolic effects

in peripheral tissue would promote weight gain. These two major actions of insulin tend to counterbalance one another, as the peripheral anabolic effect of insulin would cause weight gain yet appetite would be suppressed via insulin's central catabolic action (Schwartz *et al.,* 1994). It is believed that insulin and leptin (Zhang *et al.,* 1994), an adipose tissue hormone, modulate energy homeostasis, such as causing change in food intake and body weight (Woods *et al.,* 1998).

Management of diabetes mellitus is considered a global problem and successful treatment is yet to be discovered. The modern drugs, including insulin and other oral hypoglycemic agents such as biguanides, sulphonylureas, alpha-glucosidase inhibitors are control the blood glucose level as long as they are regularly administered and they may also produce a number of undesirable effects. Increased side effects, lack of curative treatment for several chronic diseases, high cost of new drugs, microbial resistance and emerging diseases are some reasons for renewed public interest in complementary and alternative medicines (Humber, 2002).

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. So the traditional herbal medicines are mainly used which are obtained from plants, it plays important role in the management of diabetes mellitus (Patel and Srinivasan, 1997). In recent years, herbal medicines have started to gain importance as a source of hypoglycemic agents. Herbal treatments are becoming increasing by popular as the herbal preparations have no least side effects (Raja sekaran *et al.,* 2005). Many traditional plant treatments for diabetes mellitus are used throughout the world (Swanston Flatt *et al.,* 1990). Few of the traditional plant treatments for diabetes have received scientific scrutiny, and the World Health Organization has recommended that this area warrants attention (WHO, 1980). Therefore, in the present study, an investigation was made on the antidiabetic effect of a methanolic extract of *Vitex agnus-castus* leaves on in normal and STZ-induced diabetic rats.

MATERIALS AND METHODS

Experimental Animals

Adult male albino rats of Wistar strain (160-180 g) were procured from the Animal Experimental Laboratory of Tamil Nadu Veterinary and Animal Sciences, Chennai, India for the present the study. The animals were maintained in colony cages at 25 ± 2^{O}C, relative humidity of 45 ± 5% and maintained under 12 h light and 12 h dark cycles. The animals were fed with standard animals feed (Hindustan Lever Ltd.) and water *ad libitum*. All the animals were acclimatized for a week before use and they were maintained in hygienic environment in the animal house, J.J. College of Arts and Science, Pudukkottai. The study was conducted accordance with the rules and regulations of Institutional Animal Ethical Committee.

Induction of Diabetes mellitus

Diabetes mellitus was induced by single intraperitoneal injection of freshly prepared streptozotocin (STZ) 50 mg/kg body weight. STZ was dissolved in a freshly prepared 0.1 M cold citrate buffer pH 4.5. The control animals were administrated with only citrate buffer. Diabetes was developed and stabilized in the STZ treated rats over a period of 7 days. After 7 days of STZ administration, plasma glucose levels of each rat were calculated. Rats with fasting plasma glucose (FPG) range of 280 – 350 mg/dl were considered as diabetic and included in this study (Subash babu *et al.,* 2008). Blood was collected by sin ocular puncture.

Preparation of the *Vitex agnus-castus* extracts (VACExt)

Fresh disease free leaves of *Vitex agnus-castus* was collected from in and around Tiruchirappalli District, Tamil Nadu, India and identified by Rev. Dr. John Britto,, Botanist, St. Joseph's College, Tiruchirappalli. Voucher specimens were prepared in the form of herbaria and were deposited in Herbarium of St. Joseph's College, Tiruchirappalli. Shade dried and coarsely powdered leaves of *Vitex agnus-castus* (2 kg) were extracted with methanol by soxhelation at room

temperature for 48 hour. The extract was filtered and concentrated under reduced pressure using rotary evaporator to get completely dried extract (VACExt). The yield of the crude methanol extract was about 120g was used for the present study.

Acute toxicity study

The methanol extract of *Vitex agnus-castus* were tested for its acute and short-term toxicity in rats. The acute toxicity (LD50) of the extract was calculated by Miller and Tainter (1944). In brief, the method involved the administration of 5 different doses of the extract to 5 different groups of rats (6 rats per group). The number of death in each group and behavioral changes were observed over a period of 72 hours for sign of acute toxicity. The number of mortality caused by the VACExt within this period of time was observed in order to fix the lethal dose (LD50) of the compound (Lorke, 1983). The LD50 was estimated from the graph of percentage (%) mortality (converted to probit) against log-dose of the extract-probit 5 being 50%.

Dose Determination

To determine the effective dose in experimental animals, a total of 54 rats were utilized and the animals were randomly divided into 9 groups of six animals each as given below. Different doses (50, 100, 200 mg/kg b.w.) of VACExt were suspended in vehicle solution (DMSO 0.5%; 1ml/kg b.w.) and administered orally using an intragastric tube for 15 days daily to the respective groups. Reference drug glibenclamide (600 µg/ml b.w.) was suspended in distilled water as vehicle solution and administered orally for 15 days daily.

Experimental design

The rats were divided into seven groups (n=6)

Group 1 Normal control rats + Vehicle alone (DMSO 0.5%; 1 ml/kg b.w.)
Group2 Normal rats + 50 mg/kg b.w. VACExt
Group3 Normal rats + 100 mg/kg b.w. VACExt
Group4 Normal rats + 200 mg/kg b.w. VACExt
Group 5 Diabetic control rats + Vehicle alone (DMSO 0.5%; 1 ml/kg b.w.)
Group 6 Diabetic rats + 50 mg/kg b.w. VACExt
Group 7 Diabetic rats + 100 mg/kg b.w. VACExt
Group 8 Diabetic rats + 200 mg/kg b.w. VACExt
Group 9 Diabetic rats + 0.6 mg/kg b.w. Glibenclamide for 45 days.

Experimental protocol

The rats were divided into 5 groups of 6 rats each. VACExt was suspended in vehicle solution and administered orally using an intragastric tube for 45 days. Based on the tentative experiments, 200mg/kg b.w. VACExt was selected for the experiments.

Group 1 Normal rats + Vehicle alone
Group 2 Normal rats + 200mg/kg b.w. of VACExt
Group3 STZ induced diabetic rats + Vehicle alone
Group 4 STZ induced diabetic rats +200 mg/kg b.w. of VACExt
Group 5 STZ induced diabetic rats + Glibenclamide (0.6 mg/kg b.w.)

After 45 days of treatment, the 12 h fasted animals were anaesthetized between 7 am to 8 am, using ketamine (24 mg/kg b.w., intramuscular injection) and sacrified. Blood was collected in two different tubes (i.e.,) one with whole blood for serum separation and another with anticoagulant-potassium oxalate and sodium fluoride for plasma insulin assay.

Biochemical Analysis

Blood samples were collected from various groups of experimental animals periodically, in tubes with and without EDTA plasma and serum were separated by centrifugation at 3000 rpm and was analyzed for various hematological and biochemical parameters. The plasma glucose level was estimated by Glucose Oxidase peroxidase method of Trinder (1969). Plasma Insulin and C-peptide were estimated using Radio Immuno Assay (RIA) assay kits supplied by Linco Research Inc. (Stat Diagnostics, Mumbai). Haemoglobin in the blood was estimated by the method of Drabkin and Austin (1932). Glycosylated hemoglobin in the blood was estimated by the method of Sudhakar Nayak and Pattabiraman, (1981). Liver glycogen was extracted and estimated by the method of Morales *et al.,* (1975).

Total cholesterol in the plasma was estimated by the enzymatic method described by Allain *et al.,* (1974). HDL-cholesterol was estimated using the diagnostic kit based on the enzymatic method described by Izzo *et al.,* (1981). These were calculated using the formula (Friedwald *et al.,* 1972). Free fatty acids in the plasma and tissues were estimated by the method of Falholt *et al.,* (1973). Triglyceride in the plasma was estimated using the diagnostic kit based on the enzymatic method described by McGowan *et al.,* (1983).

RESULTS

The acute toxicity studies revealed the nontoxic nature of the *Vitex agnus-castus*. There was no lethality or any toxic reactions at any of the doses selected until the end of the study period. To determine the effective dose of VACExt and glycemic control in STZ induced diabetic rats, the different doses of VACExt such as 50, 100, and 200 mg/kg b.w. were administrated once a day for a period of 15 days to the diabetes induced rats. Oral administration of 200 mg/kg b.w. VACExt for 15th day significantly lowered the plasma glucose level (80%) in diabetic rats when compared to control diabetic rats. Since, VACExt at a dose of 200 mg/kg b.w. was fixed as effective dose for chronic experiment about 45days (Fig 1.1).

There was a significant decrease ($p < 0.05$) in the total body weight of the diabetic control rats compared to normal controls. Administration of VACExt for 45 days to diabetic rats (Groups IV and V) increased body weight significantly ($p < 0.05$) (Table 3.1).

Fasting blood glucose (FBG)

Fasting blood glucose level in the normal control rats remained unchanged during the course of the experiment. There was a significant ($p< 0.05$) increase in blood glucose level in diabetic rats after the STZ (50 mg/kg b.w.) administration. The oral administration of 200 mg/kg b.w. VACExt for 45 days on diabetic rats, the plasma glucose level was decreased when compared to normal rats. The VACExt significantly ($p<0.05$) reduced the plasma glucose levels to near normal level. Administration of standard drug glibenclamide (0.6mg/kg b.w.) decreased the plasma glucose level significantly ($p< 0.05$) (Fig 1.2).

Food intake

Food intakes were significantly (140.53% respectively) high in the diabetic control group when compared with normal group. Oral administration of VACExt for 45 days significantly increased the food intake in diabetic groups. Oral administration of VACExt (200 mg/kg b.w.) to normal rats did not show any significant effect. Administration of Glibenclamide (0.6mg/kg b.w.) to the diabetic rats showed an increase in food intake when compared to normal rats (Table 3.2).

Hemoglobin

The level of hemoglobin was decreased during diabetes than control group. Administration of VACExt (200 mg/kg b.w.) and Glibenclamide (0.6mg/kg b.w.) increased hemoglobin levels in diabetic rats than diabetic untreated rats. Oral administration of 200 mg/kg b.w. VACExt for 45 days did not show any changes the hemoglobin levels in normal rats. Glycosylated hemoglobin levels were significantly elevated in diabetic rats as compared with normal rats. Oral administration of 200 mg/kg b.w. VACExt for 45 days decreased the glycosylated hemoglobin levels to near normal status in diabetic rats. Oral administration of VACExt (200 mg/kg b.w.) to normal rats did not show any significant effect.

Plasma insulin

There was significant decrease in plasma insulin level in STZ-induced diabetic rats, when compared to normal control rats. Administrations of the VAC extract (200 mg/kg b.w.) and glibenclamide tends to significantly bring the level to normal (Table 3.3).

Glycogen

The level of glycogen decreased significantly ($p< 0.001$) in the STZ induced diabetic rats as compared to control. Treatment with the VAM extracts (200mg/kg) significantly ($p< 0.001$) increased the glycogen and brought them near to normal level (Table 3.3). The effect of standard drug glibenclamide on glycogen in diabetic rats was comparable to that of the herbal extract.

Oral Glucose Tolerance (OGT)

The blood glucose levels of the normal rats reached a peak at 60 minutes after the oral administration of glucose and gradually decreased to pre-glucose load level. The VACExt 200 mg/kg dose caused a significant attenuation in the blood glucose at 180 minutes compared to the vehicle-treated control group-I ($P<0.05$). Glibenclamide (0.6mg/kg) also produced a significant decrease ($P<0.01$) in blood glucose level at 180 minutes after the administration of the oral glucose load. Oral administration of VACExt (200mg/kg b.w.) to normal rats did not show any significant effect (Table 3.4).

Cholesterol

In STZ induced diabetic rats, the serum cholesterol level was 203.9mg/dl. The cholesterol level was (172.43%) increased in diabetic rats when compared to normal rats. Oral administration of 200 mg/kg b.w. VACExt for 45 days decreased the cholesterol levels in diabetic rats. There was a significant decrease in serum cholesterol ($P<0.05$) in Glibenclamide (0.6mg/kg) treated rats, when compared to the vehicle-treated control rats (Table 3.5).

Serum Triglyceride (TG) and free fatty acid

A marked increase in the frequency of triglycerides (155.23%) and free fatty acids (153.35%) were observed in diabetic control rats. Treatment with VACExt (200mg/kg) significantly reduced the lipid levels. The oral administration of Glibenclamide (0.6mg/kg) to STZ induced diabetic rats caused a significant decrease in the serum TG and free fatty acid ($P<0.01$) when compared to the control rats (Table 3.5).

LDL, VLDL and HDL

The diabetic rats had elevated levels of LDL and VLDL and decreased level of HDL when compared with normal control rats. Oral administration with VACExt (200mg/kg) and Glibenclamide (0.6mg/kg) for 45 days significantly increased the HDL levels and decreased the LDL and VLDL levels towards near normal, respectively (Table 3.6).

DISCUSSION

Streptozotocin is well known for its selective pancreatic islet β-cell cytotoxicity and has been extensively used to induce diabetes mellitus in animals. It interferes with cellular metabolic oxidative mechanisms (Papaccio, 2000). Intraperitoneal administration of streptozotocin (50 mg/kg) effectively induced diabetes in normal rats as reflected by glycosuria, hyperglycaemia, polyphagia, polydipsia and body weight loss when compared with normal rats (Calabresi and Chabner, 2001).

The STZ induced diabetic rats, the body weight was decreased significantly than control. It might be due to the catabolism of fats, protein and insulin deficiency. Similarly, Defranzo *et al.* (1992) reported that decrease in body weight is due to continuous excretion of glucose and glycogen synthesis. Oral administration of VACExt significantly improves body weight in diabetic rats. The decrease in the weight was prevented by administration of VACExt partially improved the body weight in STZ induced diabetic rats.

The present results reveal that an aqueous extracts of *Vitex agnus-castus* reverse these effects. This might be due to antihyperglycemic potentiation of VACExt and enhanced pancreatic secretion of insulin from β-cell of islets. This was clearly evidenced by the increased level of insulin in diabetic rats treated with VACExt. In this context a number of other plants- *Smilax chinensis* L and *Momordica charantia* have also been reported to have antihyperglycemic and insulin-release stimulatory effect (Prince *et al*., 1998; Pari and Uma Maheswari, 1999). The increased levels of plasma glucose in STZ induced diabetic rats were lowered (78.05%) by VACExt administration.

The plasma glucose lowering activity was compared with Glibenclamide, a standard hypoglycemic drug. Glibenclamide has been used for many years to treat diabetes, to stimulate insulin secretion from pancreatic β-cells (Tian *et al.,* 1998). From the results of the present study, glucose lowering effect of VACExt results on the plasma insulin release from pancreatic β-cells of the islets of Langerhans. It directly indicates that part of the antihyperglycemic activity of VACExt is

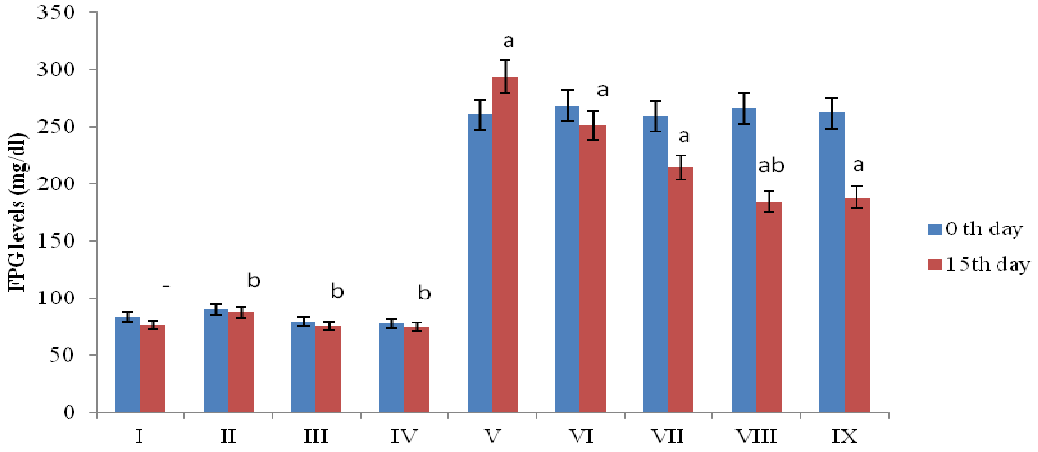
through release of insulin many folds probably through β-cells stimulation resembling direct insulin secretory effect. Insulin secretory effect of VACExt is directly related to the increased glucose level in STZ induced diabetic rats. In the present study, the administration of VACExt showed a significant effect, without inducing hypoglycemic stage. Insulin regulates blood glucose primarily by stimulating uptake of glucose into muscle and adipose tissue and by inhibiting hepatic glucose production. Insulin resistance plays an important role in the pathogenesis of type 2 diabetes. One of the hallmarks of diabetes is the inability of insulin to inhibit hepatic glucose production (Hofmann *et al.,* 1992).

There was a decrease in total haemoglobin while diabetes and this may be due to the formation of glycosylated haemoglobin. But, it was increased in the level of haemoglobin in animals administrated with VACExt. It would be due to decreased level of blood glucose and glycosylated haemoglobin. Administration of VACExt on streptozotocin dosed animals reversed the weight loss. The ability of recovering body weight might to be due to the antihyperglycemic effect of VAC extract. The glycosylated hemoglobin (HBA_1C) gives an accurate reflection of mean plasma glucose concentration and correlates best with the degree of glycemia (Danze *et al.,* 1987). Oral administration of VACExt prevents a significant elevation in Glycosylated hemoglobin thereby increasing the level of total hemoglobin in diabetic rats. This could be due to the result of improved glycemic control hemoglobin in diabetic rats.

Excess of fatty acids in serum produced by the streptozotocin-induced diabetes promotes conversion of excess fatty acids into phospholipids and cholesterol in liver. These two substances along with excess triglycerides formed at the same time in liver may be discharged into blood in the form of lipoproteins (Bopanna *et al.,* 1997). The abnormal high concentration of serum lipids in the diabetic subject is due, mainly to increase in the mobilisation of free fatty acids from the peripheral fat depots, since insulin inhibits the hormone sensitive lipase. Hypercholesterolemia and hypertriglyceridemia have been reported to occur in streptozotocin diabetic rats (Sharma *et al.,* 1996; Pushparaj *et al.,* 2000) and significant increase was observed in the present experiment also and it accordance with the above studies. The marked hyperlipidaemia that characterize the diabetic state may therefore be regarded as a consequence of the uninhibited actions of lipolytic hormones on the fat depots (Goodman and Gilman, 1985).

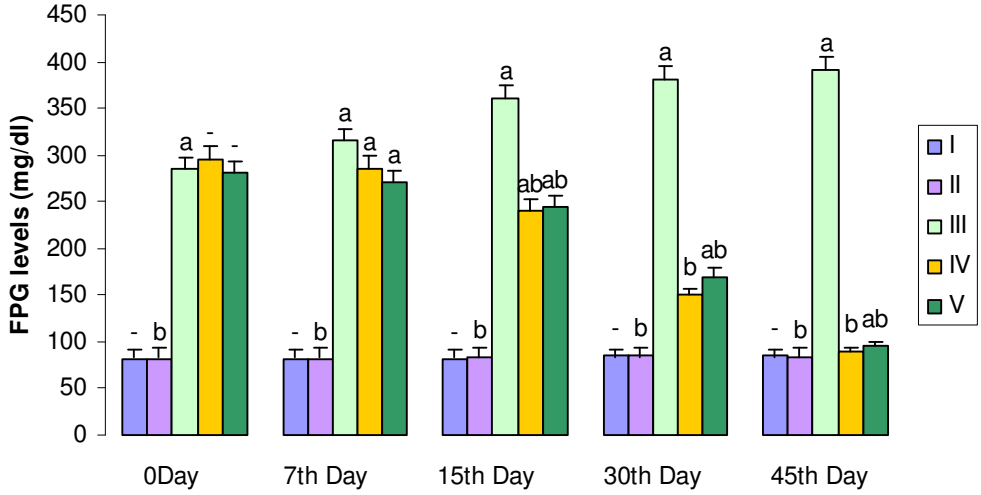
It is well known that in uncontrolled type 2 diabetes mellitus, shown an increase in the levels of TC, LDL and VLDL-cholesterol and triglyceride HDL level was declined by contributing to secondary complications (Palumbo, 1998; Arvind *et al.,* 2002). High levels of total cholesterol and more importantly LDL-cholesterol in blood are major coronary risk factors. Insulin deficiency or insulin resistance may be responsible for dyslipidemia, because insulin has an inhibitory action on HMG-coA reductase, a key rate-limiting enzyme responsible for the metabolism of cholesterol rich LDL particles. Acute insulin deficiency initially causes an increase in free fatty acid mobilization from adipose tissue, this resulted an increase in the production of cholesterol rich LDL particle (Murali *et al.,* 2002). Oral administration of VACExt normalized these effects, possibly by controlling the hydrolysis of certain lipoproteins and their selective uptake and metabolism by different tissues.

Figure 1.1: Effect of different doses of VACExt on fasting plasma glucose level (mg/dl) in normal and STZ induced diabetic rats



I (Normal control) II (Normal + 50 mg/kg b.w. VACExt)
III (Normal + 100 mg/kg b.w. VACExt) IV (Normal + 200 mg/kg b.w. VACExt)
V (Diabetic control) VI (Diabetic + 50 mg/kg b.w. VACExt)
VII (Diabetic + 100 mg/kg b.w. VACExt) VIII (Diabetic + 200 mg/kg b.w. VACExt)
IX (Diabetic + 0.6 mg/kg b.w.) glibenclamide

Figure1.2: Changes in fasting plasma glucose level (mg/dl) in 45 days treatment with effective dose of VACExt (200 mg/kg b.w.) on control and STZ induced diabetic rats



I (Normal control) II (Normal + 200 mg/kg b.w. VACExt)
III (Diabetic control) IV (Diabetic + 200 mg/kg b.w. VACExt)
V (Diabetic + 0.6 mg/kg b.w.) glibenclamide

Table 3.1: Changes on the body weight of VACExt (200 mg/kg b.w.) treated, STZ induced diabetic and control rats

Groups	Initial body weight (g)	Final body weight (g)
Group-I Control	190.83±2.35^{-}	225.65±3.65^{-}
Group-II VACExt 200 mg/kg	188.32±4.25^{-}	223.10±4.92^{b}

Group-III Diabetic control	200.16±5.23^{-}	150.63±5.50^{a}
Group-IV Diabetic + VACExt 200 mg/kg	210.66±2.58^{-}	235.83±6.29^{b}
Group-V Diabetic + glibenclamide 0.6mg/kg	208.50±5.66^{-}	232.67±5.84^{b}

Table 3.2: Food (g/day) intake levels in control and STZ induced diabetic rats

Groups	Food Intake (g/day)
Group-I Control	54.35±2.30^{-}
Group-II VACExt 200 mg/kg	55.82±5.10^{-}
Group-III Diabetic control	66.16±3.53^{-}
Group-IV Diabetic + VACExt 200 mg/kg	61.54±6.18^{-}
Group-V Diabetic + glibenclamide 0.6mg/kg	60.50±4.25^{-}

Each value is mean ± S.E.M for 6 rats in each group

a: $p<0.05$ by comparison with normal rats

b: $p< 0.05$ by comparison with streptozotocin induced diabetic rats

-: Not significant

Table 3.3: Changes on the level of Hemoglobin (Hb), Glycosylated hemoglobin (HbA_1C), plasma insulin and hepatic glycogen level in control and STZ induced diabetic rats

Groups	Hb (mg/dl)	HbA1C (mg/g of Hb)	Plasma Insulin (IU/L)	Hepatic glycogen (g/100 g wet tissue)
Group-I Control	11.41±1.67^{-}	0.42±0.04^{-}	13.00±1.36^{-}	3.45±0.57^{-}
Group-II VACExt 200 mg/kg	11.25±0.85^{b}	0.41±0.03^{b}	13.33±0.40^{b}	3.51±0.31^{b}
Group-III Diabetic control	07.20±0.87^{a}	1.52±0.50^{a}	4.39±0.49^{a}	1.32±0.18^{a}
Group-IV Diabetic + VACExt 200 mg/kg	11.34±0.89^{b}	0.53±0.29^{b}	12.06±0.76^{ab}	2.70±0.40^{b}
Group-V Diabetic + glibenclamide 0.6mg/kg	10.05±0.96^{b}	0.57±0.04^{ab}	11.69± 0.83^{ab}	2.31±0.35^{ab}

Table 3.4: Oral Glucose Tolerance test in control and STZ induced diabetic rats

Groups	0 min	30 min	60 min	120 min	180 min
Group-I Control	85.36±3.51^{-}	84.54±5.20^{-}	82.46±4.51^{-}	80.47±5.81^{-}	78.77±7.15^{-}
Group-II VACExt 200 mg/kg	83.45±5.42^{b}	82.36±7.32^{b}	80.82±5.5^{b}	77.26±5.82^{-}	76.58±4.31^{b}

Group-III Diabetic control	340.62±5.60[a]	390.23±4.92[a]	392.65±5.64[a]	390.42±7.30[a]	380.48±6.10[a]
Group-IV Diabetic + VACExt 200 mg/kg	95.82±6.42[b]	135.78±5.52[ab]	100.25±4.32[b]	90.63±4.81[b]	85.26±6.52[b]
Group-V Diabetic + glibenclamide 0.6mg/kg	88.78±4.73[b]	160.58±6.63[ab]	162.52±6.31[ab]	112.25±5.72[ab]	97.46±6.44[ab]

Each value is mean ± S.E.M for 6 rats in each group

a: p<0.05 by comparison with normal rats

b: p< 0.05 by comparison with streptozotocin induced diabetic rats

-:Not significant

Table 3.5: Changes on the concentration of serum cholesterol, triglyceride and free fatty acid in Control and STZ induced diabetic rats

Groups	Total Cholesterol (mg/dl)	Triglyceride (mg/dl)	Free fatty acids (mg/dl)
Group-I Control	118.25±6.5	52.34±1.31	62.86±2.47
Group-II VACExt 200 mg/kg	117.18±4.16[b]	52.79±1.16[b]	62.16±4.06[b]
Group-III Diabetic control	203.90±3.81[a]	81.25±6.28[a]	96.40±2.02[a]
Group-IV Diabetic + VACExt 200 mg/kg	124.47±5.91[b]	57.00±2.74[ab]	68.75±4.79[ab]
Group-V Diabetic + glibenclamide 0.6mg/kg	129.53±2.56[ab]	59.76±2.34[ab]	71.00±5.66[ab]

Table 3.6: Effect of VACExt treatment on serum HDL, LDL and VLDL levels in Control and STZ induced diabetic rats.

Groups	HDL-Cholesterol (mg/dL)	LDL-Cholesterol (mg/dL)	VLDL-Cholesterol (mg/dL)
Group-I Control	39.44±1.92	19.92±2.53	15.35±1.79
Group-II VACExt 200 mg/kg	40.93±3.32[b]	20.31±2.61[b]	16.61±2.29[-]
Group-III Diabetic control	22.09±1.73[a]	70.41±4.05[a]	38.82±2.27[a]
Group-IV Diabetic + VACExt 200 mg/kg	35.75±3.72[b]	28.92±3.59[b]	19.86±1.08[b]
Group-V Diabetic + glibenclamide 0.6mg/kg	33.69±1.38[b]	32.3±2.03[b]	22.18±2.54[b]

Each value is mean ± S.E.M for 6 rats in each group

a: p<0.05 by comparison with normal rats

b: p< 0.05 by comparison with streptozotocin induced diabetic rats

-: Not significant

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