Innovations

Antidiabetic Effect of *Azima Tetracantha* extract in Streptozotocin-Induced Diabetic Wistar Rats

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Abstract

The aim of this study was to evaluate the antidiabetic activity of the aqueous extract of Azima tetracantha in streptozotocin-induced diabetic rats.Diabetes mellitus wasinduced by single intraperitoneal administration of streptozotocin (45 mg/kg) and diabetic rats were treated with 300mg/kg bodyweight of the extract(s) for 30 days.Antidiabetic effect was monitored by body weight, blood glucose level, serum total cholesterol, serum triglycerides, HDL-Cholesterol, LDL-Cholesterol, liver glycogen, LPO, SOD, GSH and Catalase levels in diabetes induced rat (induced by Streptozotocin). Diabetic rat treated with 45 mg/kg body weight of aqueous extract of Azima tetracanthafor 30 days showed a significant decline in their blood glucose level, total cholesterol, triglycerides,LDL-Cholesterol and significantly increased HDL-Cholesterol and liver glycogen.In diabetic rat, a significant elevated LPO level was detected but later restored to normal after the intraperitoneal administration of Azima tetracanthaextract. The levels of SOD, GSH and Catalase had a significant decrease in diabetic rat. Subsequently, administration of Azima tetracanthaextract was done which resulted in increased SOD, GSH and Catalase levels.Thus the present findings suggested that the aqueous extract of Azima tetracanthahad a good antidiabetic potential in enhance the diabetic condition in Wistar rat.

Keywords : *Azima tetracantha, Streptozotocin, Wistar rat, antidiabetic activity*

1. Introduction

Diabetes mellitus is a common and chronic disease characterized by hyperglycemia. It is very prevalent disease affecting the citizens of both developed and developing countries. As estimated by the World Health Organization more than 176 million people are suffering from this disease globally (WHO, 2006). The number is estimated to rise to 642 million by the year 2040 and it was also estimated to cause the mortality of a person every 6 s in year 2015 (IDF, 2017). Diabetes mellitus is caused by the abnormality of carbohydrate metabolism which is linked to low blood insulin (Maitie*t al.,*2004). The common cause of chronic morbidity and disability among the working population is the complications which are caused due to diabetes. Type 2 diabetes mellitus begins with a period of insulin resistance with increased pancreatic insulin secretion. As the disease advances, pancreatic functions are decreased and are no longer able to meet peripheral requirements.Thus, insulin levels fail to sustain with the body requirements (Inzucchi, 2003).The increase in blood glucose level of diabetic patients usually leads to excessive generation of free radicals and aberration in lipid metabolism which have been associated with virtually all complications of diabetes mellitus. Diabetic complication has reported to develop in patients with diabetes and has become one of leading causes of mortality worldwide (Snehal*et al*. 2017).Cardiovascular diseases, neuropathy, nephropathy, and retinopathy are among the major risks that are associated with diabetes. These chronic complications may lead to hardening and narrowing of arteries (atherosclerosis) that could advance to stroke, coronary heart disease and other blood vessel diseases, nerve damage, kidney failure, and blindness with time (Rubin *et al*. 2012). Diabetes mellitus can be managed by diet, physical exercise, and modern drugs (insulin and/or oral hypoglycemic drugs such as sulfonylureas and biguanides)(Koski, 2006). Different extracts from medicinal plants have also been used traditionally to manage diabetes globally and these are considered as relatively inexpensive, less toxic and with relatively little or no side effects (Gupta *et al*. 2008). There are also medicinal plants that contain some toxic constituents such as the cytotoxic anti-cancer plant derived drugs, digitalis; however, the side effects of the phytotherapeutic agents are less common compared with synthetic drugs (Calixto, 2000).

Azima tetracantha belongs to the family, Salvadoraceae and known as mulchangu in Siddha and kundali in Ayurvedha (Kirtikar and Basu, 2001). It occurs naturally in Central, Eastern and South Africa as well as in the Indian Ocean islands

and extends through Arabia to tropical Asia. In East Africa the pounded roots of *A. tetracantha* are applied directly to snakebites and an infusion is taken orally as a treatment for them, while in Zimbabwe a mixture of roots and leaves is used similarly (Ekbote*et al*. 2010). The plant parts of *Azima tetracantha* such as roots, leaves, fruits and stems are used traditionally to treat various ailments and possesses activities like stimulant, expectorant, antispasmodic, analgesic, anti-inflammatory, anti-ulcer, anti-diarrhoeal, anti-microbial, hepatoprotective, nephroprotective, hypoglycemic and hyperlipidemic activities (Khare, 2007).This study was done with the extracts of *Azima tetracantha* goal to explore the antidiabetic activity of *Azima tetracantha* on diabetes induced Wistar rats, where Streptozotocin was used for diabetic induction.

2. Materials and methods

2.1. Collectionand Preparation of Leaf extract

Azima tetracantha leaves were collected from the surroundings of Srivilliputhur and Krishnankoil, Virudhunagar District, Tamil Nadu, India (It is located 9.51 latitude and 77.63 longitude). This plant specimen was authenticated at the PG Department of Botany, Ayya Nadar Janaki Ammal College, Sivakasi. Fresh and healthy leaves were collected locally and rinsed thoroughly first with tap water followed by distilled water to remove all the dust and unwanted visible particles, cut into small pieces and dried at room temperature. About 10 g of these finely incised leaves of each plant type were weighed separately and transferred into 250 ml beakers containing 100 ml distilled water and boiled for about 20 min. The extracts were then filtered thrice through Whatman No. 1 filter paper (HiMedia) to remove particulate matter and to get clear solutions which were then refrigerated (4°C) in 250 ml Erlenmeyer flasks for subsequent experiments(Paramasivam *et al*. 2017).

2.2. Experimental Animals

Wistar albino male rats (120-180 g) were selected for the study. The protocol of experimental and conditions were accepted by the official Review Board at TANBIO R and D solution, Periyar Maniammai Institute of Science and Technology, Vallam, India (Ethical Number – SAC/IAEC/BC/2020-CP-005).All the animals were housed in polypropylene cages at standard husbandry conditions at temperature (22° C), 12 hlight/dark cycle, under relative humidity of 50% ± 5with standard pellet diet and water ad libitum.They were initially acclimatized for the study.

2.3. Acute toxicity studies

Acute toxicity studies for fixing the dosage level before experimentation was performed(Ghosh *et al*. 2019). According to CPC SEA, OECD guide lines, the dosage level was fixed in which animals were divided into 3 groups. Each group containing 3 animals. The aqueous ex tract of *Azima tetracantha* was administered

intraperitoneally. Each group was given a different concentration. 3 groups were given 100 mg/ kg, 250 mg/ kg and 500 mg per kg body weight of animal respectively. Additionally, symptoms like lethargy, salivation, coma, tremors, convulsions, diarrhea and lethality were also observed.

2.4. Diabetes induction

After acclimatization for a week, rats were fasted overnight. Thenext day, streptozotocin dose was calculated based on bodyweight. Streptozotocin was diluted with (0.1 M) citrate buffer solution (pH 4.5) and intraperitoneal injection of 60 mg/kg of bodyweight for the experimental study. The same volume of buffersolution was given to normal control rats. Glucose concentrationsof rats measured after 72 h, using test strips glucometer (ACCUCHEK Active, Germany). One droplet of blood samples was loaded from a tail vein incision onto each strip. Rats of 200 mg/dl blood glucose or above were considered as diabetic (AlFaris *et al*. 2020; Karigidi and Olaiya, 2020). The standard (glibenclamide) and herbal formulation were suspended in 1% w/v carboxymethyl cellulose (CMC) and administered once daily through oral gavage for 30 consecutive days.

2.5. Experimental design

The male Wistar rats were randomly divided into six groups each group contains six rats, the rats groups then named and treated as follows: Group I – normal rats, Group II – STZ induced diabetic rats, Group III: STZ (45mg/kgbw) induced diabetic rats were treated with aqueous extract of *A. tetracantha* (100mg/kgbw), Group IV: STZ (45mg/kgbw) induced diabetic rats were treated with aqueous extract of *A. tetracantha* (200mg/kgbw),Group V: STZ (45mg/kgbw) induced diabetic rats were treated with aqueous extract of *A. tetracantha* (300mg/kgbw) and Group VI: STZ (45mg/kgbw) induced diabetic rats were treated with Glibenclamide (1mg/kgbw). The period of treatment was 30 days for all groups (AlFaris *et al*. 2020; Karigidi and Olaiya, 2020).

2.6. Collection of blood samples

Blood samples were collected in all groups of rats in clean sterile Eppen-dorf tubes followed by separation of serum by centrifugation and stored at - 20 °C for further analysis (Renittae*t al*. 2020).

2.7. Monitoring rat body weight

The body weight of normal, diabetic induced and diabetic rats treated with Azima tetracantha extract were noted on 0^{th} day and 30 th day of experimental study(Renittae*t al*. 2020).

2.8. Biochemical measurements

2.8.1. Estimation of Blood Glucose

FBG levels (mg/dl) of rats of all groups were estimated every week after overnight fasting by glucometer (Biogen, Bangalore) (AlFaris *et al*. 2020; Karigidi and Olaiya, 2020).

2.8.2. Lipid profiles

Serum and liver total cholesterol (Gupta *et al*. 2016), triglycerides (Gupta *et al*. 2016), LDL-C (Yim*et al*. 2019), HDL-C (Yim*et al*. 2019)and liver glycogen levels in the animals were determined by enzymatic colorimetric methods using diagnostic kits (Crescent, Jeddah, KSA).

2.8.3. LPO and Antioxidant enzymes activity

The antioxidant parameters like lipid peroxidase (LPO), superoxide dismutase (SOD), reduced glutathione (GSH) and Catalase (CAT) levels were determined by live tissues (Pottathil *et al*. 2020).

2.9.Statistical analysis

The study results were analysed statistically by SPSS V. 21 software. Data were expressed as mean and stand deviation (Mean ± SD). One-way analysis of variance ANOVA and turkey's multiple post hoc test were utilized to determine the significant differences ($P < 0.05$) between groups.

3. Result

3.1. Effect on Body weight

Body weights of all rats groups were similar at the starting of the experiment. Initial and final week, weight decreased in all groups, except in the control, which increased and it was comparable to that of reference drug, glibenclamide. In the initial week, statistically there was no difference in body weight. In final week the body weight of the Group II animals were significantly decreased when compared to Group I animals.Whereas Group III, Group IV, Group V and Group VI animals were significantly increased when compared to Group II animals (Fig. 1 and Table 1).

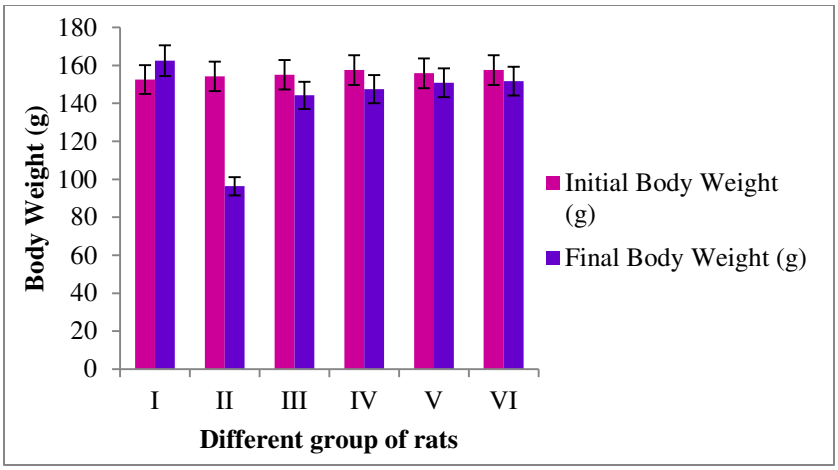

Fig. 1.Effect of *A. tetracantha* extracts on body weight in normal and experimental rats

Table 1. Effect of *A. tetracantha* extracts on body weight in normal and experimental rats

Groups	Initial Body Weight (g)	Final Body Weight (g)
I	152.50 ± 2.14	162.5±2.14
II	154.17 ± 2.14[a]	96.33±1.56 [a]
III	155.00 ± 1.83 [b]	144.17±1.54 [b]
IV	157.50 ± 1.12 [b]	147.5±1.12 [b]
V	155.83 ± 1.54[b]	150.83±1.54 [b]
VI	157.50 ± 1.71[ab]	151.67±1.67 [ab]

Data are expressed as mean ± SEM, n =6. [a] p <0.05 when experimental groups were compared with control group, [b] p <0.05 when experimental groups were compared with diabetic control group.

3.2. Effect on fasting blood glucose

The Group II animals showed significant higher glucose level when compared to the Group I animals. Whereas Group III, Group IV and Group V treated animals and Group VI animals were significantly decreased the glucose levels. Highly significant differences were observed between Group II animals and animals from all other groups, with $P < 0.05$. However, the *A. tetracantha* extract and glibenclamide inhibited the glucose level in Group II (Fig. 2).The results are presented inTable 2. Group II animals showed severe hyperglycemia comparedto Group I animals. The mean blood glucose level in the Group II animals on day 0 was 81±1.24mg/dl and onday 30 was 214±1.53mg/dl. It was observed that the standarddrug glibenclamide (Group VI animals) lowered the blood glucose level

significantly. *A. tetracantha* extract in Group III showed133.83±0.91, Group IV showed 114.17±1.05and Group V showed 101.5±0.85significantly decreased the blood glucose level on 30th days, as compared to the Group II.

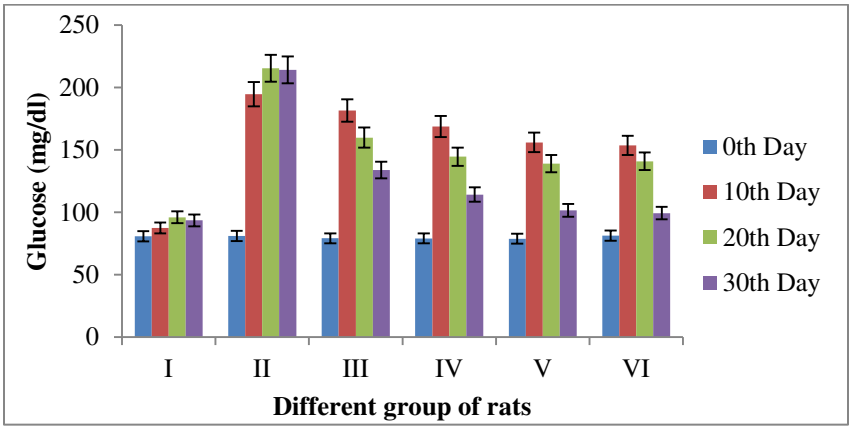

Fig. 2. Effect of *A. tetracantha* extracts on Glucose (mg/dl) in normal and experimental rats

Table. 2. Effect of *A. tetracantha* extracts on Glucose (mg/dl) in normal and experimental rats

Groups	0th Day	10th Day	20th Day	30th Day
I	80.83±1.01	87.33±0.95	96±0.93	93.5±0.89
II	81±1.24[a]	194.67±1.45[a]	215.33±1.17[a]	214±1.53[a]
III	79.17±1.01[b]	181.5±0.62[b]	159.83±0.65[b]	133.83±0.91[b]
IV	79±1.06[b]	168.67±0.88[b]	144.5±1.38[b]	114.17±1.05[b]
V	78.83±0.7[b]	156±1.24[b]	139±0.97[b]	101.5±0.85[b]
VI	81.33±1.05[ab]	153.5±1.26[ab]	140.83±0.7[ab]	99.33±0.61[ab]

Data are expressed as mean ± SEM, n =6. [a] p <0.05 when experimental groups were compared with control group, [b] p <0.05 when experimental groups were compared with diabetic control group.

3.3. Effects on total cholesterol

The result of the current study revealed a significantly increased when compared to Group I animals with high significant differences (P < 0.05). After the treatment with aqueous extract of *Azima tetracantha*, a gradually decrease in the alteration of lipid mechanism was observed which was evidenced by decreased serum to total cholesterol level (Fig. 3 and Table 3).

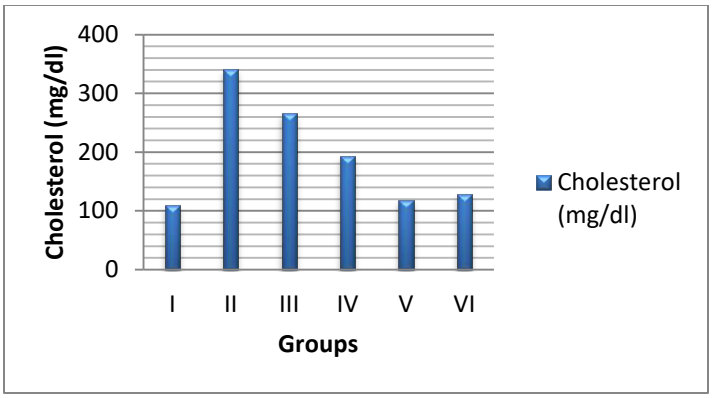

Fig. 3. Effect of *A. tetracantha* extracts on cholesterol mg/dl) in normal and experimental rats

Table. 3. Effect of *A. tetracantha* extracts on lipid profile and liver glycogen in normal and experimental rats

Groups	Cholesterol (mg/dl)	Triglyceride (mg/dl)	HDL-CL (mg/dl)	LDL-CL (mg/dl)	Liver Glycogen (mg/g)
I	109±6.82	99.67±1.87	59.5±6.5	36.27±3.99	134.42±10.54
II	340.67±4.98 [a]	225.26±9.84 [a]	39.33±3.24 [a]	180.33±2.04 [a]	72.25±4.75 [a]
III	266±5.39 [b]	193.33±3.49 [b]	45.5±2.74 [b]	160.5±1.5 [b]	80.89±4.01 [b]
IV	193.83±5.68 [b]	155.67±2.96 [b]	51.67±2.53 [b]	118.33±3.02 [b]	100.46±2.72 [b]
V	118.67±4.03 [b]	103.83±1.74 [b]	56.54±2.39 [b]	87.83±1.68 [b]	119.73±8.84 [b]
VI	129±1.46 [ab]	101.17±1.89 [ab]	41.38±1.46 [ab]	65.33±1.43 [ab]	125.6±8.05 [ab]

Data are expressed as mean ± SEM, n =6. [a] p <0.05 when experimental groups were compared with control group, [b] p <0.05 when experimental groups were compared with diabetic control group.

3.4. Effects on triglyceride

A significant rise in the triglyceride levels were seen in Group II animals when compared to Group I animals with high significant differences (P < 0.05).Whereas GroupIII, GroupIV, Group V and GroupVI treated animals were significantly decreased the triglycerides (TG)when compared with Group-II as represented in Fig. 4 and Table 3.

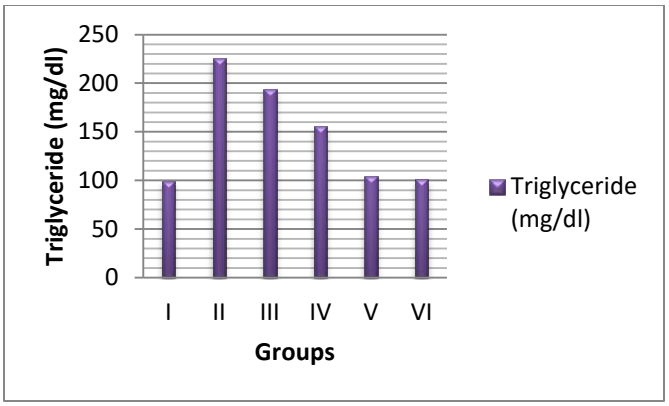

Fig. 4. Effect of *A. tetracantha* extracts on triglyceride (mg/dl) in normal and experimental rats

3.5. Effects on HDL-CL

HDL was lowered in Group II animals when compared to Group I animals. The administration of *A. tetracantha*leaf extract gradually improved the levels of HDL in Group III, Group IV and Group V as compared to Group II. Similarly Group VI treated animals were significantly increased in HDL (Fig.5 and Table 3).

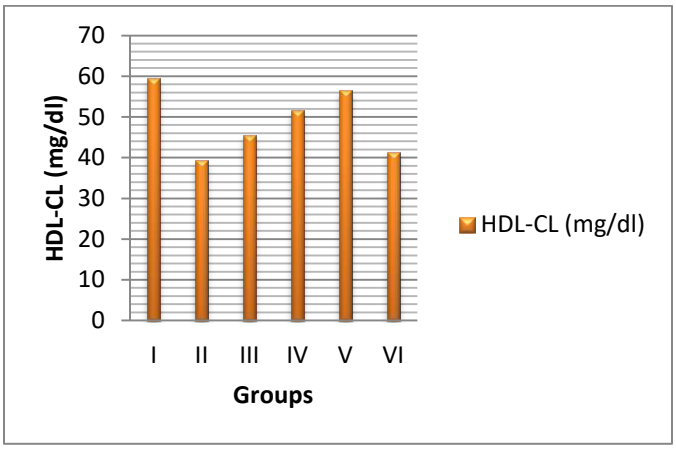

Fig. 5. Effect of *A. tetracantha* extracts on HDL-CL (mg/dl) in normal and experimental rats

3.6. Effects on LDL-CL

LDL were analysed in Group I, Group II, Group III, Group IV and Group V and Group VI. LDL in Group II animals were significantly increased when compared to Group I animals with high significant differences ($P < 0.05$).Whereas GroupIII, GroupIV, Group V and GroupVI treated animals were significantly decreased the LDL when compared with Group-II (Fig.6 and Table 3).

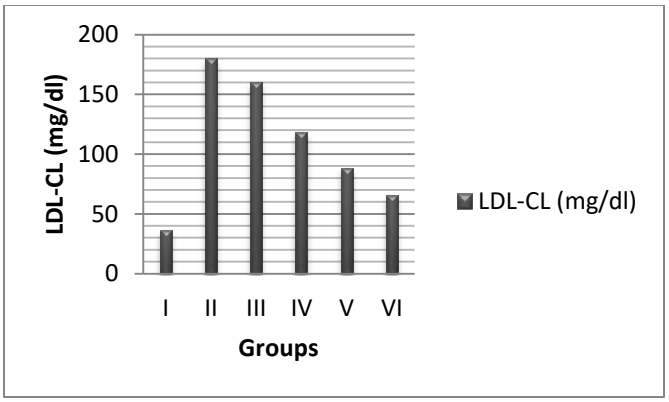

Fig. 7. Effect of *A. tetracantha* extracts on LDL-CL (mg/dl) in normal and experimental rats

3.7. Effects on Liver glycogen

Liver Glycogen were lowered in Group II animals when compared to Group I animals. The administration of *A. tetracantha*leaf extract gradually improved the levels of liver glycogen in Group III, Group IV and Group V as compared to Group II. Similarly Group VI treated animals were significantly increased liver glycogen (Fig.7 and Table 3).

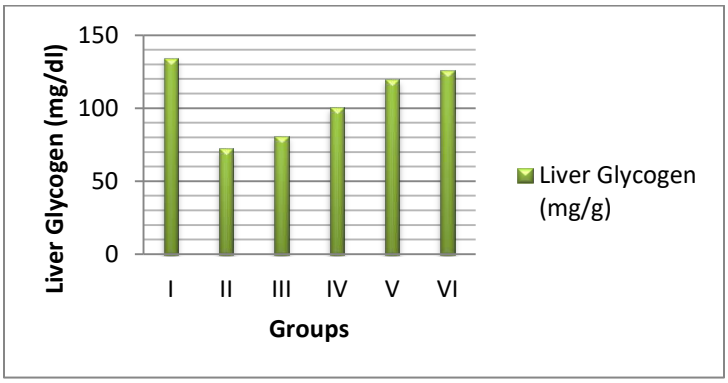

Fig. 7. Effect of *A. tetracantha* extracts on Liver glycogen (mg/dl) in normal and experimental rats

3.8. Effects on LPO

The hepatic function of diabetic rats was studied in terms of lipid peroxidase (LPO). The effect of *A. tetracantha* on erythrocyte antioxidant enzymeand lipid peroxidation of Streptozotocin intoxicated rats ispresented showed in Fig 8 and Table 4. The lipid peroxidase in Group II animals were significantly increased when

compared with Group I animals. Whereas Group III, Group IV, Group Vand Group VI treated animals were significantly decreased.

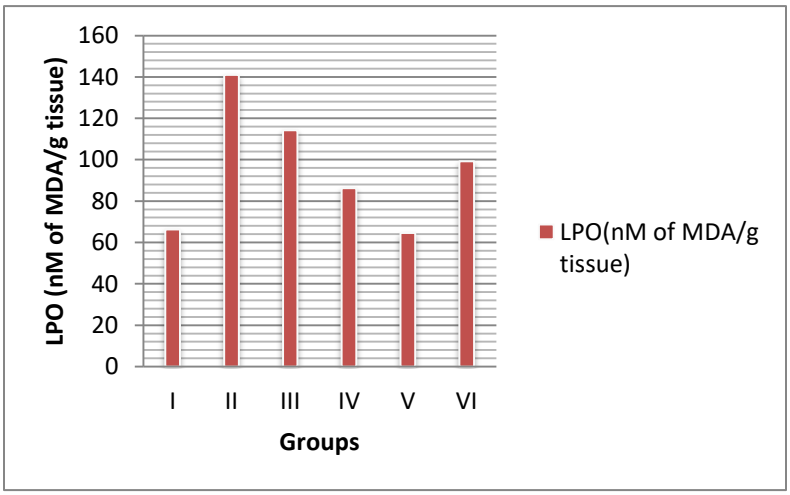

Fig. 8. Effect of *A. tetracantha* extracts on LPO in normal and experimental rats

Table 4. Effect of *A. tetracantha* extracts on LPO and Antioxidant enzymes in normal and experimental rats

Groups	LPO(nM of MDA/g tissue)	SOD (mg of Epinephrine oxidized /mg protein)	GSH (mg/g tissue)	CATALASE (mg of H_2O_2 hydrolyzed/mg protein)
I	66.33±1.96	13.94±1.05	18.67±0.83	39.1±0.97
II	141±2.41 [a]	5.68±0.63 [a]	11.17±1.17 [a]	14.2±2.11 [a]
III	114.33±1.89 [b]	7.08±0.59 [b]	16.42±0.2 [b]	25.1±0.84 [b]
IV	86.33±2.89 [b]	8.71±0.52 [b]	17.17±0.94 [b]	31.9±1.2 [b]
V	64.67±1.91 [b]	13.08±0.64 [b]	18.33±0.42 [b]	37.9±0.48 [b]
VI	99.33±3.85 [ab]	6.5±0.27 [ab]	15.92±1.14 [ab]	22.81±0.44 [ab]

3.9. Effects on SOD, GSH and Catalase

The antioxidant enzymes like SOD, Catalase and GSH in Group II were significantly decreased when compared with Group I. Whereas Group III, Group IV,

Group V and Group VI treated animals were significantly increased level of SOD, Catalase and GSH when compared with Group-II as shown in Fig. 9 and Table 4.

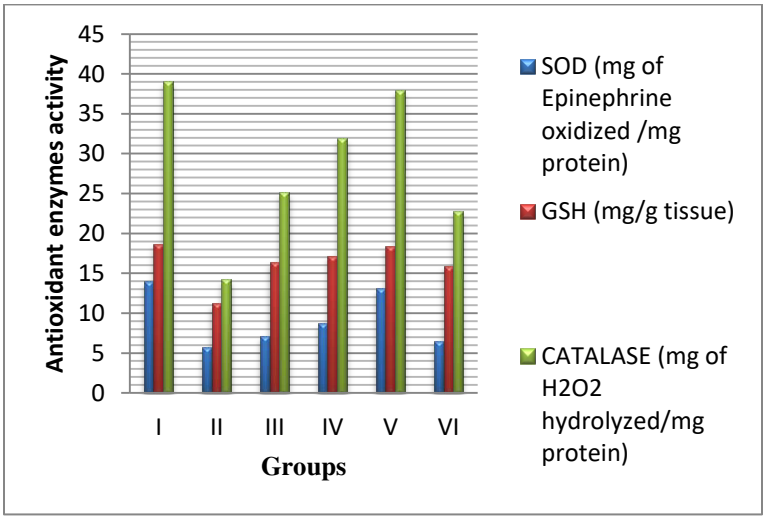

Fig. 9. Effect of *A. tetracantha* extracts on Antioxidant enzymes in normal and experimental rats

Discussion

The current study was focused the scientific evidence for the safe use of the aqueous extract of *Azima tetracantha* to treat diabetes mellitus.At low dose, STZ (50 mg/kg bw) partially destructs the beta cells resulting in insufficient insulin secretion causing type 2 diabetes (Gomes *et al*. 2001). Streptozotocin is used as an agent to induce diabetes mellitus by selective cytotoxicity effect on pancreatic beta cells. Thus it affects endogenous insulin release and as a result increases blood glucose level (Nastaran, 2011). It is widely accepted animal model and reported to resemble human hyperglycemic non ketotic diabetes mellitus (Weir *et al*. 1981). Glibenclamide is a standard antidiabetic drug that stimulates insulin secretion from beta cells of islets of Langerhans. The probable mechanisms of action of the plant extract at higher dose could be linked to potentiating of insulin from beta cells or by increasing peripheral glucose uptake (Bedoya*et al*. 1996).

The loss in body weights observed in STZ induced diabetic rat group (after a period of 30 days) may be due to muscle wasting and loss of tissue proteins upon induction of diabetes with STZ (Swanston-Flat *et al*. 1990; Chatterjee and Shinde, 2002).The decrease in body weight with diabetes mellitus has been attributed to the gluconeogenesis i.e., metabolism of proteins and fats, which is associated with the characteristic loss of body weight due to increased muscle wasting and loss of tissue proteins (Shirwaikar*et al*. 2005).The gain in body weight was observed both in normal treated and diabetic treated groups. PlAqe treatment in diabetic treated

group for 30 days resulted in a significant (66%) reduction in their FBG levels and these effects were higher than those of the standard oral hypoglycemic agent glibenclamide (Nabi*et al*. 2013). Likewise, Jaiswal*et al*. 2016 reported that the ethanolic extract of *Anacardiumoccidentale* leaves also demonstrated antidiabetic activities in neonatal STZ induced diabetic rats. Oral administration of 100 mg/kg body weight of *A. occidentale* extract for 30 days, showed significant reductions in fasting sugar levels, serum insulin level (11.69 ± 0.93 IU.mL^{-1}) and FIRI.

Hafizur*et al*. 2012, reported similar results that showed that the extracts of the this plants significantly improved glucose tolerance in diabetic rats suggesting that they enhanced insulin secretion as reported in similar results for the hypoglycemic effect of *G. alata.* The aqueous extract of *Pleurotusostreatus* demonstrated glucose-reducing effects in high-fat diet and STZ induced insulin resistant diabetic rats were 100, 200 and 400mg kg 1.day 1 oral treatment of *P. ostreatus* extract for 4 weeks showed that the fasting blood glucose level in treatment group were significantly lower as compared to control group at day 14, 21 and 28 by Zhang *et al*. 2016, which is similar to our results.Relevant to our findings is the demonstration by Gidado*et al*.2008, that the aqueous and ethanolic extracts of *N. latifolia* leaves had a significant antihperglycemic effect on fasting blood glucose levels in streptozotocin-induced diabetic rats in a dose-dependent manner.Sharma *et al* 2013 reported that pancreatic toxins such as STZ induce experimental diabetes by damaging β-cells and reducing insulin output. AECS increased serum insulin levels by 40.6%, indicating that it enhances insulin release from stressed pancreatic β-cells, either by regenerating the partially destroyed cells or by the stimulating release of insulin stored in the granules, which in turn improves glucose tolerance.

Diabetic rats exhibited abnormalities in lipid metabolism as evidenced from the elevated levels of cholesterol, triglycerides and high levels of low density lipoprotein cholesterol and low levels of HDL-C (Florence *et al.* 2014;Ananthan *et al*.2003).Pothuraju*et al*. 2016 studied that the plasma lipids, liver cholesterol and kidney triglycerides (TG) levels of the tested diabetic rats also being reduced after the administration of *Aloe vera* extract.Cholesterol is a structural component of cell membrane and an important form in which lipoprotein are transported in the body. Highly significant increases ($p<0.01$) in cholesterol level was observed in diabetic rats 29.07% compared to the normal control (Sharma *et al*. 2013).Gupta*et al*. 2016 reported that the poly herbal plant extract was administered to diabetic rats for 28 days reduction of 26.0% for total cholesterol was observed when compared to diabetic control group while glibenclamide treated group showed reduction of 37.0% in total cholesterol levels respectively at the end of study.

Rani *et al*. 2020 reported that the aqueous extract of the whole plant of *Cressacretica*(200mg/kg & 400mg/kg) significantly decreased the triglyceride levels in the treated group received aqueous extract doses (200 mg/kg & 400 mg/kg body weight) respectively orally. Ramachandran *et al*. 2013 reported that a significantly (P<0.001) increased level of TG was observed after STZ-NIC-induced diabetic rats than normal control. AETPB treatment significantly (P<0.001) decreased TG levels in diabetic rats when compared to diabetic rats treated with vehicle.Salahuddin and Jalalpure, 2010reported that HDL cholesterol level was significantly increased when treated with the aqueous fruit extract of *Cucumistrigonus*Roxb. Against streptozotocin-induced-diabetic rats. Similarly an insignificant increase was observed in case of diabetic rats treated with aqueous extracts from *S. hermonthica* and *N. latifolia*. Interestingly, values of HDL-C in diabetic rats treated with *R. nilotica* and *T. bakis* were significantly (P < 0.05) higher than those of normal control rats (Alamin*et al*. 2015).

The increase in serum LDL in the diabetic controls (Group B) was significantly upturned by the aqueous extract of *C. planchonii* leaves in a dose-dependent manner. There were significant reductions (P<0.01) in the lipid profile of the diabetic rats treated with the extract compared with the standard drug, MET (Abraham*et al*. 2017). Mooradian, 2009 studied that the major distinctive features of diabetic dyslipidemia are a high serum TG concentration and LDL cholesterol with corresponding low HDL cholesterol.Pandhare*et al*. 2011 reported that the significant increase was observed in glycogen levels of the aqueous leaves extract of *Sesbaniasesban* treated diabetic rats. The extract did not produce any significant effects on normal animals.Ahmad and Ahmad, 2018 studied that the diabetic rats received *stevia* aqueous extracts (200, 300, 400 and 500 ppm/kg) were able to significantly (P < 0.05) improve the liver glycogen levels. Ali *et al*.2017 reported that the significantly reduced LPO levels were observed in liver, kidney, heart, and pancreas tissues from the rats treated with 1000 mg/kg GP and with glibenclamide, and the rats treated with 500 mg/kg GP had significantly reduced LPO levels in both liver and heart tissues compared with diabetic control rats.

Arora *et al*.2021 reported that the significant changes in antioxidant parameters (SOD, CAT, GSH and LPO) in the erythrocytes and pancreas of experimental animal groups were observed and recorded. SOD, CAT and GSH levels were decreased, while LPO level was increased significantly in diabetic rats as compared to normal rats.According to Sefi*et al*. 2011, diabetes was induced by a single dose of STZ (65 mg/kg)administered by intraperitoneal way inthe aqueous leafextract of *Centauriumerythrea*. The oxidative stresswas measured by tissue MDA. The estimation of pancreasantioxidant enzymes such as superoxide dismutase(SOD),

catalase (CAT) and glutathione peroxidase (GPx).A significant decrement in the levels of pancreas tissueTBARS was recorded in diabetic treated rats whencompared to that of normal animals. The activity levelswere significantly increased in the diabetictreated animals.

Conclusion

The conclusion of this study suggested that the aqueous extract of *Azima tetracantha*exhibited a potential antidiabetic agent and cure associated complications.The plant also showed improvement in parameters such as body weight, fasting blood glucose, lipid profile, liver glycogen, LPO and antioxidant enzyme activity.Further elucidation of compounds present in *Azima tetracantha* would be useful to treat diabetic patients.

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