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Research Article

HYPOGLYCAEMIC EFFECT OF *LUFFA ECHINATA* IN ALLOXAN INDUCED DIABETIC RATS

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ABSTRACT

Objective: Luffa echinata has been traditionally claimed for its use in diabetes mellitus and still no scientific studies have been performed for exploring its anti-hyperglycaemic effect. The present research work aims to establish, authenticate and to scientifically validate the folkloric therapeutic uses of fruits of Luffa echinata in the treatment and management of diabetes mellitus in alloxan induced diabetes mellitus in rats.

Method: The effect of HLE 200 and HLE400 mg/kg dose of hydroalcoholic extract of Luffa echinata for were evaluated for 28 days by estimation of blood glucose level and various biochemical parameters including SGOT, SGPT, HbA1C, Serum creatinine, bilirubin and lipid profile. Moreover, histopathological examination of heart, liver, kidney and pancreas were performed.

Results: HLE 200 showed significant ($p \leq 0.01$) reduction in the blood glucose level as compared to diabetic control rats. Iin addition HLE 200 treated group of rats showed significant ($p \leq 0.01$) improvement in biochemical parameters.

Conclusion: The result of phytochemical and pharmacological screening of hydroalcoholic extract of fruits of Luffa echinata at 200mg/kg dose validates the traditional use of the plant for treatment and management of diabetes mellitus.

KEY WORDS: Diabetes Mellitus, *Luffa echinata*

1. INTRODUCTION

Diabetes mellitus is a metabolic disease, characterized by hyperglycemia together with impaired metabolism of glucose and other energy-yielding fuels, such as lipids and proteins[1]. The worldwide survey reported that the diabetes is affecting nearly 10% of the population [2]. Due to several limitations of currently available drugs including side effects and failure of response after prolonged use, plant based medicines are gaining prominence in treatment of metabolic diseases like diabetes mellitus[3]. Treatment of illness and maintenance of health using herbal medicine is oldest and most popular form of healthcare practice that has been practised by all cultures throughout the history of civilization [4]. *Luffa echinata* (L. echinata) belongs to family Cucurbitaceae. The genus *Luffa* comprises more than eight species, three of which are found in India viz*. Luffa acutangula* Roxb., *Luffa aegyptiaca* Mill. and *Luffa echinata* Roxb[5]. Ayurveda is the most old conventional arrangement of medicine in India, which is utilized to treat the human diseases [6]. In spite of the fact that logical thinks about have been completed by researchers on numerous Indian botanicals, yet at the same time various medications have entered the universal market through the investigation of ethanopharmacology [4]. Practitioners of the indigenous system of medicine, affirm to obtain beneficial results with *Luffa echinata* Roxb. in the treatment of various ailments[7]. The plant is reported to possess many

traditional uses in Jaundice[8], leukoderma[7], piles[7], enlargement of liver[9], paralysis[7] and diabetes mellitus[10].

2. Material and methods

2.1. Plant material

In the present study, *Luffa echinata* plant was collected from Khejarla village of Jodhpur. The whole plant was identified and authenticated from BSI, Jodhpur. A voucher specimen (BSI/AZRC/Tech./ I.12014/ 2017-18- (PI. Id.)/ 507) of the plant was deposited in the laboratory.

2.2. Preparation of extract

Continuous hot percolation (Soxhelation) method was used for successive extraction of fruits of *Luffa echinata* with Pet. ether & Hydroalcoholic extraction[9].

2.3. Extraction of fruits of Luffa echinata by using Pet. ether (Defattation)

1000 g powder of dried fruits of *Luffa echinata* was packed in Soxhlet extractor. 2000 ml of petroleum ether was added to round bottom flask and the temperature was maintained at 40-60ºC by using heating mantle. Defattation of the plant material was done by soxhelation process. Extraction was carried out with pet. ether for several cycles till a drop of solvent from the syphon tube did not leave a greasy spot on filter paper after evaporation. It took approx. 8 cycles. After defattation, the marc was taken out from the extractor and was spread as a bed on a clean filter paper and dried till whole solvent got evaporated. 972 g of dried defatted marc was obtained and used for further extraction with hydroalcoholic solvent.

2.4. Hydroalcoholic extraction of defatted marc of Luffa echinata

972 g of dried marc obtained after defattation was packed in soxhlet apparatus and 2000 ml of hydroalcoholic solvent was added to round bottom flask (1000 ml) and the temperature was maintained at 40-60ºC by using heating mantle. The hydroalcoholic solvent was prepared by mixing ethanol and water in the ratio 50:50. The extraction was carried out for several cycles, until a drop of solvent from the syphon tube did not show charring effect on the treatment with concentrated sulphuric acid on the watch glass. The extract was dried on water bath till every trace of solvent got evaporated. The Percentage yield of hydroalcoholic extract was found to be 4.2 %.

2.5. Phytochemical analysis

A preliminary phytochemical tests were conducted for Pet. ether and hydroalcoholic extract of *Luffa echinata* to identify the presence of various phytoconstituents[11].

2.6. TLC profile of extract

TLC was carried out for hydroalcoholic extract of fruits of *Luffa echinata* on silica gel G coated plate by using suitable solvent systems. A single spot was observed in these solvent system and their R_f values was determined.

2.7. Animals

Male albino Wistar rats of body weight 180–220 g were selected from the animal house of Lachoo memorial College of science and technology, Pharmacy wing, Jodhpur (Rajasthan). Animals were kept in animal house at an ambient room temperature of (25$\pm$2°c), humidity (45-55%) and 12 h of dark and light cycle[12]. The animals were fed *ad libitum* with normal laboratory chow standard pellet diet. The animals were allowed to acclimatize for next 7 days before commencement of experiment. All the studies were conducted in accordance with the Institutional Animal Ethical Committee (No. 1719/PO/Re/S/13/CPCSEA) of the present study was prepared and approved by local IAEC of Lachoo Memorial College of Science and technology, Pharmacy wing, Jodhpur.

2.8. Induction of diabetes and experimental design

After 2 weeks of acclimatization of the lab animals, diabetes was induced in male wistar rats by intraperitoneal injection of 120 mg/kg body weight of alloxan monohydrate (freshly prepared solution of alloxan in 0.1 M phospho-citrate buffer)[13]. Alloxan monohydrate was purchased from Loba Chemie Ltd. Mumbai. Rats were orally treated with 20% glucose solution (5–10 ml) after 6 hr of alloxan administration, because alloxan is able to produce fatal hypoglycaemia as a result of massive pancreatic insulin release. The rats that only have blood

glucose level in the range of 200-300 mg/dl were included in the study[14]. The animals were tested for evidence of diabetes by estimation of their blood glucose level by using Glucometer.

The animals were divided into six groups and each group contains 6 animals after induction of diabetes with alloxan. The amount of hydroalcoholic extract of fruits of *Luffa echinata* and standard drug were calculated as per the body weight of rats. Hydroalcoholic extract of fruits of *Luffa echinata* and standard drug were administered orally to each group of rats by using stainless steel oral feeding needle [14]. The animals were divided in various groups as follow:

Group I: Normal control group (NCG) served as a control and given normal saline at dose 1ml/kg.

Group II: Diabetic control group (DCG) served as diabetic control and given normal saline at dose 1mg/kg.

Group III: Standard glibenclamide group (SCG) treated with Glibenclamide (Sanofi Indian Ltd. Ankleshwar) at dose 2.5 mg/kg .

Group IV: Standard Insulin group (SIG) treated with Insulin (Biocon Ltd. Banglore) at dose 1IU/kg.

Group V: Hydroalcoholic *Luffa echinata* 200 (HLE 200) treated with hydroalcoholic *Luffa echinata* extract at a dose 200 mg/kg.

Group VI: Hydroalcoholic *Luffa echinata* 400 (HLE 400) treated with hydroalcoholic *Luffa echinata* extract at a dose 400 mg/kg.

Each group of rats received their respective doses of *Luffa echinata* in the morning and the treatment were continued for next 28 days. The dose selection was done on the basis of previous study [15] where the extract of *Luffa echinata* was evaluated for its anti-ulcer [15] and hepatoprotective [9] activity. The blood samples of different treated groups of rats were estimated at different time intervals (0, 1, 2, 4 and 6 hrs) on 1st, 10th and 28th days for acute and chronic hypoglycaemic study.

2.9. Blood glucose monitoring

The BGL were tested in different treated groups for acute and chronic study on 1st, 10th and 28th day[16]. The blood sample of each rat was collected by tail cutting method[17] and BGL were measured at different time intervals (0, 1, 4 and 6 hr[12]) in acute and chronic study by using glucometer (Gluco-one).

2.10. Biochemical analysis

On 28th day of the study, the animals were anaesthetized using ether [18]. Approximately 2 ml of blood samples of each group of rats were collected via direct heart puncture[19]. Blood was collected in vacutainer and centrifuged immediately at 10,000 rpm for 10 min and plasma supernatant was separated. Blood in aliquot without anticoagulant was allowed to clot and then centrifuged in the same manner. Serum was removed and aliquot was stored at -80°C and analysed by Aotozyme^{TM} analyser kits.

2.11. Histopathological examinations

The animals were anaesthetized by using ether [18] after anaesthetizing the animal dissection was carried out and various organs like: heart, kidney, liver and pancreas were removed from the control as well as from the treated group of rats. These organs were washed and fixed in 10% buffered formalin solution. After that organs were embedded in paraffin and stained with hematoxylin-eosin and PAS for histopathological investigations. The degree of injury and necrosis was evaluated in all sections of organs.

2.12. Statistical analysis

All data were expressed as Mean± SEM (n=6 per group). ANOVA followed by Dunnett's test were used for statistical analysis.

• represents statistical significance vs diabetic control rats ($p \leq 0.05$) and * represents statistical significance vs diabetic control rats ($p \leq 0.01$).

3. Results

3.1. Phtyochemical analysis

The results revealed the presence of flavonoids, steroids, terpenoids and saponins in hydroalcoholic extract of fruits of *Luffa echinata*. It indicates that maximum numbers of phytoconstituents were dissolved in hydroalcoholic extract of *Luffa echinata*.

3.2. TLC profile

The results of TLC analysis indicated the presence of flavonoids, steroids and saponins in hydrochloric extract of fruits of *Luffa echinata*. The results of TLC study analysis revealed the separation of single phytoconstituent under these solvent systems. Further the literature review for various plants also suggests that presence of flavonoids, steroids, terpenoids and saponins may responsible for observed potent hypoglycaemic effect. [20-22]

3.3. Blood glucose

The effects of hydroalcoholic extract of *Luffa echinata* (fruit) on BGL at different time interval for acute and chronic study were depicted in table no. 1-3. Diabetic control rats showed significant ($p \leq 0.01$) rise in the BGL as compared to untreated normal control rats.

The results of acute and chronic models of alloxan induced diabetes revealed that the HLE 200 treated group of rats showed significant ($p \leq 0.01$) effect in reducing the BGL at different time intervals as compared to diabetic control rats. However, HLE 400 treatment did not showed significant reduction in BGL both in acute and chronic study. It indicates that the hydroalcoholic extract did not show its hypoglycaemic effect in dose dependent manner. The reason may be presence of any phytoconstituents in the plant extract which at higher dose interfere with its pharmacological effect. The maximum hypoglycaemic effect of the HLE 200 treated rats were observed at 4 hr of dosing, it indicates that HLE 200 provides good glycaemic control in diabetic rats for longer duration of action.

Table no. 1: Effect of hydroalcoholic extract of fruits of *Luffa echinata* on blood glucose level in diabetic rats on first day of the treatment

Acute study						
Groups	Blood glucose level (mg/dl) (Mean±SEM) at different time intervals					
	Dose	0 Hr	1Hr	2Hr	4Hr	6Hr
NCG	Normal saline	97.8±6.55*	97.2±6.4*	97.2±6.85*	97.1±6.36*	97.1±6.33*
DCG	120 mg/dl	321±15.7	321±13.4	320±12.4	314±13.1	317±13.1
SGG	2.5 mg/kg	307±34.7•	276±30*	150±10.3*	144±11.7*	225±20.1*
SIG	1IU/kg	281±20.9•	111±4.03*	94.6±3.07*	84.1±3.31*	88.3±1.63*
HLE200	200 mg/kg	260±21.4*	171±4.08*	133±4.23*	106±3.06*	123±5.54*
HLE400	400 mg/kg	304±47.6•	290±45.6•	284±45.1•	281±44.1•	287±45.4•

All data were expressed as mean± SEM (n=6 per group). ANOVA followed by Dunnett's test were used for statistical analysis.

• represents statistical significance vs diabetic control rats ($p \leq 0.05$) and * represents statistical significance vs diabetic control rats ($p \leq 0.01$).

Table no. 2: Effect of hydroalcoholic extract of fruits of *Luffa echinata* on blood glucose level in diabetic rats on 10th day of the treatment

Sub –chronic study (10th Day)						
Group	Blood glucose level (mg/dl) (Mean±SEM) at different time interval					
	Dose	0 Hr	1Hr	2Hr	4Hr	6Hr
NCG	Normal saline	97.8±6.55*	96.6±6.12*	96.8±6.61*	97.1±6.36*	96.5±6.12*
DCG	120 mg/dl	296±14.4	295±14.3	293±10.4	294±10.4	293±10.1
SGG	2.5	188±5.08*	160±7.22*	153±3.48*	146±5.03*	150±3.61*

	mg/kg					
SIG	1IU/kg	140±11.1*	98.5±5.01*	92.2±6.21*	81.6±5.68*	84.5±2.07*
HLE200	200 mg/kg	201±15.9*	149±5.61*	109±3.72*	93.8±3.97*	97.8±2.13*
HLE400	400 mg/kg	280±6.22•	280±5.78•	281±6.19•	283±4.76•	283±5.20•

All data were expressed as mean± SEM (n=6 per group). ANOVA followed by Dunnett's test were used for statistical analysis.

• represents statistical significance vs diabetic control rats ($p \leq 0.05$) and * represents statistical significance vs diabetic control rats ($p \leq 0.01$).

Table no. 3 : Effect of hydroalcoholic extract of fruits of *Luffa echinata* on blood glucose level in diabetic rats on 28th day of the treatment

Chronic study (28th Day)						
Groups	Blood glucose level at different time interval					
	Dose	0 Hr	1Hr	2Hr	4Hr	6Hr
NCG	Normal saline	97.3±6.83*	96.6±6.12*	96.8±6.61*	97.2±6.36*	96.5±6.12*
DCG	120 mg/dl	283±28.8	284±22.4	286±21.5	287±20.1	288±20.2
SGG	2.5 mg/kg	145±3.72*	138±4.88*	137±4.87*	135±5.24*	140±4.16*
SIG	1IU/kg	115±4.99*	88±3.22*	79.1±2.92*	72.3±4.23*	77.8±4.21*
HLE200	200 mg/kg	135±3.93*	112±4.45*	106±2.50*	99.1±2.31*	104±1.16*
HLE400	400 mg/kg	280±13.7•	280±14.6•	282±14.2•	283±13.7•	284±13.2•

All data were expressed as mean± SEM (n=6 per group). ANOVA followed by Dunnett's test were used for statistical analysis.

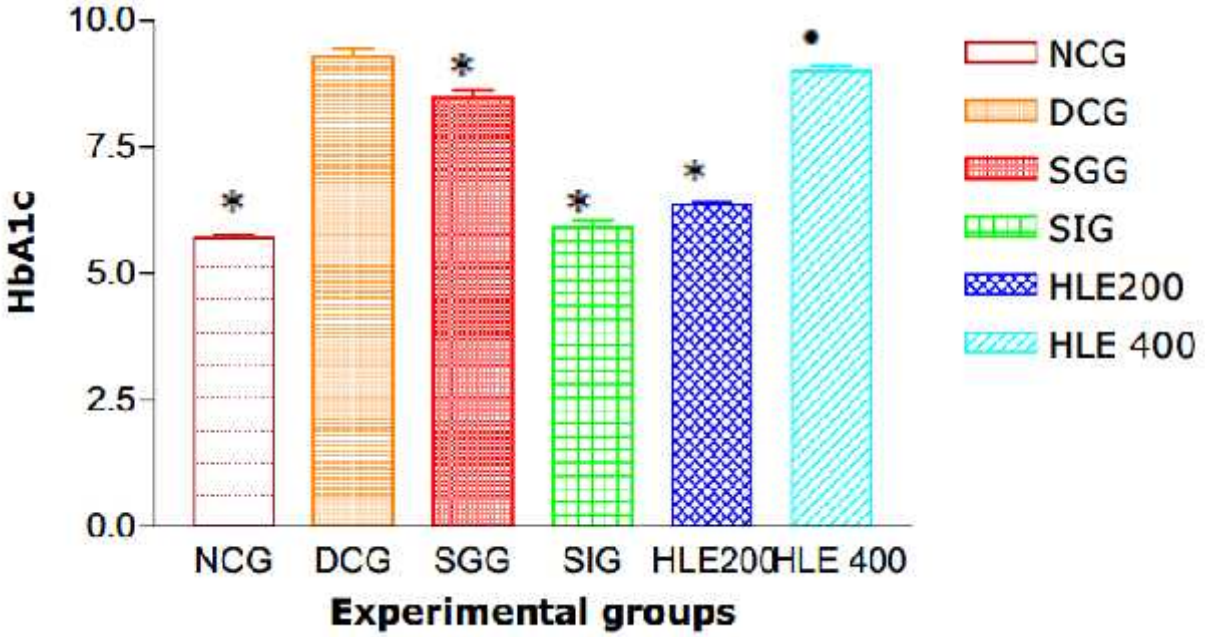
• represents statistical significance vs diabetic control rats ($p \leq 0.05$) and * represents statistical significance vs diabetic control rats ($p \leq 0.01$).

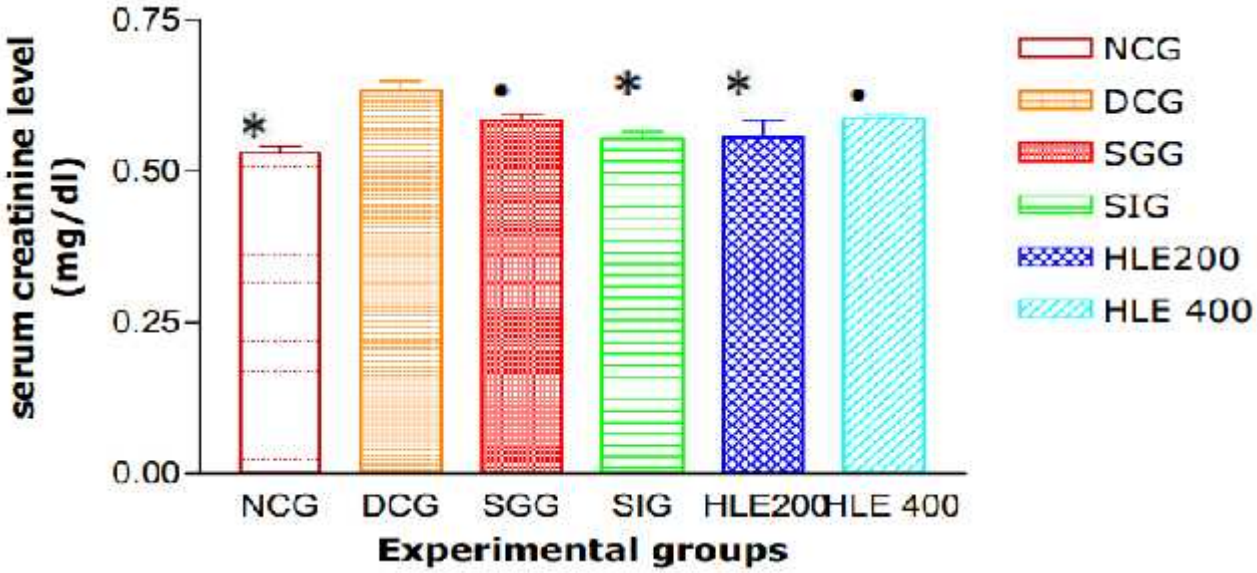
3.4. Effect on Biochemical parameters

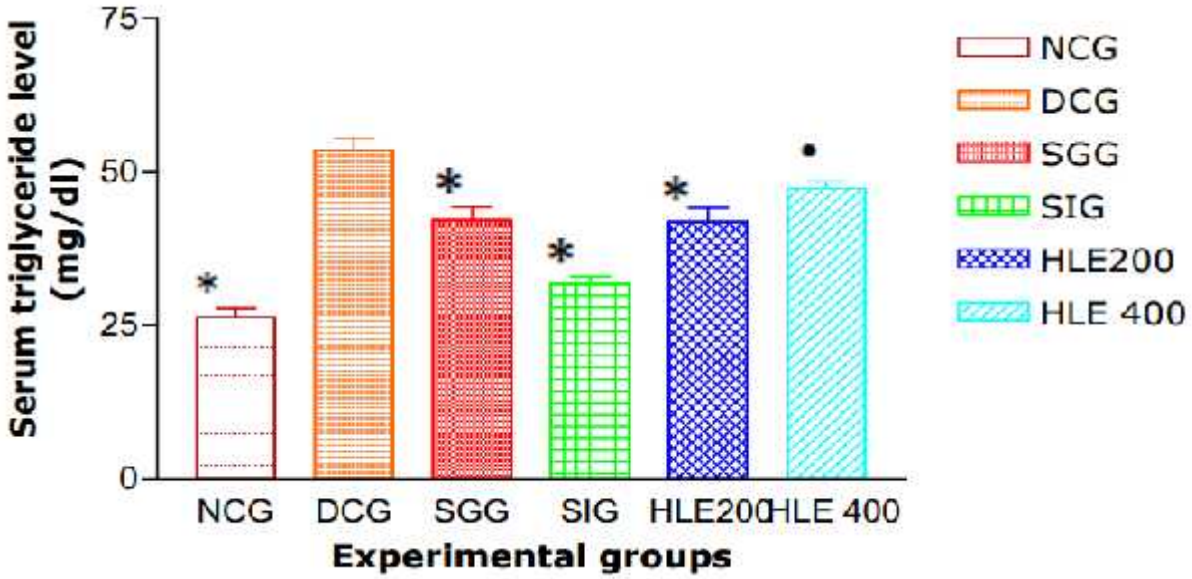
HLE 200 dose of *Luffa echinata* treated group of rats showed significant ($p \leq 0.01$) improvement in biochemical parameters as compared to untreated DC rats while HLE 200 mg/kg dose of *Luffa echinata* showed significant improvement in the levels of various biochemical parameters as compared HLE 400 mg/kg dose of *Luffa echinata* . It indicated these HLE extract did not show their effect in a dose dependent manner.

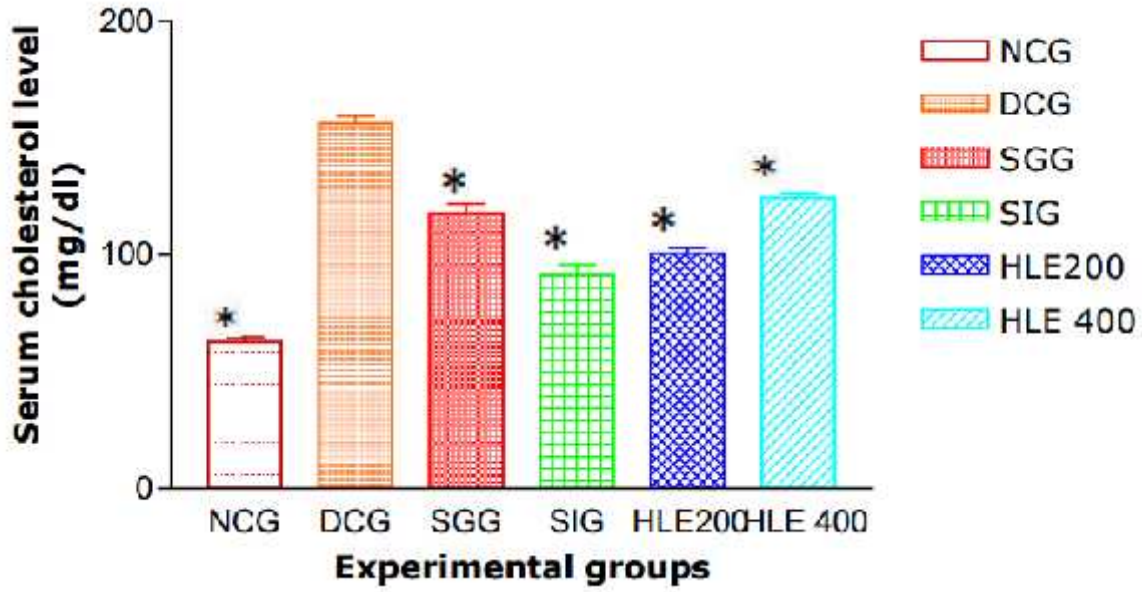
HbA1c % level commonly used to measure the glycaemic control of patients with Diabetes Mellitus [23]. Orally administered HLE 200 treated group of diabetic control rats showed significant reduction ($p \leq 0.01$) in HbA1c% levels as compared to diabetic control rats. This may be due to the improvement in the glycaemic control mechanisms via one of the mechanism for controlling blood glucose level ie. Increase in insulin secretion, decrease in insulin resistance and decrease in hepatic glucose production. Diabetes Mellitus is often linked with abnormal lipid metabolism.[24] The impairment of insulin secretion results in enhanced metabolism of lipids from the adipose tissue to the plasma.[25] It has been demonstrated that insulin deficiency in diabetes mellitus leads to a variety of dearrangements in metabolic and regulatory process, which intern leads to accumulation of lipids such as total cholesterol and triglycerides in diabetic patients[25] . The abnormal high concentration of serum lipids in the diabetic subject is mainly due to increase in the mobilization of free fatty acids from the peripheral fat depots.[26] It has also been shown that administration of insulin significantly reduced as well as normalized lipid levels in diabetic rats as compared to diabetic control rats [27].

Thus, the normalization of lipids levels in diabetic rats treated with HLE 200 may be due to its stimulatory effect on insulin secretion from ruminant pancreatic β-cells or may be due to the uptake of glucose by peripheral tissues.






Serum triglyceride level (mg/dl)
75
50
25
0
NCG
DCG
SGG
SIG
HLE200
HLE 400
Experimental groups


Serum cholesterol level (mg/dl)
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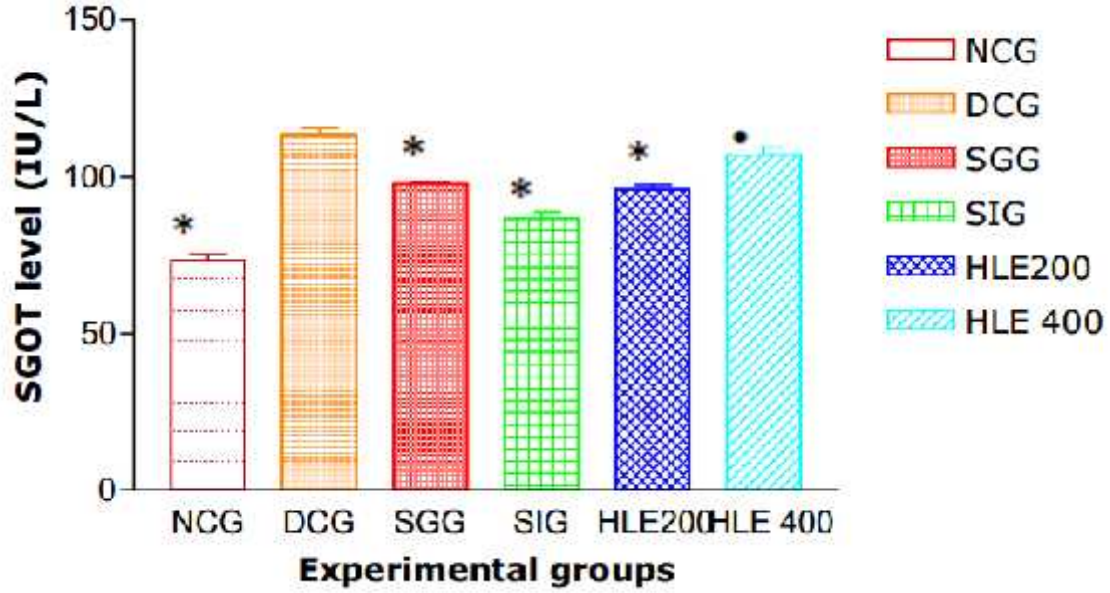
100
0
NCG
DCG
SGG
SIG
HLE200
HLE 400
Experimental groups


SGOT level (IU/L)
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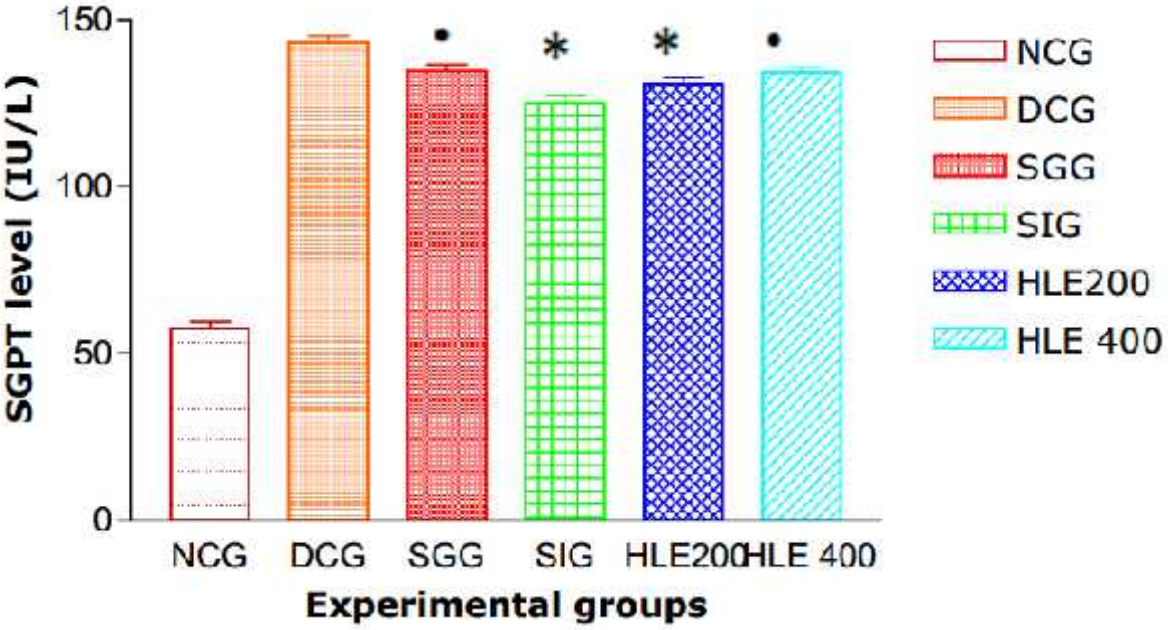
100
50
0
NCG
DCG
SGG
SIG
HLE200
HLE 400
Experimental groups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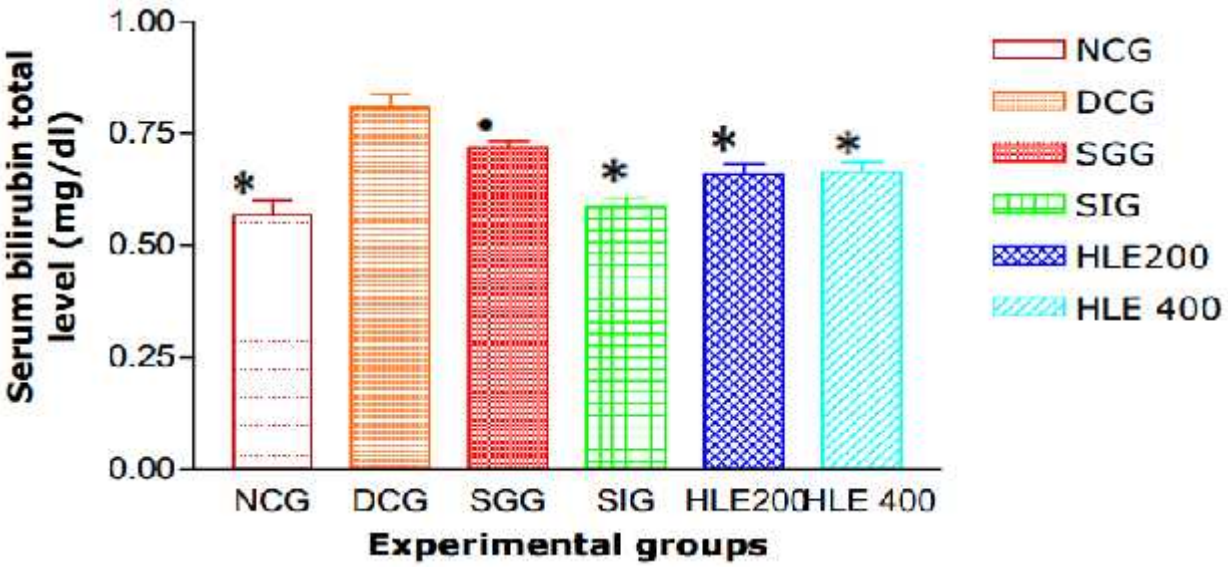
DCG
SGG
SIG
HLE200
HLE 400
Experimental groups


Serum bilirubin total level (mg/dl)
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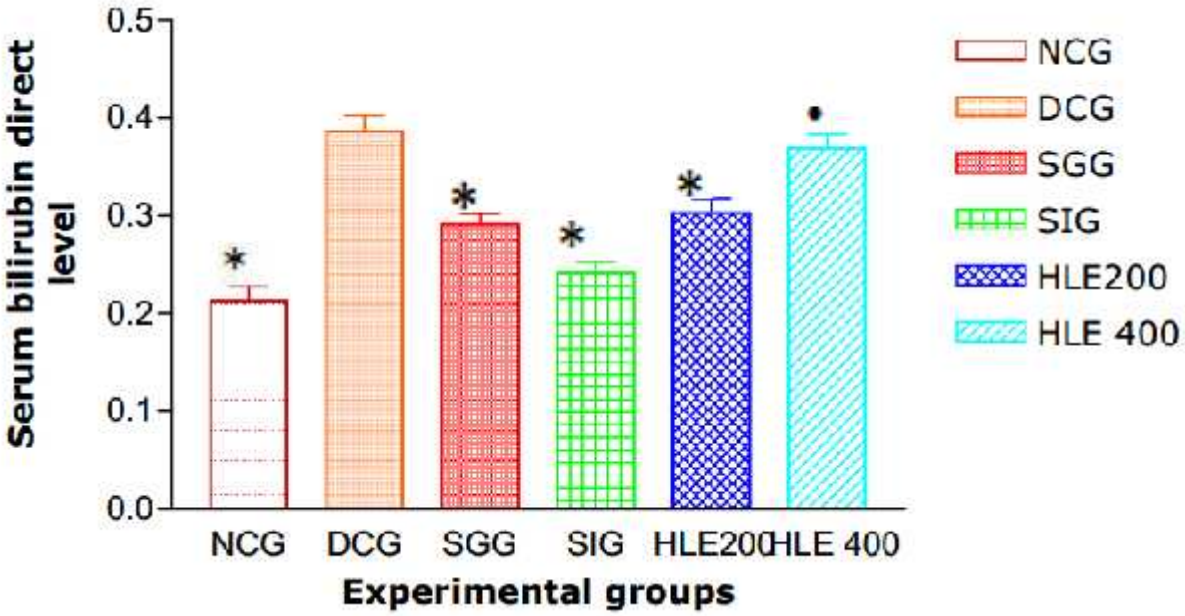
0.75
0.50
0.25
0.00
NCG
DCG
SGG
SIG
HLE200
HLE 400
Experimental groups
NCG
DCG
SGG
SIG
HLE200
HLE 400


Serum bilirubin direct level
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0.3
0.2
0.1
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Experimental groups
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DCG
SGG
SIG
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HLE 400

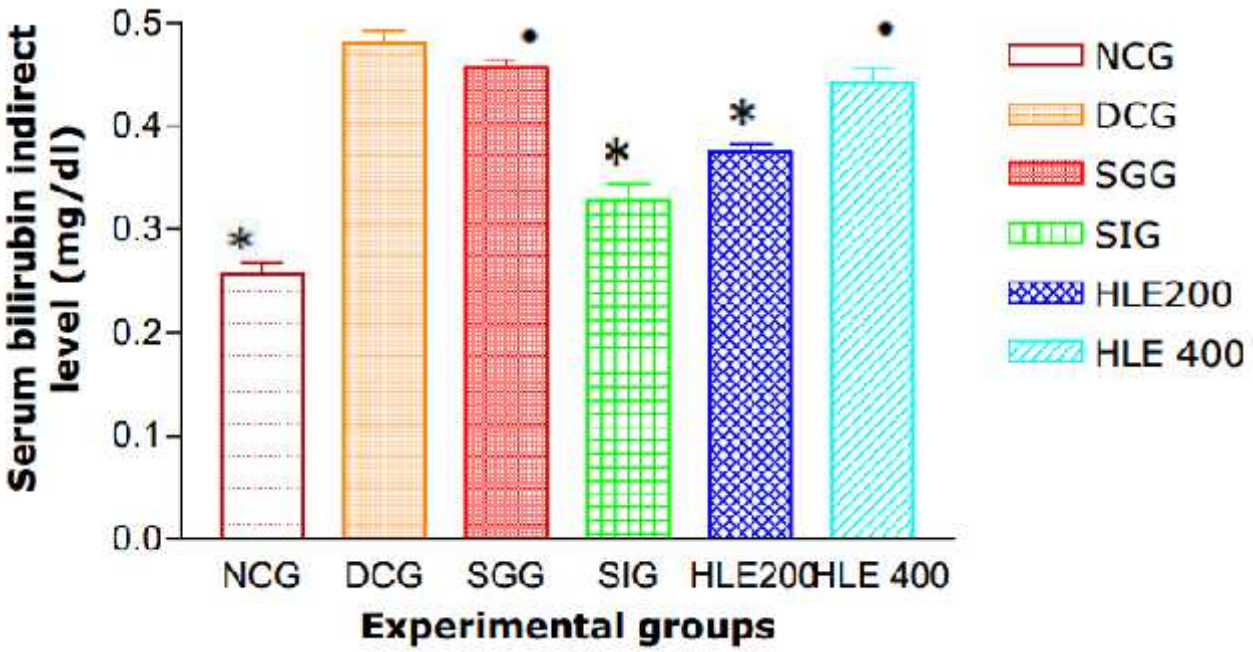
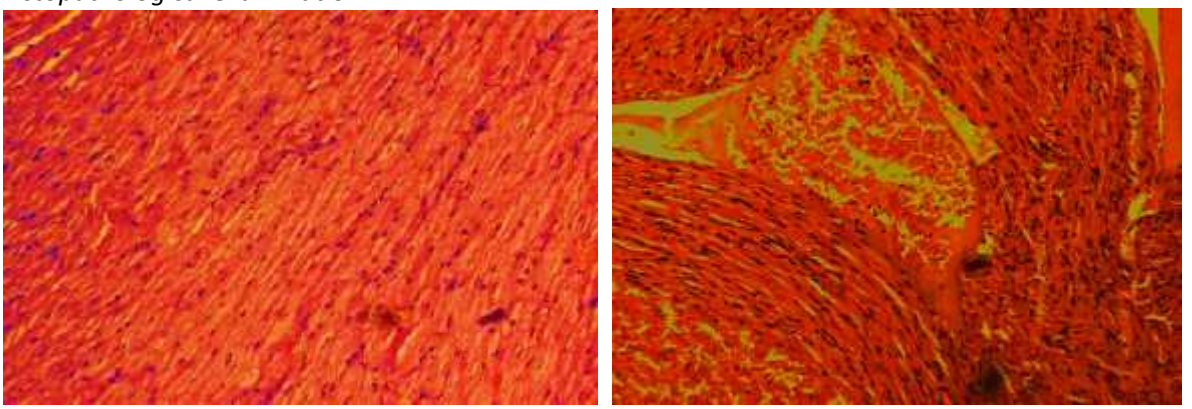
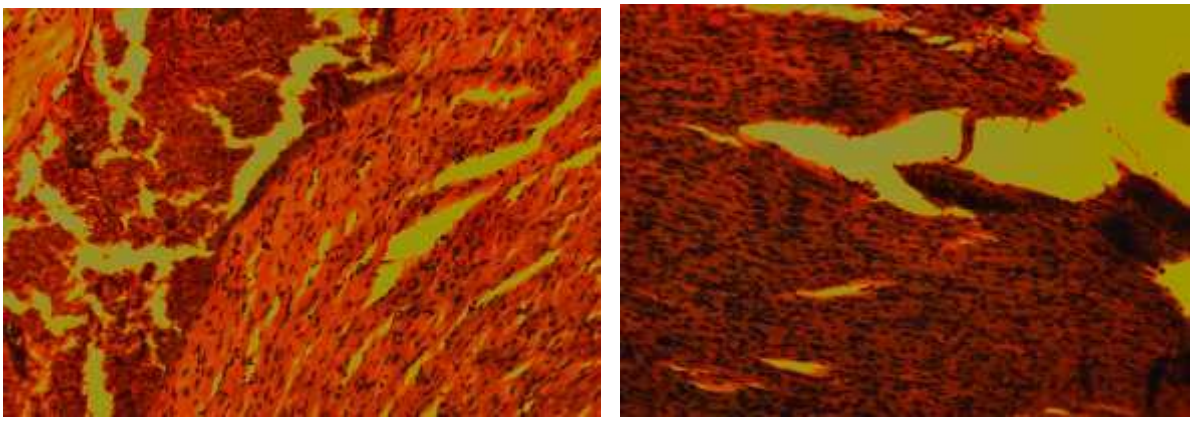


Figure 1: Effect of hydroalcoholic extract of *Luffa echinata* on biochemical parameters in diabetic rats.
All data were expressed as mean± SEM (n=6 per group). ANOVA followed by Dunnett's test were used for statistical analysis.
• represents statistical significance vs diabetic control rats ($p<0.05$) and * represents statistical significance vs diabetic control rats ($p<0.01$).

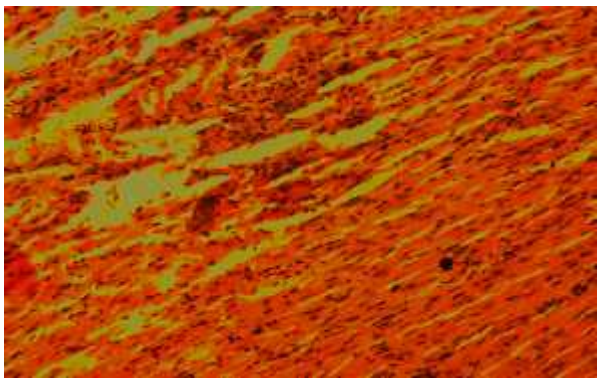
3.5. Histopathological examination

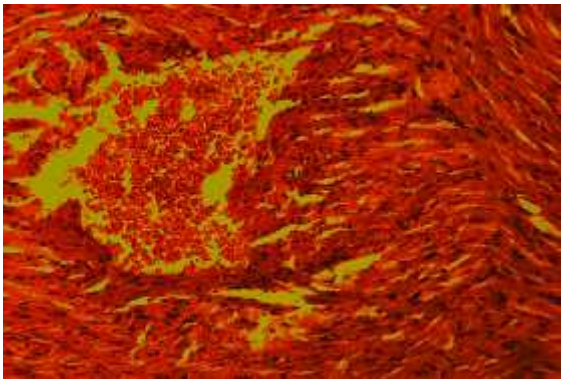


Normal control **Diabetic control**



Standard Insulin **Standard Glibenclamide**

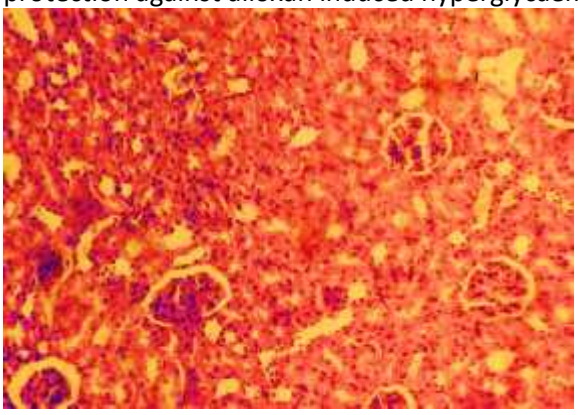


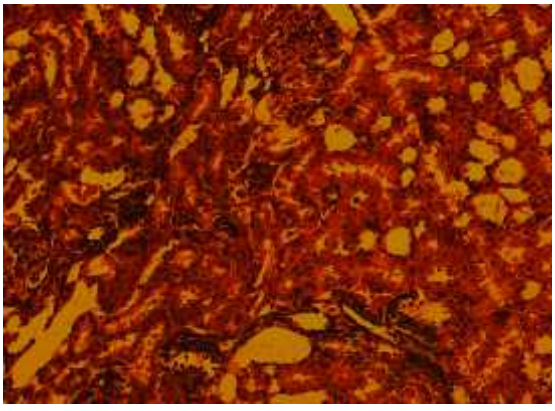


HLE 200 **HLE 400**

Figure 2: Effect of *Luffa echinata* on the histopathology of heart of diabetic rats stained with hematoxylin (Magnification 100x).

Normal architecture of myocardial fibres was seen in normal control vehicle treated group of rats with the appearance of nucleus in every cell. No lesions of pathological importance were revealed. Severely disrupted and contracted muscle fibres with inter-fibrillar haemorrhage and with no appearance of nucleus in the cells were seen in Diabetic control groups of rats. This indicates the poor cardiac protection from alloxan induced hyperglycaemia. Even nucleus is separated from many cells and gets collected at one place. Normal architecture of myocardial fibres was observed in the section of insulin treated heart showed with appearance of nucleus in every cell. There was no myocardial fibrosis. Every nucleus was intact at their respective place. Normal architecture of myocardial fibres was also seen in glibenclamide treated group of rats with appearance of nucleus in every cell but there was mild fibrosis in contracted myocardial fibres. This indicated the poor protection against alloxan induced hyperglycaemia by glibenclamide in comparison to insulin. Improvement in cardiac architecture with mild congestion was clearly seen in test group HLE 200, nucleus of every myocardial cell was evenly distributed. It clearly indicated that test group HLE 200 showed marked recovery trends against alloxan induced degenerative changes in myocardial cells, indicating improvement in cardiac architecture against alloxan induced necrosis. Disrupted and contracted fibres with appearance of fibrosis were observed in test group HLE 400 group of rats with no even distribution of nucleus of myocardial cells. It showed poor protection against alloxan induced hyperglycaemia.





Normal control **Diabetic control**

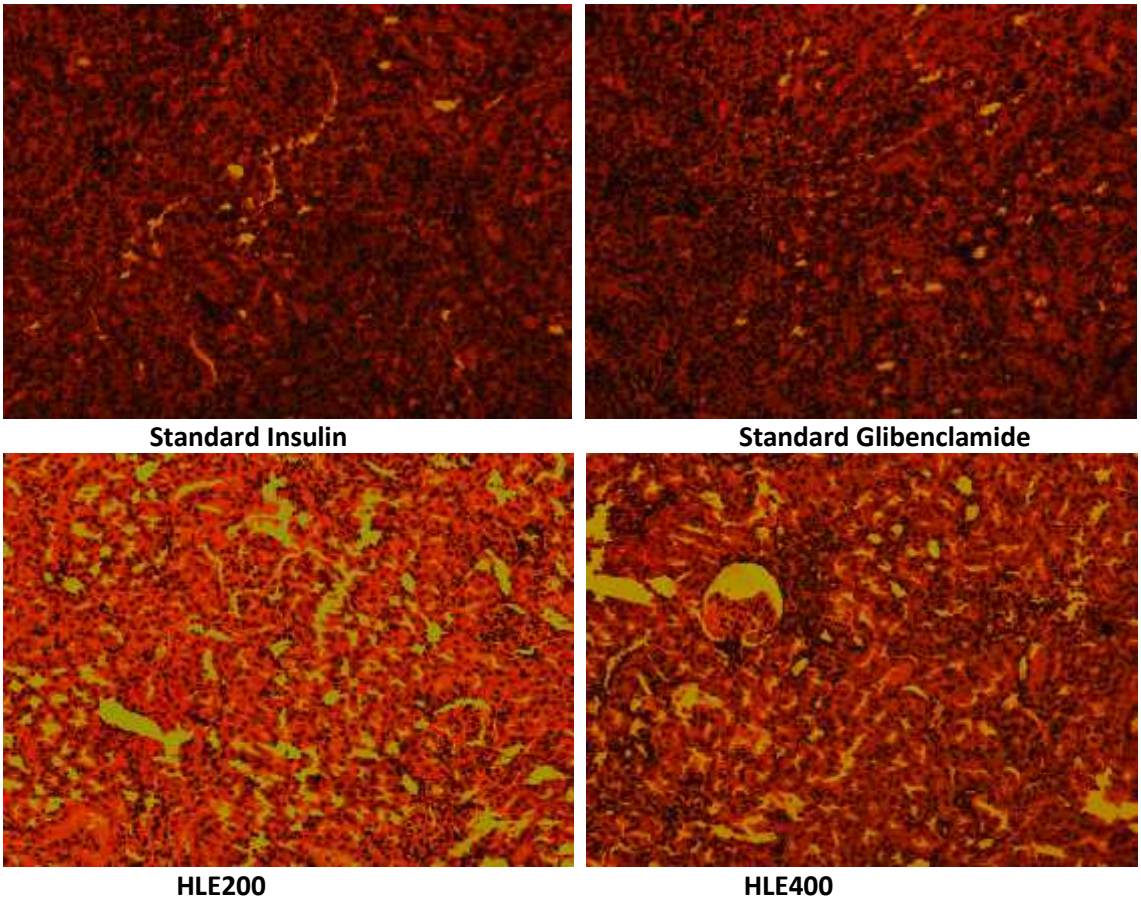


Figure 3: Effect of *Luffa echinata* on the histopathology of kidney of diabetic rats stained with PAS (Magnification 100x).

The section of kidney of normal group of rats did not reveal any significant lesions of pathological importance in renal tubular epithelial cells and glomerulus. It indicated normal structure of glomerulus and kidney tubules with no injury to the tubules. The section of kidney of diabetic control of rats showed appearance of mild dilation in the capillaries, proliferation of mesangial cells, and hyaline deposition with KW lesions in the glomerular cells. Presence of KW lesions in diabetic control group of rats indicated poor protection of glomerular cells against alloxan induced hyperglycaemia. As depicted in the figure (c), the section of kidney obtained from standard insulin group of rats showed better architecture of glomerular cells with few appearances of mild capillaries dilation and slight increase in bowman's space. It indicated the protection of endothelial cell proliferation and congestion of glomerular capillaries against alloxan induced hyperglycaemia.

Group of rats that were treated with glibenclamide showed normal architecture of bowman's capsule and glomerular capillaries but little KW lesions were present. It indicated little protection against hyperglycaemia induced by alloxan, in comparison to insulin treated rats. HLE 200 group of rats showed normal architecture of bowman's capsule and glomerulus. Fibrosis was not seen near bowman's capsule. It indicated protection against alloxan induced hyperglycaemia similar to glibenclamide. Section of kidney of test group treated with HLE 400 showed little fibrosis near bowman's capsule and poor architecture of glomerulus. It showed poor protection against alloxan induced hyperglycaemia compared to standard glibenclamide treated group of rats.

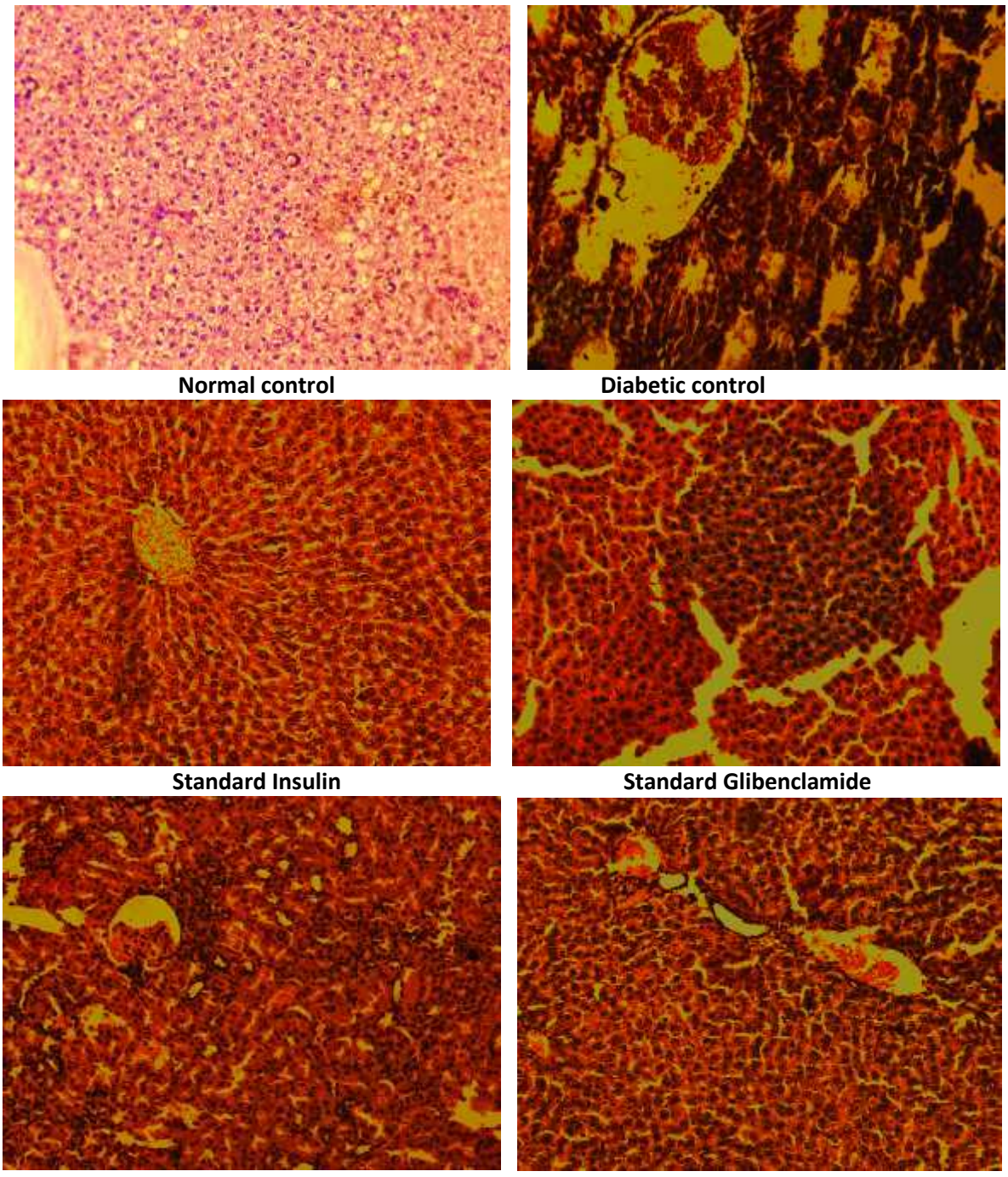


Figure 4: Effect of *Luffa echinata* on the histopathology of liver of diabetic rats (Magnification 100x).

Normal control group of rats showed the normal architecture of the cells in the liver lobule with appearance of mild dilation of central vein. Normal arrangements of kupffer cells showed, which did not reveal any significant lesions of pathological importance. Diabetic control group of rats showed dilation of central vein and sinusoidal space, marked centrilobular necrosis of hepatocytes, severe fibrosis near central vein and hepatocytes, severe fibrosis near central vein and hepatocytes with degenerative changes in hepatocytes and irregular architecture of kupffer cell which indicated hepatic injury. Standard insulin showed the normal architecture of hepatocytes and better arrangement of kupffer cell. It did not reveal any significant lesion of pathological importance. In standard glibenclamide treated group of rats showed the architecture of hepatocytes with appearance of very mild dilation of central vein and little centrilobular congestion of sinusoids. The hepatocytes and kupffer cell architecture was found to be normal. It did not reveal any

significant lesion of pathological importance. HLE 200 group of rats showed normal architecture of hepatocytes with better arrangement of kupffer cell. No marked central vacuole formation and fibrosis is seen. Section of liver of HLE200 showed normal hepatocytes with well-preserved cytoplasm, nucleus and central vein. It clearly indicated the protection against hepatic injury. HLE 400 treated group showed the dilation of sinusoidal space, marked centrilobular necrosis of hepatocytes, severe fibrosis near central vein and hepatocytes with degenerative changes in hepatocytes and irregular architecture of kupffer cell which reveal poor protection of hepatocytes from hepatic injury.

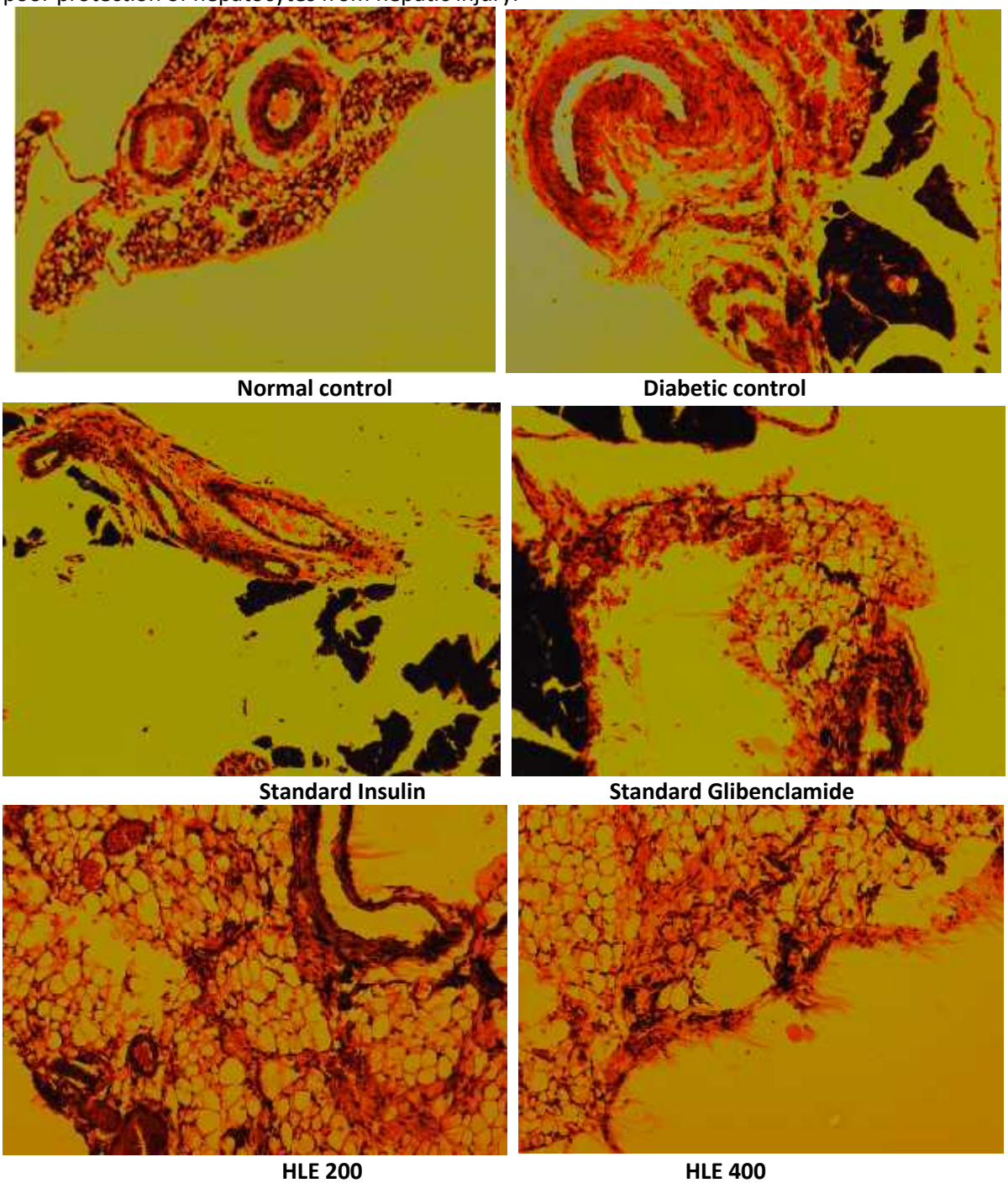


Figure 5: Effect of *Luffa echinata* on the histopathology of pancreas of diabetic rats stained with haematoxylin (Magnification 100x).

Normal control group of rats showed normal size pancreatic islet structure with good number of β-cells, no lymphocyte was seen to be present in between islet cells. It indicated normal structure of islets of Langerhans.

Section of pancreas of diabetic control group of rats showed marked degenerative and necrotic changes in the structure of islets of Langerhans like infiltration of lymphocytes in islets cells, dilation of extra pancreatic acnii cells with marked destruction in islets of Langerhans as shown in figure (b). It indicated that all β-cell islets of Langerhans were markedly shrunken due to severe injury by alloxan and entire β-cell mass was completely replaced by fat cell. Section of pancreas of group of rats treated with insulin showed better architecture of islets of Langerhans with appearance of β-cells and normal structure of acnii cells, but some lymphocytes were seen. This indicates the development of some fibrosis in this section. Normal architecture of islets of Langerhans and acnii cells indicated protection against the alloxan induced hypoglycaemia. In standard glibenclamide treated group of rats, section of pancreas abnormal architecture of islets with acnii cells was present. Due to migration of lymphocytes, some of the cells were converted to fat cells. This indicated poor protection against alloxan induced hyperglycaemia. Section of pancreas of group of rats treated with HLE200 showed normal architecture of islets and acnii cells. Disruption of β-cells was even in the section, indicating better protection against alloxan induced hyperglycaemia in comparison to diabetic control groups of rats. Section of pancreas of group of rats treated with HLE 400 showed disrupted structure of islet cells with little fibrosis in the mid-section which is completely replaced by fat cells. This indicated poor protection of pancreas compared to diabetic control group of rats.

4. Discussions

HbA1c % level commonly used to measure the glycaemic control of patients with diabetes mellitus [23]. Orally administered HLE 200 treated group of diabetic control rats showed decrease in HbA1c% levels as compared to diabetic rats. This may be due to the improvement in the glycaemic control mechanisms via one of the mechanisms for controlling blood glucose level. In the present study HLE 200 treated rats showed improvement in the biochemical parameters as compared to the DC rats significantly ($p \leq 0.01$). Diabetes mellitus is often linked with abnormal lipid metabolism.[24] The impairment of insulin secretion results in enhanced metabolism of lipids from the adipose tissue to the plasma.[25] It has been demonstrated that insulin deficiency in diabetes mellitus leads to a variety of derangements in metabolic and regulatory process, which intern leads to accumulation of lipids such as total cholesterol and triglycerides in diabetic patients.[26] It has also been shown that administration of insulin significantly reduced as well as normalized lipid levels in diabetic rats [27]. The abnormal high concentration of serum lipids in the diabetic subject is mainly due to increase in the mobilization of free fatty acids from the peripheral fat depots. [28] In the present study HLE 200 mg/kg while at the same time significantly ($p \leq 0.01$) increased in serum of alloxan induced diabetic rats further validated the above hypothesis. Thus, the normalization of lipids levels in diabetic rats treated with HLE 200 may be due to its stimulatory effect on insulin secretion from ruminant pancreatic β-cells or may be due to the uptake of glucose peripheral tissue.

5. Conclusion

The study confirms the positive impact of extract of fruits of *Luffa echinata* in controlling hyperglycaemia. Both acute and chronic models revealed that the extract showed anti-hyperglycaemic activity along with improvement in renal, hepatic functions and decrease in HbA1C% levels. Although HLE extract did not act in dose dependent manner. However, HLE 200 extract was more potent as compared to HLE 400 extract both in acute and chronic hyperglycaemic activity. The result of phytochemical and pharmacological screening of hydroalcoholic extract of fruits of *Luffa echinata validates* the traditional use of the plant for treatment and management of Diabetes Mellitus.

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