



## Pharmacological Study

# Safety and efficacy of hydroalcoholic extract from *Lawsonia inermis* leaves on lipid profile in alloxan-induced diabetic rats

Surender Singh, Nishikant Verma, Ritu Karwasra, Prerna Kalra, Rohit Kumar, Yogendra Kumar Gupta

Department of Pharmacology, All India Institute of Medical Sciences, New Delhi, India

## Abstract

**Introduction:** Dyslipidemia is one of the most common risk factor for cardiac-related disorders in diabetes mellitus. Diabetic dyslipidemia is characterized by hypertriglyceridemia, low high density lipoprotein and elevated low density lipoprotein concentration. **Aim:** To explore the effect of *Lawsonia inermis* hydroalcoholic extract (LIHE) for diabetic dyslipidemic activity along with its safety profile. **Materials and Methods:** LIHE administered at doses of 100, 200 and 400 mg/kg in rats after induction of hyperglycemia by alloxan. Insulin (1 IU/kg), glibenclamide (2.5 mg/kg), and metformin (100 mg/kg) were used as positive control and 1% gum acacia as normal control. Statistical analysis was performed using one-way analysis of variance, followed by Dunnett's *t*-test. **Results:** The percentage reduction in blood glucose level of LIHE at dose of 400 mg/kg was 39.08% on day 21 when compared to baseline (day 0), which is comparable to glibenclamide (44.77%) and metformin (46.30%). Decrease in blood glucose level exhibited significant improvement in lipid profile, plasma albumin, total plasma protein and serum creatinine. **Conclusion:** Results of this study demonstrated that LIHE significantly improved lipid and lipoprotein pattern observed in diabetic rats and this could be due to improvement in insulin secretion or action, thus has potential to be used in treatment of diabetes mellitus associated dyslipidemia.

**Key words:** Alloxan, anti-dyslipidemic, anti-hyperglycemic, *Lawsonia inermis*, metformin

## Introduction

Diabetes mellitus is a metabolic disorder constituting a major health concern today whose prevalence has continuously increased worldwide over the past few decades. Moreover, it has been considered as an incurable metabolic disorder affecting about 4.4% of the global population.<sup>[1]</sup> It is primarily characterized by chronic hyperglycemia with disturbances of carbohydrate, fat and protein metabolism resulting from defects in insulin secretion, insulin action, or both.<sup>[2,3]</sup> Despite the availability of conventional anti-diabetic drugs and insulin, morbidity and mortality due to complications of diabetes is high. Furthermore, cost and adverse effects like hypoglycemia are major issues for anti-diabetic drugs. Hence, the search of new drugs for diabetes mellitus associated dyslipidemia continues along traditional and alternative medicine, which should be more effective with fewer adverse effects.<sup>[4]</sup>

*Lawsonia inermis* Linn. (known as *Madayantika* in Ayurveda) is an herbaceous member of the *Lythraceae* family.<sup>[5,6]</sup> Different parts of *L. inermis* have been widely used in Ayurvedic system of medicine for the treatment of bleeding disorders, ulcers, eczema, skin disorders.<sup>[7,8]</sup> The reported biological properties of *L. inermis* are anti-hyperglycemic,<sup>[9]</sup> immunomodulatory effect,<sup>[10]</sup> hepatoprotective<sup>[11]</sup> and memory enhancing activity.<sup>[12]</sup> The methanolic (95%) extract of leaves from *L. inermis* showed significant *in-vitro* anti-hyperglycemic effect.<sup>[13]</sup> Ethanolic (70%) extract of *L. inermis* showed significant hypoglycemic activities in alloxan-induced diabetic mice. *L. inermis* extract at dose of

This is an open access article distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 3.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as the author is credited and the new creations are licensed under the identical terms.

For reprints contact: reprints@medknow.com

**Address for correspondence:** Dr. Surender Singh, Additional Professor, Department of Pharmacology, All India Institute of Medical Sciences, New Delhi - 110 029, India. E-mail: surenderaiims@gmail.com

**How to cite this article:** Singh S, Verma N, Karwasra R, Kalra P, Kumar R, Gupta YK. Safety and efficacy of hydroalcoholic extract from *Lawsonia inermis* leaves on lipid profile in alloxan-induced diabetic rats. Ayu 2015;36:107-12.

0.8 g/kg decreased the concentration of glucose, cholesterol, and triglycerides to normal. The present study was thus designed to evaluate the diabetes associated anti-dyslipidemic efficacy of *L. inermis* hydroalcoholic extract (LIHE) in alloxan-induced diabetic male Wistar rats.

## Materials and Methods

### Plant material

The leaves of *L. inermis* were obtained from the Herb Suppliers in Delhi, India. The leaves were identified and authenticated at Department of Pharmacognosy and Phytochemistry, Faculty of Pharmacy, Hamdard University, New Delhi. A voucher specimen (No. NK/011/2012) was deposited in the laboratory for future references.

### Extraction

Dried and pulverized leaves (400 g) of *L. inermis* were extracted by cold maceration with 50% v/v methanol for 72 h with solvent changes at every 24 h (5 L solvent/per change). The collected solvent was decanted, pooled together and filtered through tightly packed cotton wool to remove suspended particulate matter. The solvent was then evaporated at 40°C under reduced pressure (Buchi R-220 Rotary Evaporator) till a semisolid residue was obtained.

### Animals

Male Wistar rats, of approximately same age (12–14 weeks old), weighing about 150–180 g, obtained from Central Animal Facility, AIIMS, New Delhi were used for the study. They were housed in polypropylene cages at  $23 \pm 2^\circ\text{C}$  with a 45–55% of relative humidity and exposed to alternate cycles of 12 h light and darkness. The animals were allowed to adapt to the environment for a week prior to experimentation with free access to water and standard diet for laboratory animals. Before experimentation, animals were kept on fasting overnight with free access to water. The experimental protocol was reviewed and approved by the Institutional Animal Ethics Committee (IAEC), All India Institute of Medical Sciences, New Delhi, India (IAEC approval no. IAEC/597/2010 dated 3<sup>rd</sup> May 2011).

### Chemicals

Alloxan was purchased from Sigma-Aldrich Co., St. Louis, MO, USA and insulin from Novo Nordisk, Denmark. All the biochemicals used in this study were obtained from E. Merck (India) Pvt. Ltd., Mumbai, and were of analytical grade.

### Acute toxicity (LD<sub>50</sub>) test

The acute oral toxicity test (LD<sub>50</sub>) of LIHE was performed as per Organization for Economic Cooperation and Development (OECD-425) Guidelines.<sup>[13]</sup> A limit test (2000 mg/kg body weight) was done for hydroalcoholic extract by using five male Wistar rats (150–180 g). Animals were administered a dose of 2000 mg/kg body weight of the extract and observed for signs of mortality for a period of 48 h.

### Twenty-eight day sub-acute oral toxicity study

Evaluation of 28 days oral toxicity of the extract was carried out according to OECD Guidelines for testing of chemicals-407.<sup>[14]</sup> Two groups of Wistar rats of both sexes ( $n = 10$ , five female and five male rats) were used in the study. Group I received vehicle (2 ml/kg, 1% gum acacia orally) and served as normal

control, group II received LIHE (1200 mg/kg orally). Vehicle/test was administered daily for 28 days. Body weight was recorded on days 1, 7, 14, 21, and 28. At the end of 28 days, rats were sacrificed after an overnight fasting, under diethyl ether anesthesia. Blood was collected for hematological and biochemical analysis through the retro-orbital sinus. The liver, kidney and heart were harvested immediately, and organ weights were measured. The liver and kidney were then fixed in 10% formalin for histopathological examination.

### Alloxan induced hyperglycemia

Eight groups of male Wistar albino rats ( $n = 6$ ) were used in the study. Animals were fasted overnight with free access to water before the experiment. The rats were treated with a single dose of 120 mg/kg alloxan monohydrate (intraperitoneal injection), dissolved in normal saline and was injected immediately within few minutes to avoid degradation. 5% glucose solution was given overnight to the animals to prevent hypoglycemia. The development of hyperglycemia in rats was confirmed by estimating blood glucose level, 72 h post alloxan injection. The rats with blood glucose level above 200 mg/dL were considered diabetic, and only diabetic rats were included in the study. Thereafter group I received 2 ml/kg 1% gum acacia suspension and served as the normal control, group II served as diabetic control (vehicle-treated diabetic rats) and groups III, IV and V received LIHE at doses of 100, 200 and 400 mg/kg body weight, respectively by oral gavage. Groups VI, VII and VIII received insulin (1 IU/kg), glibenclamide (2.5 mg/kg) and metformin (100 mg/kg) and served as a positive control. Vehicle, LIHE, insulin, glibenclamide, and metformin were administered once daily for 21 days from the day of the start of the experiment. Blood samples were taken on day 0, 7, 14, and 21 by puncturing the retro-orbital sinus under mild ether anesthesia for hematological and biochemical estimation.<sup>[15]</sup>

### Oral glucose tolerance test in rats

Animals were divided into eight groups ( $n = 6$ ) and were fasted overnight with free access to water *ad libitum*. Group I received 1% gum acacia (2 ml/kg) and served as normal control, group II served as diabetic control (glucose at a dose of 2 g/kg). In groups III, IV and V, rats were fed with glucose (2 g/kg), 30 min after the administration of LIHE (100, 200 and 400 mg/kg) respectively. Thereafter, groups VI, VII and VIII received glucose (2 g/kg), 30 min after the administration of insulin (1 IU/kg), glibenclamide (2.5 mg/kg) and metformin (100 mg/kg) and served as positive control. Blood samples were taken from the retro-orbital sinus under mild ether anesthesia at 30, 60, 90, and 120 min of glucose administration on the end of 21<sup>st</sup> day. Blood samples were centrifuged at 2000 rpm and serum was separated from each sample. All animals were then sacrificed, and their liver and kidney were preserved in 10% neutral buffered formalin for histopathological examination.<sup>[16]</sup>

### Biochemical assays

Stored serum samples were analyzed for glucose level on days 0, 7, 14, and 21 using the kits available from Vital Diagnostics (P) Ltd., India. Estimation of serum total cholesterol (TCH), serum triglyceride, serum high density lipoprotein (HDL), total plasma protein (TP), plasma albumin and serum creatinine was done on days 0, 7, 14, and 21 using the method described by Friedewald's formula, 1972.<sup>[17]</sup>

## Statistical analysis

Statistical analysis was performed using GraphPad InStat software, Inc. CA 92037 USA. Data obtained were expressed as mean  $\pm$  standard error of the mean. The data were analyzed using one-way analysis of variance, and the group mean were compared by Dunnett's multiple comparisons. Values were considered as statistically significant at  $P < 0.05$ .

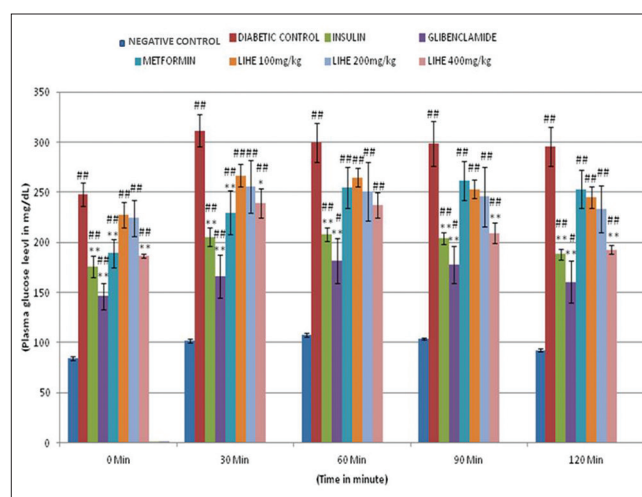
## Results

Results of toxicity studies showed that in LIHE treated group, >50% of the animals survived, which concludes that the oral LD<sub>50</sub> of the plant extract is more than 2000 mg/kg body weight. In sub-acute oral toxicity study, no abnormalities were seen in hematological parameters and biochemical parameters in 28 days of the administration of LIHE. However, bleeding time showed a significant increase in LIHE treated group compared with normal control. The treatment of LIHE in sub-acute toxicity study did not show any significant toxicological changes as observed by histopathological examination in liver and kidney tissues.

LIHE in the doses of 100 mg/kg and 200 mg/kg did not reduce blood glucose levels significantly in alloxan-diabetic rats as compared to diabetic control rats which signify that these doses are not efficacious in reducing elevated blood glucose in diabetic rats. The higher dose of 400 mg/kg of LIHE significantly ( $P < 0.01$ ) reduced blood glucose levels in alloxan-induced diabetic rats when compared to diabetic control [Table 1]. The percentage reduction of blood glucose at 400 mg/kg dose was 39.08% on day 21 as compared to base line (day 0), which is comparable to glibenclamide (44.77%) and metformin (46.30%), thus LIHE may act by potentiating the secretion of insulin from intact pancreatic  $\beta$ -cells or by increasing the consumption of glucose in peripheral tissues, or by both. In oral glucose tolerance test, LIHE treatment also showed significant improvement in glucose tolerance with a decrease in blood glucose started from 60 min of administration of LIHE [Figure 1]. A significant decrease in TCH, triglycerides, low-density lipoprotein (LDL), and very LDL (VLDL) levels, and an increase in HDL level were seen [Table 2] and a significant increase in plasma albumin and TP were also observed [Table 3]. Histological examination of liver and kidney did not reveal any pathological changes in sub-acute toxicity study [Figure 2 and 3].

## Discussion

Alloxan (2,4,5,6-tetraoxypyrimidine) is a toxic glucose analogue, which selectively causes destruction of pancreatic  $\beta$ -cells, provoking a state of primary deficiency of insulin and thus producing a hyperglycemic condition.<sup>[18]</sup> It has been used as an experimental agent to induce diabetes mellitus in Wistar rats but due to the reported high incidence of ketosis and resulting mortality, low dose (120 mg/kg) of this agent was used. The animals developed significant hyperglycemia, hyperlipidemia, and other symptoms of uncontrolled diabetes mellitus within 72 h of administration of alloxan and this persisted till the end of the experimental period of 21 days.<sup>[19]</sup> The animals also showed increased serum creatinine, decreased plasma albumin and TP, most probably due to muscle wasting or due to complications associated with diabetes mellitus. Plasma albumin concentration is a predictor of hemoglobin A1c among type II diabetic patient. In present study, the blood sugar level was increased subsequent to alloxan administration, due to excess production of reactive oxygen species leading to cytotoxicity in pancreatic  $\beta$ -cells which reduces the synthesis and release of insulin, while affecting organs such as liver, kidney, pancreas and hemopoietic system.<sup>[20]</sup> The findings of the study revealed that



**Figure 1: Effect of *Lawsonia inermis* hydroalcoholic extract on glucose tolerance test in alloxan-induced diabetic Wistar rats. All values are mean  $\pm$  standard error # $P < 0.05$ , ## $P < 0.01$  as compared with positive control; \* $P < 0.05$ , \*\* $P < 0.01$  as compared to diabetic control**

**Table 1: Effect of LIHE on fasting blood glucose in alloxan-induced diabetic Wistar rats**

Groups	Fasting plasma glucose level (mg/dL)			
	Day 0	Day 7	Day 14	Day 21
Normal control	84.563 $\pm$ 2.19	84.331 $\pm$ 1.695	84.491 $\pm$ 1.849	84.318 $\pm$ 1.665
Diabetic control	226.205 $\pm$ 8.61 <sup>##</sup>	244.09 $\pm$ 3.507 <sup>##</sup>	238.545 $\pm$ 1.780 <sup>##</sup>	247.827 $\pm$ 11.926 <sup>##</sup>
Insulin	234.055 $\pm$ 15.31	175.89 $\pm$ 7.241	175.317 $\pm$ 7.719 <sup>*</sup>	175.602 $\pm$ 10.559 <sup>**</sup>
Glibenclamide	265 $\pm$ 12.95	153.47 $\pm$ 4.034 <sup>*</sup>	151.74 $\pm$ 3.076 <sup>**</sup>	146.342 $\pm$ 13.404 <sup>**</sup>
Metformin	352.231 $\pm$ 30.65 <sup>**</sup>	293.385 $\pm$ 30.161	244.008 $\pm$ 25.848	189.145 $\pm$ 13.924 <sup>**</sup>
LIHE (100 mg/kg)	238.525 $\pm$ 13.63	229.987 $\pm$ 15.082	227.102 $\pm$ 13.906	227.16 $\pm$ 12.791
LIHE (200 mg/kg)	249.775 $\pm$ 22.46	233.932 $\pm$ 19.439	229.995 $\pm$ 19.757	224.235 $\pm$ 18.190
LIHE (400 mg/kg)	305.5525 $\pm$ 17.93	250.49 $\pm$ 23.110	206.192 $\pm$ 7.746	186.17 $\pm$ 1.986 <sup>**</sup>

All values are Mean $\pm$ SE. <sup>##</sup> $P < 0.01$  as compared with normal control, \* $P < 0.05$ , \*\* $P < 0.01$  as compared to diabetic control. SE: Standard error; LIHE: *Lawsonia inermis* hydroalcoholic extract



LIHE treatment significantly reduced the blood glucose level and serum lipid level in the diabetic-treated rats. The reduction in glucose level may be due to insulin release that was impaired due to pancreatic beta-cell destruction by alloxan.

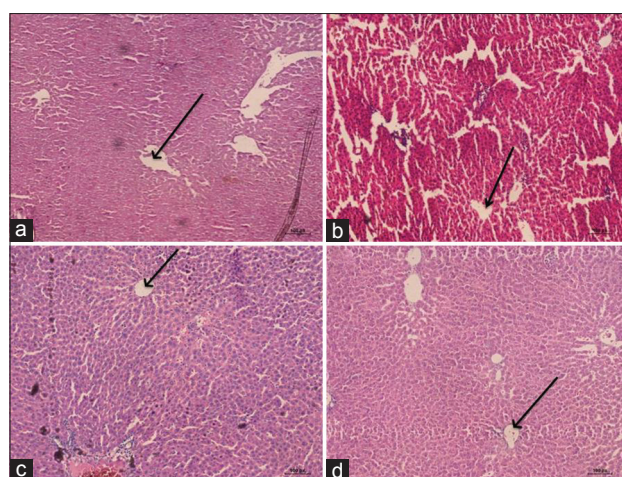
In addition to altered glucose homeostasis in diabetic rats, dyslipidemia was evident by increased triglycerides, TCH, LDL and by decreased HDL levels.<sup>[21]</sup> The significant reduction in triglyceride and cholesterol levels of LIHE-treated rats indicates its beneficial effect on fat metabolism, thus improving dyslipidemia. Hyperlipidemia is mostly coupled with hyperglycemia. High levels of triglycerides and LDL cholesterol are associated with high risk of coronary dysfunction, whereas increase in HDL cholesterol is associated with a decrease in coronary risk.<sup>[22]</sup> The main cause of the lipid changes associated with diabetic dyslipidemia is the increased free fatty-acid release from insulin-resistant fat cells.<sup>[23,24]</sup> The increased flux of free fatty acids into the liver in the presence of adequate glycogen stores promotes triglyceride production, which in turn stimulates the secretion of apolipoprotein B and VLDL cholesterol. Thus, the continuous treatment of diabetic rats with *L. inermis* for a period of 21 days normalizes all the

parameters attributing the anti-dyslipidemic activity of plant. This could be due to the presence of some biomolecules present in the plant extract that might have stimulated the beta cells of Langerhans to release insulin, leading to the improvement in the carbohydrate metabolizing enzymes and thus establishing normal blood glucose level.<sup>[25]</sup>

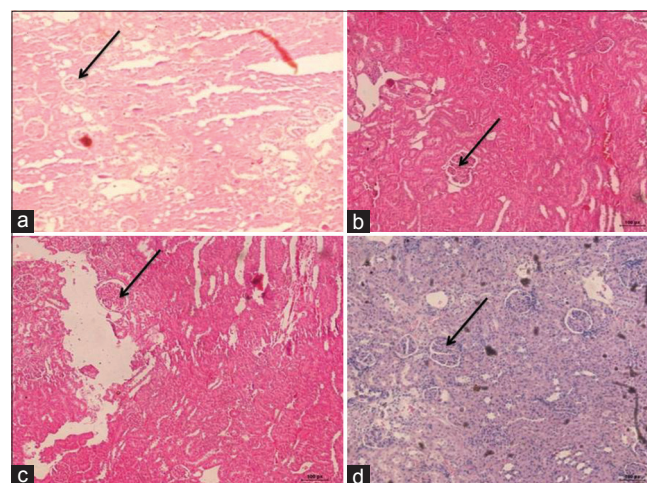
The probable mechanism behind hypolipidemic action in diabetic rat may be by potentiating the insulin effect of plasma by increasing either the pancreatic secretion of insulin from the existing beta cells or by its release from the bound form. In recent years, considerable interest has been directed towards the investigation of plasma lipids and lipoprotein pattern in diabetes mellitus due to the fact that abnormal lipid level leads to the development of coronary artery disease in diabetic patients.

## Conclusion

*Lawsonia inermis* hydroalcoholic extract showed significant anti-hyperlipidemic effects in diabetic rats, thus endorsing



**Figure 2:** Photomicrographs were taken at magnification ( $\times 10$ ). (a) Photomicrographs demonstrated intact cellular architecture of liver in normal control rat. (b) Distortion of cellular architecture with swelling of hepatocytes of liver diabetic control rat and (c-d) partial restoration of normal cellular architecture of liver by insulin and *Lawsonia inermis* hydroalcoholic extract 400 mg/kg



**Figure 3:** Photomicrographs were taken at magnification ( $\times 10$ ). (a) Photomicrographs demonstrated intact cellular architecture of kidney in normal control rat. (b) Distortion of cellular architecture with irregular glomeruli in kidney in diabetic control rat and (c-d) Partial restoration of normal cellular architecture of kidney by insulin and *Lawsonia inermis* hydroalcoholic extract 400 mg/kg

**Table 2: Effect of LIHE on serum lipid profile in alloxan-induced diabetic Wistar rats**

Groups	Serum lipid profile (mg/dL)				
	TCH	TG	LDL	HDL	VLDL
Normal control	90.34 $\pm$ 2.20	73.63 $\pm$ 1.27	23.66 $\pm$ 2.26	51.94 $\pm$ 1.44	14.72 $\pm$ 0.25
Diabetic control	162.57 $\pm$ 5.25 <sup>##</sup>	180.84 $\pm$ 4.27 <sup>##</sup>	105.43 $\pm$ 5.54 <sup>##</sup>	20.96 $\pm$ 1.36 <sup>##</sup>	36.16 $\pm$ 0.85 <sup>##</sup>
Insulin	119.71 $\pm$ 1.73 <sup>**</sup>	95.99 $\pm$ 0.52 <sup>**</sup>	56.25 $\pm$ 3.64 <sup>**</sup>	44.25 $\pm$ 3.30 <sup>**</sup>	19.19 $\pm$ 0.10 <sup>**</sup>
Glibenclamide	100.28 $\pm$ 4.96 <sup>**</sup>	95.21 $\pm$ 1.50 <sup>**</sup>	33.15 $\pm$ 6.22 <sup>**</sup>	48.01 $\pm$ 2.11 <sup>**</sup>	19.04 $\pm$ 0.30 <sup>**</sup>
Metformin	128.73 $\pm$ 3.22 <sup>**</sup>	112.53 $\pm$ 1.60 <sup>**</sup>	57.05 $\pm$ 4.39 <sup>**</sup>	49.17 $\pm$ 1.57 <sup>**</sup>	22.50 $\pm$ 0.32 <sup>**</sup>
LIHE (100 mg/kg)	173.16 $\pm$ 10.16	138.25 $\pm$ 2.16 <sup>**</sup>	117.57 $\pm$ 11.20	27.93 $\pm$ 2.20	27.65 $\pm$ 0.43 <sup>**</sup>
LIHE (200 mg/kg)	145.32 $\pm$ 8.68	124.30 $\pm$ 3.29 <sup>**</sup>	90.79 $\pm$ 9.17	29.66 $\pm$ 0.355 <sup>*</sup>	24.85 $\pm$ 0.65 <sup>**</sup>
LIHE (400 mg/kg)	125.54 $\pm$ 7.70 <sup>**</sup>	121.86 $\pm$ 3.38 <sup>**</sup>	70.49 $\pm$ 8.26 <sup>**</sup>	30.65 $\pm$ 1.22 <sup>**</sup>	24.37 $\pm$ 0.67 <sup>**</sup>

All values are Mean $\pm$ SE. <sup>##</sup>P<0.01 as compared with normal control, <sup>\*</sup>P<0.05, <sup>\*\*</sup>P<0.01 as compared to diabetic control. TCH: Total cholesterol, LDL: Low density lipoprotein, VLDL: Very low density lipoprotein, TG: Triglyceride, HDL: High density lipoprotein, LIHE: *Lawsonia inermis* hydroalcoholic extract, SE: Standard error

**Table 3: Effect of LIHE extract on plasma albumin, total plasma protein and serum creatinine level in alloxan-induced diabetic Wistar rats**

Treatment groups	Albumin (g/dL)	Total plasma protein (g/dL)	Creatinine (mg/dL)
Normal control	4.456±0.175	6.88±0.20	0.87±0.031
Diabetic control	2.69±0.17 <sup>##</sup>	5.97±0.31 <sup>##</sup>	1.73±0.027 <sup>##</sup>
Insulin	3.50±0.07 <sup>**</sup>	7.50±0.057 <sup>**</sup>	0.91±0.08 <sup>**</sup>
Glibenclamide	3.592±0.149 <sup>**</sup>	7.38±0.058 <sup>**</sup>	1.07±0.04 <sup>**</sup>
Metformin	3.64±0.074 <sup>**</sup>	6.25±0.023	1.17±0.029 <sup>**</sup>
LIHE (100 mg/kg)	4.305±0.125 <sup>**</sup>	7.33±0.17 <sup>**</sup>	1.39±0.039 <sup>**</sup>
LIHE (200 mg/kg)	3.65±0.11 <sup>**</sup>	7.42±0.023 <sup>**</sup>	1.35±0.042 <sup>**</sup>
LIHE (400 mg/kg)	3.05±0.08	6.78±0.15 <sup>*</sup>	1.22±0.035 <sup>**</sup>

All values are Mean±SE. <sup>##</sup>P<0.01 as compared with normal control, <sup>\*</sup>P<0.05,

<sup>\*\*</sup>P<0.01 as compared to diabetic control. SE: Standard error; LIHE: *Lawsonia inermis* hydroalcoholic extract

its potential to be used in treatment of diabetes mellitus. The observed effects emphasize the importance of isolating the active molecule (s) from the hydroalcoholic leaf extract of *L. inermis* and explore the possible mechanism of its anti-hyperlipidemic activity.

### Financial support and sponsorship

Nil.

### Conflicts of interest

There are no conflicts of interest.

## References

- Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes: Estimates for the year 2000 and projections for 2030. *Diabetes Care* 2004;27:1047-53.
- Nathan DM. Long-term complications of diabetes mellitus. *N Engl J Med* 1993;328:1676-85.
- Alberti KG, Zimmet PZ. Definition, diagnosis and classification of diabetes mellitus and its complications. Part 1: Diagnosis and classification of diabetes mellitus provisional report of a WHO consultation. *Diabet Med* 1998;15:539-53.
- Rates SM. Plants as source of drugs. *Toxicon* 2001;39:603-13.
- Gupta AK. Quality Standards of Indian Medicinal Plants. Vol. I. New Delhi: Indian Council of Medical Research; 2003. p. 23.
- Chopra RN, Nayer SL, Chopra IC. Glossary of India Medicinal Plants. New Delhi: CSIR Publications; 1956.
- Anonymous. The Ayurvedic Pharmacopeia of India. Vol. IV, Part-I. New Delhi: Department of AYUSH, Ministry of Health and Family Welfare, Govt. of India; 1996. p. 64-6.
- Nadkarni KM. India Materia Medica. Vol I. Bombay, India: Popular Book Depot; 1982. p. 730-73.
- Mikhaeil BR, Badria FA, Maatooq GT, Amer MM. Antioxidant and immunomodulatory constituents of henna leaves. *Z Naturforsch C* 2004;59:468-76.
- Hemalatha K, Natraj HN, Kiran AS. Hepatoprotective activity of leaves of *Lawsonia alba*. *Indian J Nat Prod* 2004;20:14-7.
- Iyer MR, Pal SC, Kasture VS, Kasture SB. Effect of *Lawsonia inermis* on memory and behaviour mediated via monoamine neurotransmitters. *Indian J Pharmacol* 1998;30:181-5.
- Arayne MS, Sultana N, Mirza AZ, Zuberi MH, Siddiqui FA. *In vitro* hypoglycemic activity of methanolic extract of some indigenous plants. *Pak J Pharm Sci* 2007;20:268-73.
- OECD 2001, OECD-Guidelines for testing of chemicals-425, organization for economic corporation and development: Paris. Available from: [http://www.OECDLibrary.org/content/package/chem\\_guide\\_pkg-en](http://www.OECDLibrary.org/content/package/chem_guide_pkg-en). [Last accessed on 2014 May 29].
- OECD 2008, OECD-Guidelines for testing of chemicals-407, organization for economic corporation and development: Paris. Available from: [http://www.OECDLibrary.org/content/package/chem\\_guide\\_pkg-en](http://www.OECDLibrary.org/content/package/chem_guide_pkg-en). [Last accessed on 2014 May 29].
- González Mosquera DM, Hernandez Ortega Y, By B, Vicet Muro L, Saucedo Hernandez Y, Grau Ábalos R, et al. Antihyperglycemic activity of extracts from *Boldoa purpurascens* leaves in alloxan-induced diabetic rats. *Phytother Res* 2013;27:721-4.
- Sharma N, Garg V. Antidiabetic and antioxidant potential of ethanolic extract of *Butea monosperma* leaves in alloxan-induced diabetic mice. *Indian J Biochem Biophys* 2009;46:99-105.
- Friedewald WT, Levy RI, Fredrickson DS. Estimation of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. *Clin Chem* 1972;18:499-502.
- Aruna RV, Ramesh B, Kartha VN. Effect of betacarotene on protein glycosylation in alloxan induced diabetic rats. *Indian J Exp Biol* 1999;37:399-401.
- Edem DO. Hypoglycaemic effects of ethanolic extracts of alligator pear seed (*Persea Americana* Mill) in rats. *Eur J Sci Res* 2009;33:669-78.
- Sabu MC, Kuttan R. Anti-diabetic activity of medicinal plants and its relationship with their antioxidant property. *J Ethnopharmacol* 2002;81:155-60.
- Mooradian AD. Dyslipidemia in type 2 diabetes mellitus. *Nat Clin Pract Endocrinol Metab* 2009;5:150-9.
- Alam S, Reddy SK, Baig A, Reddy MK, Mohiuddin M, Reddy MV, et al. Evaluation of anti-diabetic and anti-lipidemic potential of kalongi sugar powder water extract in STZ induced diabetic rats. *Int J Pharm Pharm Sci* 2013;5:94-6.
- Del Pilar Solano M, Goldberg RB. Management of diabetic dyslipidemia. *Endocrinol Metab Clin North Am* 2005;34:1-25, v.
- Chahil TJ, Ginsberg HN. Diabetic dyslipidemia. *Endocrinol Metab Clin North Am* 2006;35:491-510, vii.
- Hossain MS, Alam MB, Asadujjaman M, Islam MM, Rahman MA, Islam MA, et al. Antihyperglycemic and antihyperlipidemic effects of different fractions of *Stevia rebaudiana* leaves in alloxan induced diabetic rats. *Int J Pharm Sci Res* 2011;2:1722-9.

## हिन्दी सारांश

### एलोक्सन प्रेरित मधुमेही चूहों में वसा रूपरेखा पर लॉसोनिया इनरमिस की पत्तियों से प्राप्त हाइड्रो एल्कोहलिक सत्व की निरापदता और दक्षता

सुरेंद्र सिंह, निशिकांत वर्मा, रितु करवासरा, प्रेरणा कालरा, रोहित कुमार, योगेन्द्र कुमार गुप्ता

एलोक्सन द्वारा उद्दीपन के बाद हाइपर ग्लाइसेमिया से प्रभावित चूहों में लॉसोनिया इनरमिस (परिवार लैथीरेसी) की पत्तियों से प्राप्त हाइड्रो एल्कोहलिक सत्व के एंटी-हाइपरलिपिडेमिक और एंटी-हाइपरग्लाइसेमिक गुणों का मूल्यांकन १००, २०० और ४०० मि.ग्रा./कि.ग्रा. की खुराक पर किया गया है। इंसुलिन (१ आई.यू./कि.ग्रा.), ग्लिबेंक्लेमाइड (२.५ मि.ग्रा./कि.ग्रा.) और मेटफोरमिन (१०० मि.ग्रा./कि.ग्रा.) को धनात्मक नियंत्रण के रूप में उपयोग किया गया था और १ प्रतिशत गम एकेशिया सामान्य नियंत्रण के रूप में लिया गया था। लॉसोनिया इनरमिस से प्राप्त हाइड्रो एल्कोहलिक सत्व (एल.आई.एच.ई.) को २१ दिनों तक ४०० मि.ग्रा./कि.ग्रा. की खुराक पर देने से मधुमेह के नियंत्रण की तुलना में रक्त के ग्लूकोज स्तर में उल्लेखनीय कमी आई। रक्त ग्लूकोज में ४०० मि.ग्रा./कि.ग्रा. की खुराक पर प्रतिशत कमी २१ दिन पर आधार भूत (दिन शून्य) की तुलना में ३९.०८ प्रतिशत थी, जो ग्लिबेंक्लेमाइड और मेटफोरमिन के साथ तुलना योग्य है। रक्त ग्लूकोज के स्तर में कमी से लिपिड रूपरेखा, कुल प्लाज्मा प्रोटीन और सीरम क्रिएटिनिन में उल्लेखनीय सुधार प्रदर्शित हुआ। अध्ययन के परिणामों में दर्शाया गया है कि एल.आई.एच.ई. में मधुमेह से प्रभावित चूहों में एंटी हाइपरलिपिडेमिक प्रभाव होते हैं।