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Evaluation of anti hyperlipidemic and anti diabetic activity of *desmostachyabippinnata* extract in experimental animal model

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ABSTRACT

Background: *Hyperlipidemia and diabetes mellitus are major metabolic disorders associated with increased morbidity and mortality worldwide. Medicinal plants are increasingly being explored as potential therapeutic agents for the management of these conditions.*
Objective: *This study evaluated the antihyperlipidemic and antihyperglycemic effects of the methanolic extract of Desmostachyabipinnata in experimental rat models.*
Materials and Methods: *Adult male Wistar rats (150–200 g) were randomly allocated into five groups. Hyperlipidemia was induced using a high-fat diet in combination with Triton X-100. Animals received either the standard drug or methanolic extract of D. bipinnata at doses of 200 and 400 mg/kg. For assessment of antihyperglycemic activity, glucose-loaded rats were similarly divided into treatment groups receiving the standard drug or plant extract. Serum lipid parameters and blood glucose levels were determined using standard biochemical methods.*
Results: *Induction with a high-fat diet and Triton X-100 significantly increased total cholesterol, triglycerides, low-density lipoprotein (LDL), and very-low-density lipoprotein (VLDL) levels while reducing high-density lipoprotein (HDL) concentrations. Administration of D. bipinnata extract produced a marked improvement in the lipid profile by lowering cholesterol, triglycerides, LDL, and VLDL levels and enhancing HDL concentrations. In the oral glucose challenge model, the extract significantly reduced elevated blood glucose levels in a dose-dependent manner.*
Conclusion: *The methanolic extract of Desmostachyabipinnata demonstrated significant antihyperlipidemic and antihyperglycemic activities in experimental rats. These findings suggest that the plant possesses promising bioactive constituents that may contribute to the development of novel therapeutic agents for the management of metabolic disorders such as hyperlipidemia and diabetes.*

Keywords: *Desmostachyabipinnata, hyperlipidemia, diabetes mellitus, antihyperglycemic activity, antihyperlipidemic activity, Triton X-100*

Introduction

Hyperlipidemia is a metabolic disorder characterized by elevated concentrations of lipids and lipoproteins in the bloodstream. It is commonly referred to as hypercholesterolemia or hyperlipoproteinemia and represents a major risk factor for cardiovascular diseases worldwide. Lipids, particularly triglycerides (TG), serve as important energy reserves and are either utilized immediately by the body or stored in adipose tissues. Triglycerides are synthesized in the liver from dietary nutrients and are also absorbed through the intestinal tract following food consumption[1]. Abnormal lipid metabolism has been strongly associated with the development of atherosclerosis and related cardiovascular complications. Elevated levels of total cholesterol and low-density lipoprotein (LDL) cholesterol contribute significantly to plaque formation within arterial walls, whereas high-density lipoprotein (HDL) cholesterol plays a protective role by facilitating the transport of excess cholesterol from peripheral tissues to the liver for metabolism and excretion[2]. According to the National Cholesterol Education Program guidelines, triglyceride concentrations below 200 mg/dL are considered desirable, while values exceeding 240 mg/dL are indicative of hyperlipidemia[3]. HDL cholesterol is often described as "good cholesterol" because of its beneficial effect on lipid homeostasis and cardiovascular health[4], very-low-density lipoproteins (VLDL) are rich in triglycerides and are recognized as important contributors to atherogenesis and coronary heart disease[5]. The occurrence and severity of hyperlipidemia may also be influenced by several physiological and pathological factors, including diabetes mellitus, renal disorders, hypothyroidism, and pregnancy[6].

Age and gender are additional determinants that influence serum lipid concentrations. Clinical studies have demonstrated a gradual increase in cholesterol levels with advancing age, thereby increasing susceptibility to cardiovascular disorders[7]. Certain inherited disorders are also associated with severe lipid abnormalities. Berardinelli–Seip congenital lipodystrophy is a rare genetic condition characterized by diabetes mellitus, near-total loss of adipose tissue, hepatomegaly, accelerated skeletal growth, enlarged genitalia, and marked metabolic disturbances, including hyperlipidemia. Similarly, hereditary motor and sensory neuropathies comprise a group of progressive inherited neurological disorders that may present with metabolic and systemic abnormalities

affecting overall health status[8]. Considering the growing prevalence of hyperlipidemia and its association with diabetes and cardiovascular diseases, there is increasing interest in identifying plant-derived therapeutic agents with lipid-lowering and antihyperglycemic properties. Medicinal plants offer a valuable source of bioactive compounds that may provide safer and more effective alternatives for the management of metabolic disorders.

Objectives

The present study was designed to investigate the phytochemical constituents present in the methanolic extract of *Desmostachyabipinnata*. In addition, the study aimed to evaluate the acute oral toxicity profile of the extract and assess its antihyperlipidemic activity using Triton X-100-induced hyperlipidemic rats. The antihyperglycemic potential of the extract was also examined through the Oral Glucose Tolerance Test (OGTT) in experimental animals.

Materials and Methods

Plant Material

Leaves of *Desmostachyabipinnata* were collected from the hilly regions of Chittoor District, Tirupati, Andhra Pradesh, India. The plant material was taxonomically authenticated by Dr. K. Madhav Chetty, Assistant Professor, Department of Botany, Sri Venkateswara University, Tirupati, Andhra Pradesh. The authenticated plant specimens were cleaned, shade-dried, and processed for extraction and subsequent phytochemical investigations.

Experimental Animals

Healthy adult male Wistar rats weighing between 180 and 220 g were procured from Virchow Biotech Private Limited, Hyderabad, Telangana, India. The animals were maintained under standard laboratory conditions in well-ventilated cages at a controlled temperature of 24 ± 2°C, relative humidity of 54 ± 5%, and a 12 h light/dark photoperiod. Standard pellet diet and drinking water were provided ad libitum throughout the study period. Prior to experimentation, all animals were acclimatized to laboratory conditions for one week.

All experimental procedures were conducted in accordance with the guidelines of the Committee for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA), Government of India. The experimental protocol was reviewed and approved by the Institutional Animal Ethics Committee (IAEC) before the commencement of the study.

Preparation of Plant Extract

Freshly collected leaves of *Desmostachyabipinnata* were thoroughly cleaned and shade-dried for approximately four weeks at room temperature. The dried plant material was pulverized into a coarse powder using a mechanical grinder. About 250 g of the powdered leaf material was subjected to extraction with methanol by the maceration technique. The extraction process was carried out at room temperature with intermittent stirring to facilitate the dissolution of phytoconstituents. The resulting extract was filtered, and the solvent was removed by air drying under ambient conditions to obtain a concentrated crude extract. The percentage yield of the methanolic extract was calculated, and the dried extract was stored in airtight containers until further use in pharmacological studies.[9]

Acute Oral Toxicity Study

The acute oral toxicity of the methanolic extract of *Desmostachyabipinnata* was evaluated in accordance with the Organisation for Economic Co-operation and Development (OECD) Guideline 423 (Acute Toxic Class Method). Healthy Wistar rats of either sex (n = 3) were selected randomly for the study. Prior to dosing, the animals were fasted for 4 h while allowing free access to drinking water.

A single oral dose of 2000 mg/kg body weight of the extract was administered, and the animals were carefully observed for signs of toxicity, behavioural changes, and mortality during the initial hours following administration and subsequently for a period of 14 days. The occurrence of mortality in two or more animals was considered indicative of toxicity at the administered dose. In cases where mortality was observed in only one animal, the same dose was repeated to confirm the response. The absence of mortality and severe toxic manifestations suggested that the extract possessed a relatively high safety margin under the experimental conditions. The study was conducted following OECD recommendations for the assessment of acute toxicity.[10]

Oral Glucose Tolerance Test (OGTT)

The antihyperglycemic activity of the methanolic extract of *Desmostachyabipinnata* was evaluated using the Oral Glucose Tolerance Test (OGTT) in alloxan-induced diabetic rats. Animals were fasted for 16 h before the experiment, with free access to drinking water. Experimental diabetes was induced by a single intraperitoneal injection of alloxan monohydrate (120 mg/kg body weight) prepared in sterile normal saline. After 48 h, blood glucose levels were measured, and animals exhibiting fasting blood glucose concentrations above 200 mg/dL were considered diabetic and selected for the study.The diabetic rats were randomly allocated into different treatment groups, each comprising six animals. Following administration of the respective treatments, all animals received an oral glucose load of 2 g/kg body weight after 30 min. Blood samples were collected from the tail vein immediately before glucose administration and at 30, 60, and 90 min after glucose loading. Blood glucose concentrations were determined using a digital glucometer. The antihyperglycemic effect of the extract was assessed by comparing glucose levels among the treatment and control groups.[10,11]

Experimental Design for Antidiabetic Activity

The animals were divided into five groups, each containing six rats:

Group I: Normal control, received distilled water (vehicle).
Group II: Diabetic control, received glucose (2 g/kg, p.o.).
Group III: Standard treatment, received Metformin (150 mg/kg, p.o.).
Group IV: Received methanolic extract of *Desmostachyabipinnata* (400 mg/kg, p.o.).
Group V: Received methanolic extract of *Desmostachyabipinnata* (200 mg/kg, p.o.).

Experimental Design for Antihyperlipidemic Activity

For evaluation of antihyperlipidemic activity, the animals were randomly divided into five groups consisting of six rats each. Hyperlipidemia was induced using a high-fat diet and Triton X-100, and the study was conducted over a period of 14 days. During the experimental period, the animals received the respective treatments according to their assigned groups.

At the end of the study, biochemical parameters related to lipid metabolism were analyzed to assess the antihyperlipidemic potential of the methanolic extract of *Desmostachyabipinnata*.

Induction of Hyperlipidemia and Biochemical Evaluation

Experimental hyperlipidemia was induced in Wistar albino rats using Triton X-100, a well-established hyperlipidemic agent. Following an overnight fast of 18 h, animals received a single intraperitoneal injection of freshly prepared Triton X-100 (100 mg/kg body weight) dissolved in physiological saline.[12] The rats were randomly allocated into five groups comprising six animals each:

- **Group I (Normal Control):** Received standard pellet diet, water ad libitum, and 2% Tween 80 orally.
- **Group II (Hyperlipidemic Control):** Received Triton X-100 (100 mg/kg, i.p.). After 72 h, animals were administered 2% Tween 80 orally for 7 consecutive days.
- **Group III (Standard Treatment):**Hyperlipidemic rats treated with atorvastatin (10 mg/kg, p.o.) once daily for 7 days.
- **Group IV (Test Group High Dose):**Hyperlipidemic rats treated with methanolic extract of *Desmostachyabipinnata* (400 mg/kg, p.o.) suspended in 2% Tween 80 for 7 days.
- **Group V (Test Group Low Dose):**Hyperlipidemic rats treated with methanolic extract of *Desmostachyabipinnata* (200 mg/kg, p.o.) suspended in 2% Tween 80 for 7 days.[13]

Collection of Blood Samples

On the eighth day of treatment, blood samples were collected from the retro-orbital plexus under mild ether anesthesia. The collected blood was centrifuged at appropriate speed for 10 min to obtain serum. Serum samples were stored under refrigerated conditions and used for biochemical analyses. Subsequently, the animals were sacrificed, and liver tissues were excised for further examination.[14]

Biochemical Analysis

Serum samples were analyzed for various biochemical parameters associated with lipid metabolism and liver function. The following estimations were performed using standard analytical methods:

- Total cholesterol (TC)[15,16]
- Triglycerides (TG)[17]
- High-density lipoprotein cholesterol (HDL-C)[18]
- Serum glutamate oxaloacetate transaminase (SGOT/AST)[19,20]
- Serum glutamate pyruvate transaminase (SGPT/ALT)[21–23]
- Alkaline phosphatase (ALP)[23]
- Total serum proteins[24,25]
- Blood glucose levels[26]

These parameters were assessed to determine the antihyperlipidemic and antihyperglycemic effects of the methanolic extract of *Desmostachyabipinnata* in comparison with the standard drug atorvastatin.

Results

***Preliminary Phytochemical Screening of Desmostachyabipinnata*Extract**

Preliminary phytochemical analysis of the methanolic leaf extract of *Desmostachyabipinnata* revealed the presence of several bioactive constituents, including flavonoids, glycosides, steroids, alkaloids, saponins, carbohydrates, proteins, and amino acids. The occurrence of these phytochemicals suggests that the plant possesses significant pharmacological potential and may contribute to its observed antihyperlipidemic and antidiabetic activities.

Acute Oral Toxicity Study

The acute oral toxicity study was conducted according to OECD Guideline 423. Oral administration of the methanolic extract of *Desmostachyabipinnata* at a limit dose of 2000 mg/kg body weight did not produce any mortality or visible signs of toxicity during the observation period. The extract was therefore considered safe at the tested dose level. Based on these findings, experimental doses of 200 mg/kg and 400 mg/kg body weight were selected for subsequent pharmacological investigations.

Antidiabetic Activity: Oral Glucose Tolerance Test (OGTT)

The effect of the methanolic extract of *Desmostachyabipinnata* on glucose tolerance in alloxan-induced diabetic rats is presented in Table 1. Administration of the extract significantly improved glucose utilization and reduced elevated blood glucose levels in glucose-loaded rats.Treatment with the methanolic extract at a dose of 400 mg/kg produced a significant reduction in blood glucose concentration at 90 minutes compared with the diabetic control group. A noticeable decrease in glucose levels was also observed at 30 and 60 minutes following glucose administration. The standard drug, metformin (150 mg/kg), exhibited the highest antihyperglycemic activity throughout the experimental period. The results indicate that the methanolic extract of *Desmostachyabipinnata* possesses significant glucose-lowering activity and may enhance glucose tolerance in diabetic animals.The observed antidiabetic effect may be attributed to the presence of flavonoids, alkaloids, and glycosides, which are known to improve insulin sensitivity, stimulate glucose uptake, and reduce oxidative stress associated with diabetes mellitus.

Effect of methanol extract of Desmostachya bippinnata leaf on oral glucose tolerance Test

GROUPS	Blood glucose level mg/dl			
	0 min	30 min	60 min	90 min
Normal	97.12± 2.31	90.45 ± 1.21	91.76 ± 0.48	93.76 ± 0.84
Control (ALX 120mg/kg)	258.19± 1.49[a]	244.02 ± 1.64[a]	239.10 ± 1.12[a]	210.34 ± 1.36[a]
Standard (MET 150mg/kg)	273.12± 1.03	232.08± 1.29**	161.95± 0.12**	105.36 ± 1.85***
Desmostachya bipinnata methanol (200mg/kg)	271.34 ± 2.12	213.79± 1.87**	195.74± 1.14**	106.81 ± 0.31***
Desmostachya bipinnata methanol 400 mg/kg)	287.01 ± 1.26	250.12± 1.58**	175.03± 2.10**	102.84 ± 1.47***

All the values are expressed as Mean ± SEM, n=6, One way analysis of variance followed by multiple comparison Dunnet's test, *P< 0.05, **P<0.01 and ***P<0.001 as compared to control and [a]P<0.001, [b]P<0.01 and [c]P<0.001 when compared to normal group

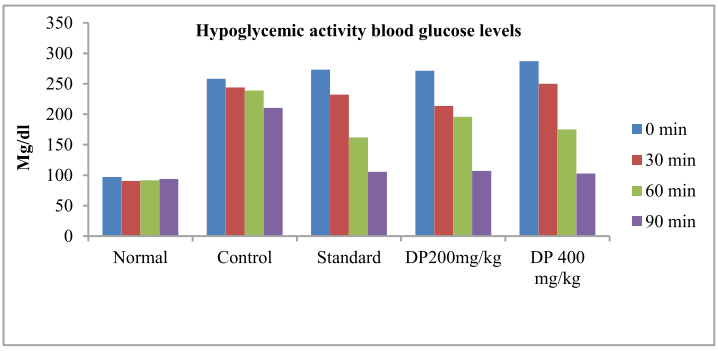


Figure 1: Effect of methanol extract of Desmostachya bippinnata leaf on oral glucose tolerance test

Evaluation of Anti Hyperlipidaemic activity of *Desmostachya bippinnata* In Rats TRITON-X-100 INDUCED MODEL

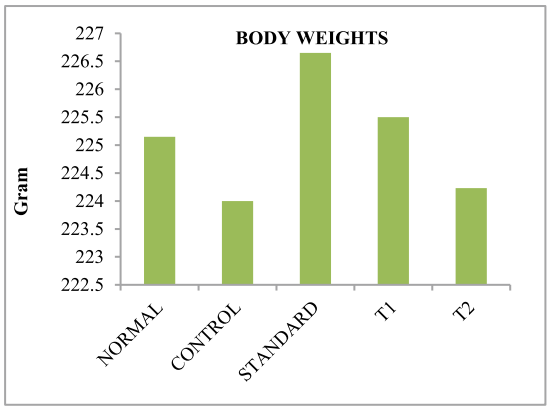
Triton-x-100 induced model Mean and s.e.m of parameters and Animal Body weight of the animals: See on

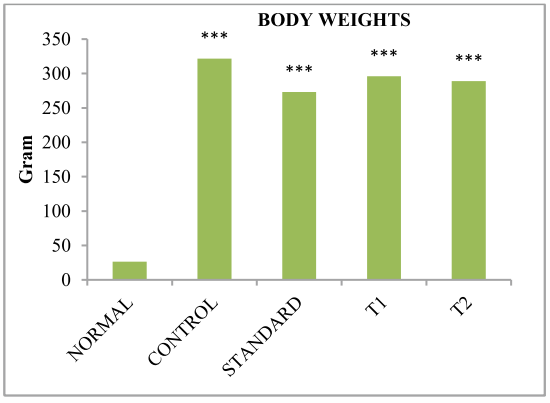
Table 2: Animal Body weight and Triton-x-100 induced model Mean and s.e.m of

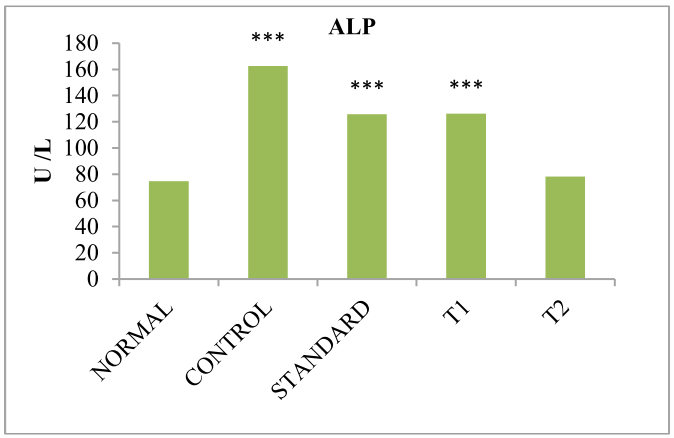
TRITON X100	NORMAL	CONTROL	STANDARD	T1	T2
Before treatment	173.0±0.96	172.66±0.89	174.0±1.12	173.33±0.88	172.0±0.85
After treatment	183.5±0.76	243.0±0.96***	194.33±0.66***	224.33±0.88***	244.83±1.14***
Triton x-100					
TEST	NORMAL	CONTROL	STANDARD	T1	T2
ALP	74.59±3.107	162.51±1.34***	125.78±1.52***	126.23±0.92***	78.2±1.423
GPT	35.26±1.275	65.80±1.413***	41.11±3.826	40.79±1.385***	35.71±1.671**
GOT	41.50±3.226	53.70±3.894*	41.68±2.426	42.35±2.310	46.32±2.075
TP	40.31±3.128	32.71±1.751***	19.56±2.321***	16.26±2.315***	22.89±1.483***
HDL	53.48±3.652***	23.82±1.516	41.69±3.971**	51.25±2.153	56.85±2.351
TG	51.12±2.128	81.76±1.621***	79.23±1.619***	81.2±2.210***	61.42±3.126***
TC	66.35±2.328	151.01±2.121***	68.05±1.451	98.52±1.612***	92.21±1.811***
VLDL	10.01±0.233	15.59±0.627***	13.85±0.352***	15.45±0.356***	13.30±1.464***
LDL	11.56±2.692	101.63±5.069***	10.63±3.114	33.83±4.159	21.98±2.700
AI	0.41±0.239	3.29±0.358	0.42±0.189	0.96±0.328	0.51±0.496
CRR	3.12±0.521	7.63±0.491	2.68±0.122	2.23±0.214	2.16±0.161

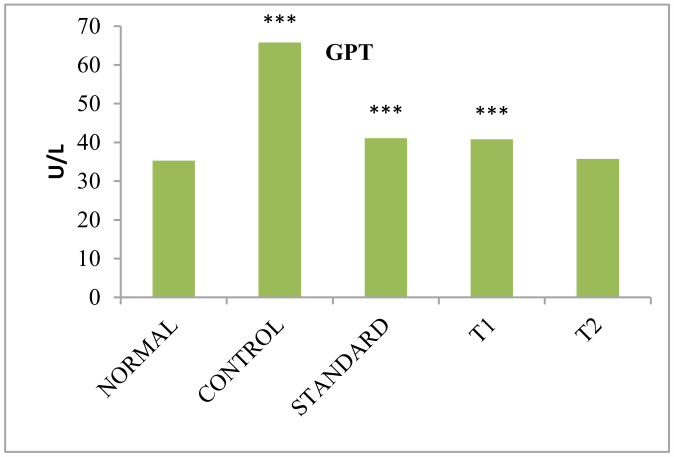
*N = 6; Significance:*** P<0.001, ** P<0.01, * P<0.05 from control*

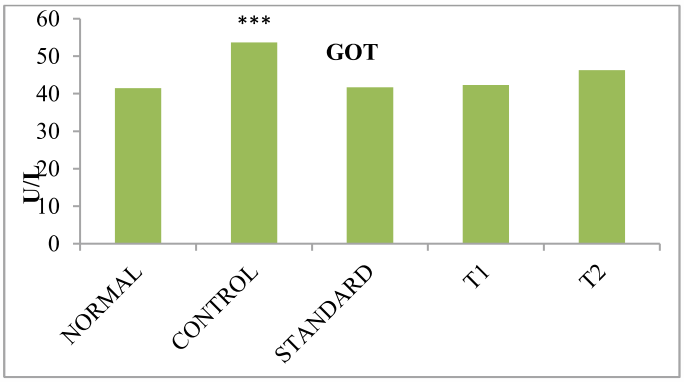
Triton-x-100 induced model Mean and s.e.m of parameters and body weight of the animals: See on Figure 2

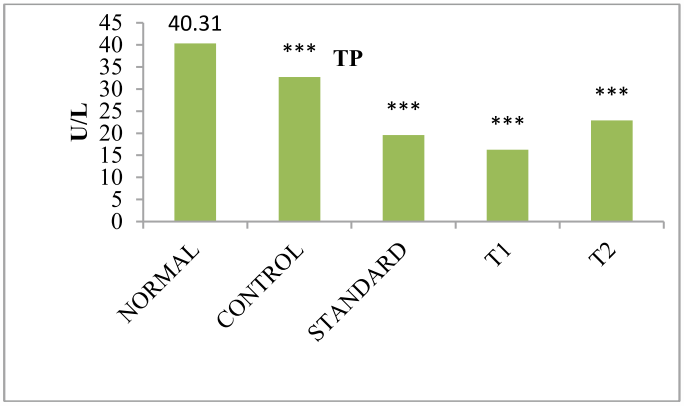


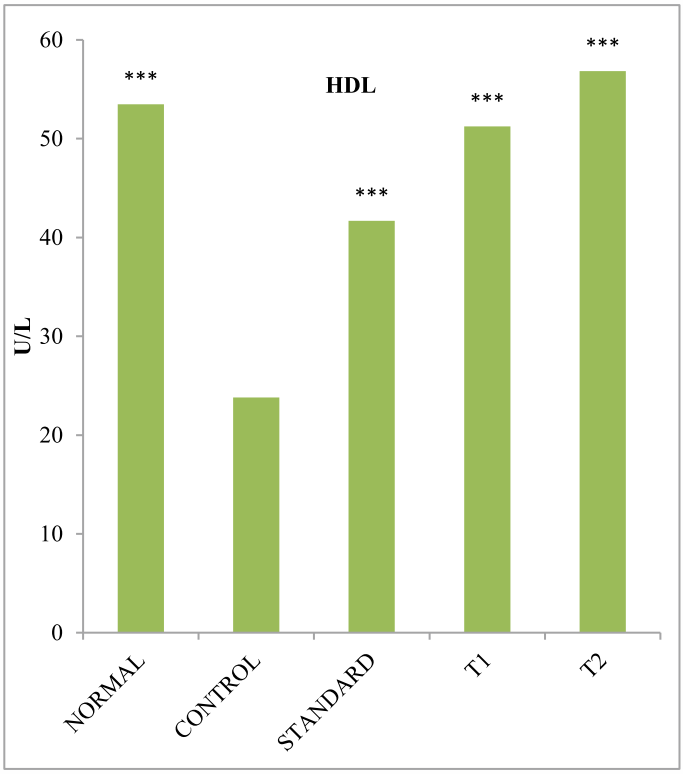


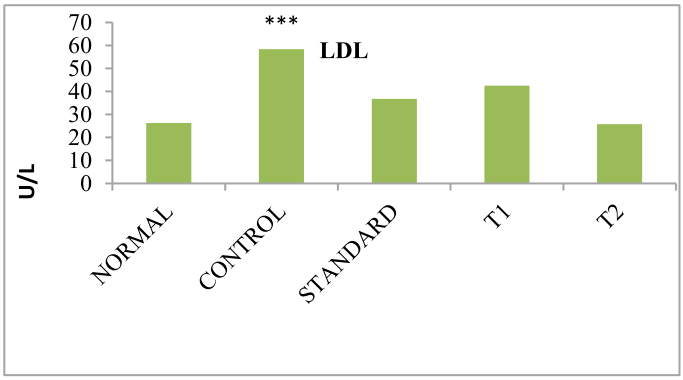


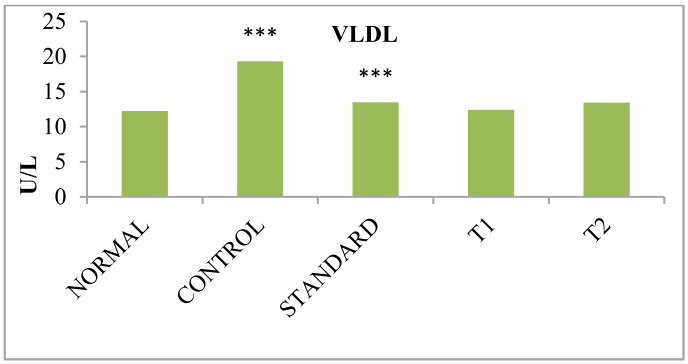


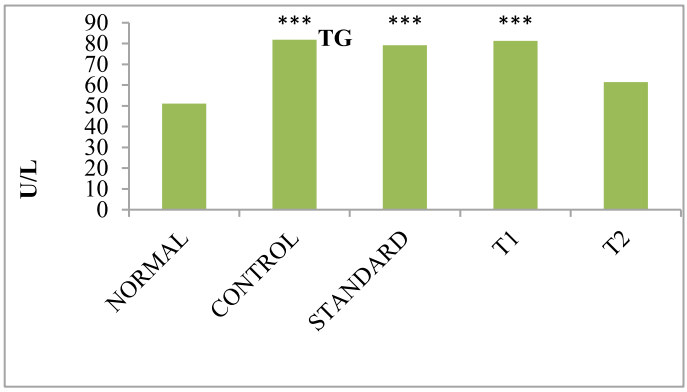


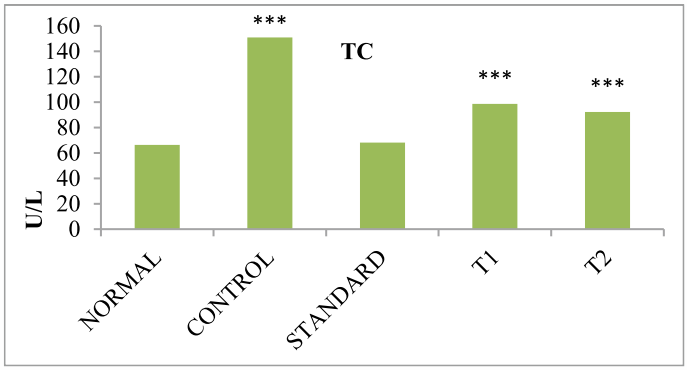


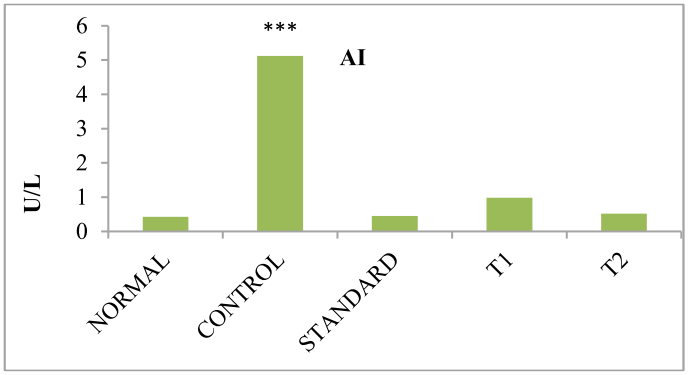












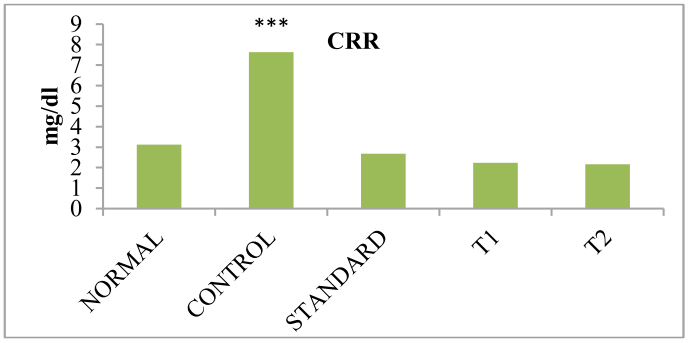


Figure 2: Histogram showing Desmostachya bippinnata on Initial and final body weight of animals, theeffectofDesmostachya bippinnata onALP, GPT, GOT, TP, HDL, TG, TC, VLDL, LDL, AI, CRRofanimals

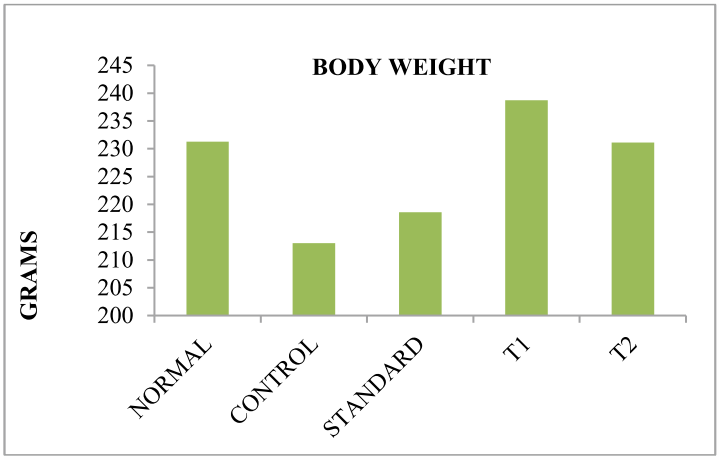
HFD DIET INDUCED MODEL: See on Table 3 Animal Body weight and Biochemical Parameters of the Animals: See onTable 3

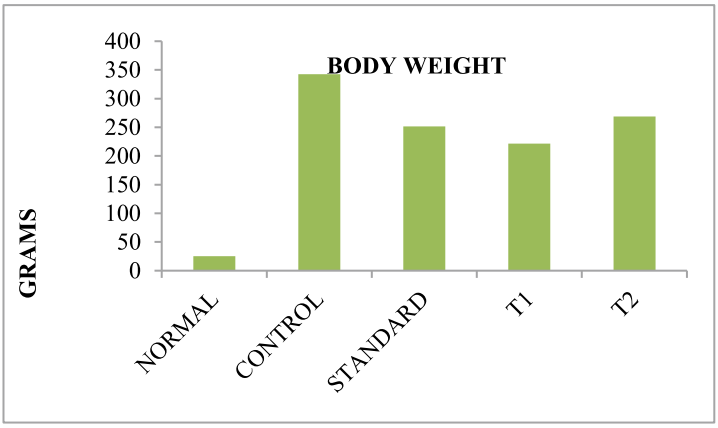
Table 3: Animal Body weightand Biochemical Parameters

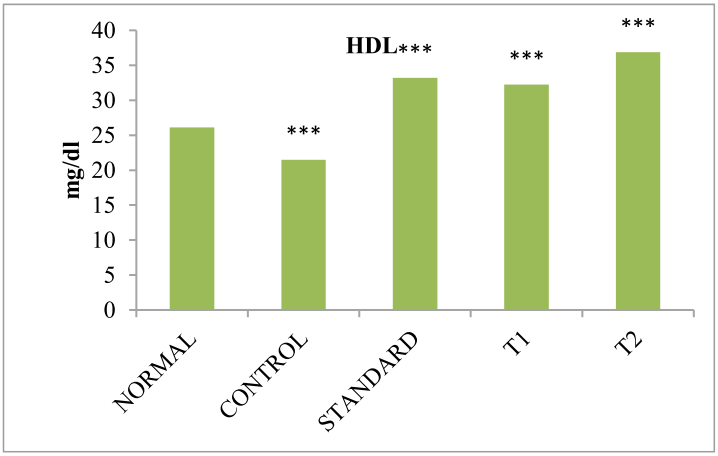
HFD diet	NORMAL	CONTROL	STANDARD	T1	T2
B.w B.T	231.28±0.1	213±1.06	218.59±2	238.7±0.43	231.12±0.61
B.w A.T	25.4±0.15	342.61±2.4***	251.29±0.5***	221.43±2.71***	269±2.75***
HFD diet	NORMAL	CONTROL	STANDARD	T1	T2
HDL	26.12±0.23	21.5±0.83**	33.19±0.54**	32.23±0.47**	36.87±0.10**
LDL	25.19±0.56	56.40±0.10***	35.85±0.26***	41.17±1.43***	26.28±1.69
VLDL	13.10±2.63	20.72±0.58***	14.38±0.59***	13.76±0.48	14.22±0.52
GLUCOSE	72.43±0.81	151.2±0.60***	107.1±0.75***	124.1±0.47***	108.1±0.70**
TC	64.02±0.51	102.0±0.19***	86.1±0.60***	81.25±2.55***	65.43±0.39
TG	52.05±1.15	92.01±0.24***	60.94±2.11***	71.55±2.46***	52.89±0.75
AI	1.41±0.574	3.67±0.529***	1.66±0.619	1.69±0.46	0.77±0.98***
CRR	2.21±0.218	3.57±0.529***	2.98±0.328	2.31±0.85	1.75±0.89***

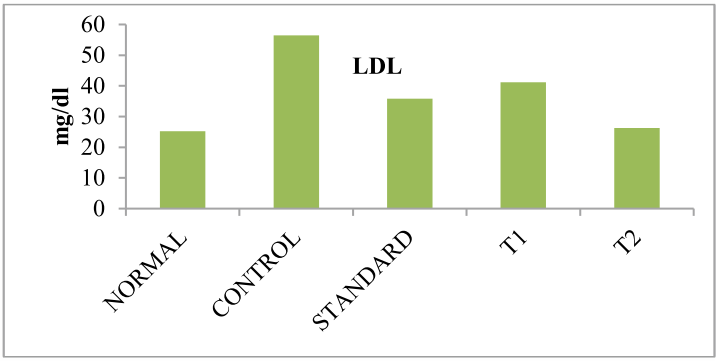
*N = 6; Significance:*** P<0.001, ** P<0.01, * P<0.05 from control*

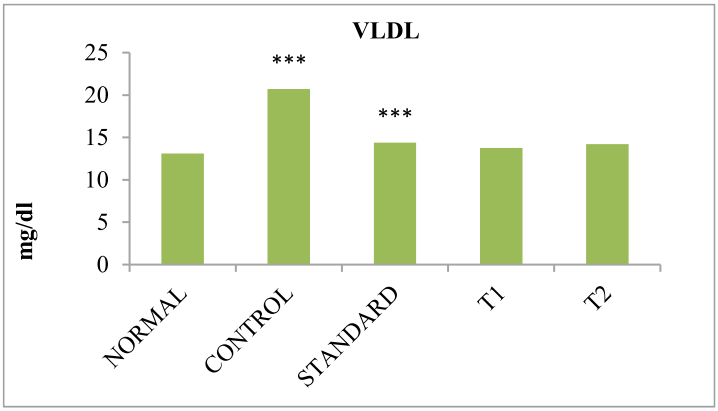
HFD induced model Mean and s.e.m of parameters and body weight of the animals: See on Figure 3

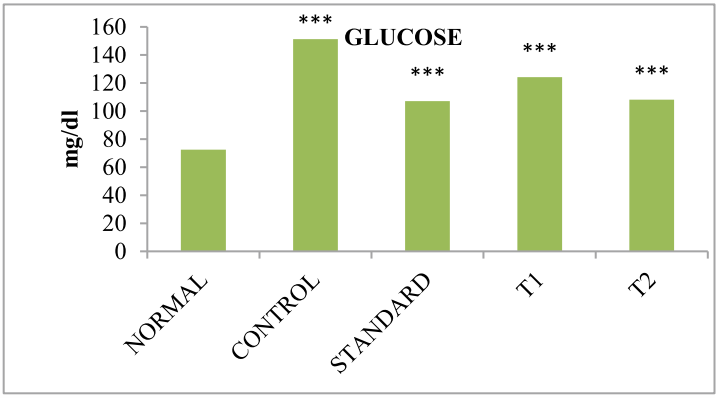












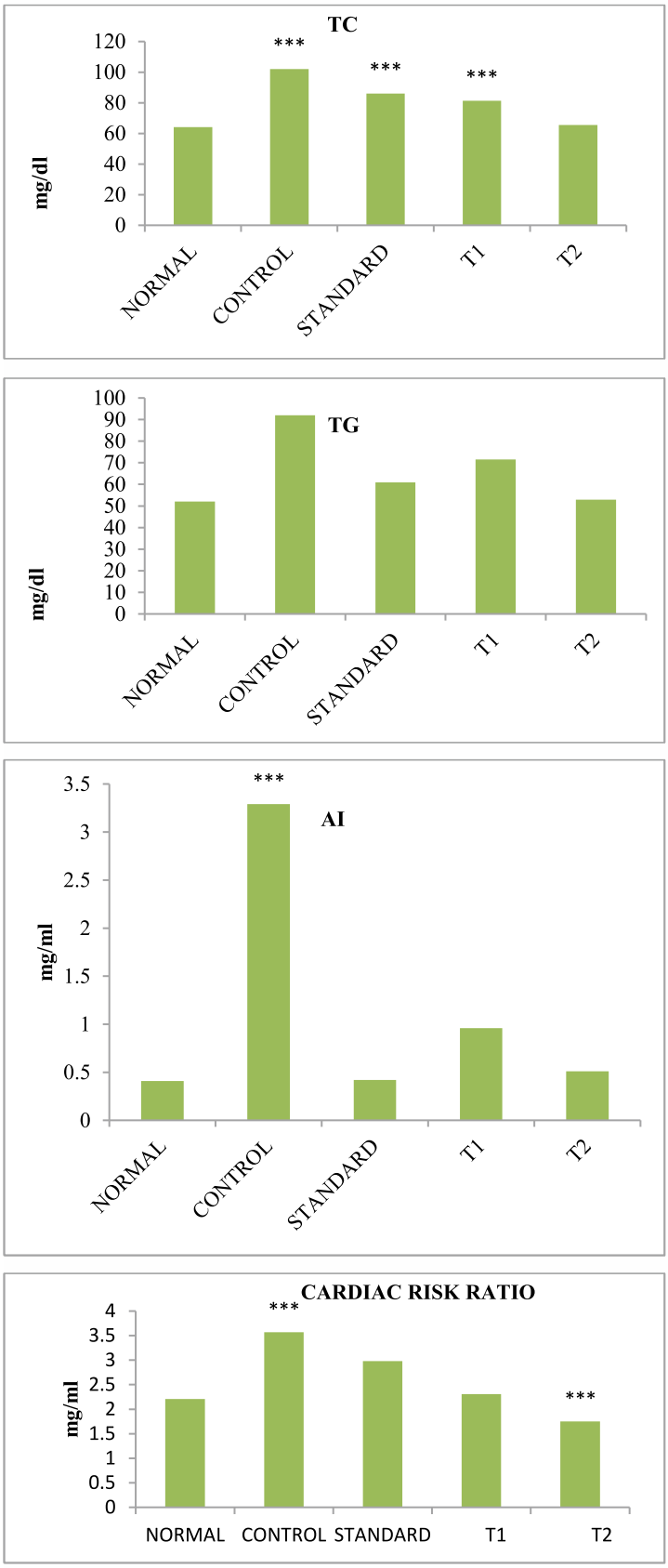


Figure 3: Histogram showing Desmostachya bippinnata on Initial, final body weight of animals, and the effect of Desmostachya bippinnata on HDL, LDL, VLDL,GLUCOSE,TOTAL CHOLESEROL,TRIGLYCERIDES, Cardiac Risk Ratio ofanimals

Discussion

The findings of the present study demonstrate that the methanolic leaf extract of *Desmostachyabipinnata* possesses significant antidiabetic and antihyperlipidemic activities in experimental animal models. Oral administration of the extract at doses of 200 and 400 mg/kg resulted in a marked reduction in elevated blood glucose levels, with the higher dose exhibiting greater efficacy. The glucose-lowering effect observed in alloxan-induced diabetic rats suggests that the extract may improve glucose utilization and regulate carbohydrate metabolism.

Alloxan is a well-established diabetogenic agent that selectively destroys pancreatic β-cells through the generation of reactive oxygen species, leading to insulin deficiency and persistent hyperglycemia[27]. The significant reduction in blood glucose levels following treatment with *D. bipinnata* indicates its potential protective or restorative effect on pancreatic function. Similar observations have been reported for medicinal plants rich in antioxidant phytoconstituents.Preliminary phytochemical screening revealed the presence of flavonoids, alkaloids, steroids, saponins, glycosides, carbohydrates, proteins, and amino acids. Flavonoids are known to possess potent antioxidant properties and may contribute to the observed antidiabetic activity by scavenging free radicals, reducing oxidative stress, and enhancing insulin sensitivity. Alkaloids and other phenolic compounds may further support glucose homeostasis through multiple biochemical pathways.

In the antihyperlipidemic study, Triton X-100 administration induced a significant increase in serum total cholesterol, triglycerides, LDL, and VLDL levels, confirming the development of hyperlipidemia. Treatment with the methanolic extract significantly improved the lipid profile by reducing serum lipid concentrations and lowering the atherogenic index. The effect was dose-dependent and comparable to that of atorvastatin, the standard reference drug. These findings suggest that *D. bipinnata* may interfere with lipid absorption, synthesis, or metabolism, thereby improving dyslipidemic conditions.The extract also restored serum total protein levels that were reduced in hyperlipidemic animals, indicating improvement in hepatic metabolic functions. Furthermore, elevated serum levels of hepatic marker enzymes such as AST (SGOT), ALT (SGPT), and alkaline phosphatase were significantly reduced following treatment. Since increased levels of these enzymes are indicative of cellular damage and hepatic dysfunction, their normalization suggests a hepatoprotective effect of the plant extract.The acute oral toxicity study revealed no mortality or behavioral abnormalities up to a dose of 2000 mg/kg, indicating a wide margin of safety. Overall, the pharmacological activities observed in this study may be attributed to the synergistic action of the bioactive phytochemicals present in *D. bipinnata*. The results support the traditional use of this plant and highlight its potential as a natural therapeutic agent for the management of diabetes mellitus and hyperlipidemia. However, further studies are required to isolate the active constituents and elucidate their precise mechanisms of action.

Conclusion

The present study demonstrated that the methanolic extract of *Desmostachyabipinnata* contains a diverse range of bioactive phytochemicals, including flavonoids, alkaloids, steroids, saponins, glycosides, carbohydrates, proteins, and other secondary metabolites that may contribute to its therapeutic potential.

Acute oral toxicity studies conducted according to OECD Guideline 423 indicated that the extract was safe at the tested doses, with no observable signs of toxicity.The extract exhibited significant antihyperlipidemic activity in high-fat diet and Triton X-100-induced hyperlipidemic rat models. Treatment with *D. bipinnata* resulted in a reduction in serum total cholesterol, triglycerides, LDL, VLDL, and atherogenic index, while simultaneously increasing HDL-cholesterol and total protein levels. These findings indicate a beneficial effect on lipid metabolism and cardiovascular risk factors, the extract showed promising antidiabetic activity by improving glucose tolerance and significantly reducing elevated blood glucose levels in experimental diabetic rats. The observed pharmacological effects may be attributed to the presence of flavonoids and other antioxidant phytoconstituents capable of modulating glucose and lipid homeostasis, the results suggest that *Desmostachyabipinnata* possesses considerable antihyperlipidemic and antidiabetic potential and may serve as a promising natural source for the development of novel therapeutic agents. However, further studies are required to isolate the active constituents, elucidate their mechanisms of action, and evaluate their clinical applicability.

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