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Anti-Diabetic Activity of *Bombax buonopozense* Methanol Leaf Extract in Diabetic Rats: An In Vivo Study

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The burden of diabetes mellitus is steadily rising, making it a serious health concern. *Bombax buonopozense* (*B. buonopozense*) is used in West Africa including Nigeria, Ghana, and Gambia for antioxidant and anti-diabetic properties. The impact of *B. buonopozense* leaves on diabetes is unclear. The study aimed to assess the antidiabetic effects of *B. buonopozense* leaves in rats with diabetes induced with streptozotocin (STZ). For the study, thirty-six (36) male albino rats were divided into six groups, each of which had (6) rats. Rats were given a single injection of STZ (60 mg/kg) to cause diabetes. The diabetic animals received oral *B. buonopozense* (100, 200, and 400 mg/kg) and metformin (150 mg/kg) for 28 days. The blood glucose levels of diabetic rats were measured at different intervals (0, 0.5, 1, 2, 4, 6, 8, 10, 12, 24 hours) to assess the single dose effect twice a week for 28 days. Hematological and biochemical profiles were assessed after 28 days of treatment. The *B. buonopozense* showed a significant ($P < 0.05$) drop in blood glucose levels after 10 hours. In the repeated-dose study. Treatment with *B. buonopozense* at all doses significantly decreased the blood glucose levels along with a significant increase in platelet (PLT). A significant decrease in ALP was observed in non-diabetic and all the treated groups when compared with the diabetic untreated group there was also a slight increase in urea and creatinine, TG, and LDL and a decrease in AST, ALT, globulin, and HDL. This study shows that *B. buonopozense* has antidiabetic properties.

Keywords: Streptozotocin, diabetes, *Bombax buonopozense*, blood glucose level, hematology, biochemical parameters.

1. Introduction

The greatest epidemic in human history is diabetes mellitus (DM), which is one of the top 10 causes of adult mortality (Ghasemi and Jeddi, 2023). One of the most devastating and prevalent chronic illnesses of our time, it shortens life expectancy and can lead to incapacitating, expensive, and potentially fatal consequences. Non-communicable diseases are becoming more and more common, and diabetes mellitus is one of the most prominent of these ailments. There are 537 million people with diabetes worldwide, which is 10.5% of the total population. By 2045, this figure is expected to rise to 784 million, or 12.5% of the total population (Abdul *et al.*, 2024). According to Abomughaid *et al.* 2024, chronic hyperglycemia raises the risk of cardiovascular disease and can result in consequences such as neuropathy, nephropathy, and retinopathy. Insulin resistance causes insulin to operate slowly or insufficiently in diabetes, which leads to hyperglycemia. Glucagon and insulin levels that are out of balance disturb glucose homeostasis (Sapra

and Bhandari, 2022). Numerous endocrine diseases are frequently indicated by diabetes and prediabetes (Popoviciu *et al.*, 2023). Type II diabetes is characterized by reduced insulin action because of abnormalities in cell membrane transporters or receptors, whereas Insulin-dependent diabetes mellitus, another name for type I diabetes mellitus, is an autoimmune disease (Malik *et al.*, 2019). To avoid or lessen diabetes consequences, blood pressure, cholesterol, and glucose levels must be identified and managed early which necessitates ongoing observation (Kottaisamy *et al.*, 2021 Devi *et al.*, 2023). At the moment Even though there are many treatment choices for diabetes, researchers are looking at alternative approaches due to the high expense, poor effectiveness, and side effects of current drugs (Wang and He, 202). Chronic hyperglycemia in diabetes mellitus is known to worsen oxidative stress, which has been connected to cognitive impairment and memory loss (Okesola *et al.*, 2020). Additionally, long-term use of several

synthetic chemical substances, particularly biguanides and sulphonylureas, can cause serious side effects, with hypoglycemia being the primary line of treatment for diabetic patients. According to Lenh *et al.* (2022), a variety of herbal medications have been suggested as alternatives to conventional therapies for diabetes mellitus, such as insulin and oral hypoglycemic drugs. Conventional diabetic treatments can cause several unfavorable side effects, including weight gain, diarrhea, hypoglycemia, hypersensitivity, GIT abnormalities, heart failure, liver failure, and nausea.

Herbal treatments, diet programs, and alternative therapies have reportedly improved the metabolism of glucose in diabetics (Malik *et al.*, 2023). Traditional medical expertise and historical medical literature have a major role in identifying new therapeutic plants. Researchers are now focusing on therapeutic plants since they are practical, readily available, and typically less harmful than medicines. Nowadays, medical practitioners are using functional foods, or nutraceuticals, to alleviate illnesses and lower risks or problems (Devi *et al.*, 2023). Plants have gained notoriety as a source of bioactive compounds, including hypoglycemic agents and antioxidants, and they may be crucial in the hunt for novel medicinal medicines (Gobinath *et al.*, 2022). According to the WHO, over 80% of individuals have treated a variety of illnesses with traditional medicine. The availability and safety of plant-based medications are causing demand for them (Akhtar *et al.*, 2023). *Bombax buonopozense* (*Bombacaceae*), also called the Red-flowered Silk Cotton tree or Gold Coast Bombax, is a significant tropical medicinal tree that grows throughout Africa. West African nations, including Ghana, Nigeria, and the Gambia, are home to the plant. Both the northern and some southern regions of Nigeria are home to it. The Hausa name it "kurya," the Igbo call it "akpuu," and the Yoruba call it "ogbolo." According to reports, the plant possesses antimalarial effects (Abdu and Ammani, 2017). Additionally, the plant's antibacterial, antidiarrheal, and antipyretic qualities were reported by Tilouri *et al.* (2021). According to Fadogba *et al.* (2024), *Bombax buonopozense* leaves have long been utilized as an arthritic remedy in southwest Nigeria. The toxicity study of the plant, according to Abdullahi Samira *et al.* (2024), showed that the LD 50 of the plant was greater than 2000mg/kg, which shows that the plant is practically non-toxic.

2. Materials and Methods

2.1. Collections of the Experimental Plant

Bombax buonopozense leaves were collected at Karmo, Abuja. Abuja's Karmo is situated inside Northern Nigeria's weathered underground aquifers (Aleke and Nwachukwu, 2018). It was identified by

Mr Hakeem at the National Institute for Pharmaceutical Research and Development (NIPRD) Herbarium Abuja. The voucher specimen number is NIPRD /H/ 7347

2.2. Extractions of the plant material

After being cleansed, dried, and left in the shade for three weeks, *Bombax buonopozense* was crushed up into tiny pieces with a mortar and pestle. The plant powder was weighed using a sensitive digital weighing balance, and 1.2 g of powdered leaf was macerated for 72 hours at room temperature (25–27°C) using 70% v/v methanol. Occasionally, shaking helped to facilitate the extraction process. Whatman filter paper No. 1 was used to filter the extract after 72 hours. The plant material was extracted completely by macerating the residue three times for an additional 72 hours using the same volume of 70% v/v methanol. A rotary evaporator was used to concentrate the filtrates from the sequential maceration under low pressure. A hot air oven set at 40°C was then used to concentrate the filtrates. Following drying, the amount of dry extract was weighed, put into sealed bottles, and kept in a refrigerator at -4°C until it was needed. To calculate the percentage yield, the weight of the dry extract was reported as a percentage of the total mass of dry plant material. The percentage yield of the extract is 8% (Adebayo *et al.*, 2010).

2.3. Experimental animals

Wistar Albino rats between 150–250 grams and between 8 and 10 weeks of age were used in the experiment. NIPRID is where the animals were bought. The animals were kept in cages with rats each, sawdust that was replaced every 24 hours, and an unlimited supply of water and pellet food. Two weeks before the start of the tests, the animals were acclimated to the lab environment. In terms of handling and care for the animal, international laboratory animal use and care guidelines were followed throughout the experiment. Under protocol number NIPRD/05.03.05-31, the Institute for Animal Experimentation's (IAEC) Ethics Committee approved the experiment.

2.4. STZ-induced diabetes in experimental rats

In this experiment, food was taken away from all animals four hours before the administration of STZ, but water was still given as usual. The rats were induced with a single intraperitoneal injection of freshly prepared streptozotocin (STZ) dissolved in 0.01 M citrate buffer (pH 4.5, 60 mg/kg BW). Blood sugar levels were measured 72 hours following the injection of STZ. Animals having plasma glucose levels higher than 200 mg/dl were included in the study (Fagbohun *et al.*, 2020).

2.5. Grouping and Dosing of Animals

A total of thirty (36) male Wistar rats were divided into six groups, each with six rats. Streptozotocin was used to initiate (24) male Wistar rats in the experimental group. Rats in Group A, who did not have diabetes, were given simply water. Diabetic rats in groups C–E were given 100, 200, and 400 mg/kg body weight (BW) of the methanol leaf extract of *B. buonopozense*, while diabetic rats in group B were given water. As the control group, Group F consisted of diabetic rats given the reference medication, metformin, at a dose of 150 mg/kg BW. For 28 days, each animal received the appropriate intervention and treatment. The levels of fasting blood glucose (FBG) were measured

2.6. Evaluation of 70% methanolic leaf extracts of *B. buonopozense*'s antihyperglycemic activity in rats with STZ-induced diabetes.

2.6.1. Short-term Effect Study

In diabetic rats, a single-dose antihyperglycemic activity of 70% *Bombax buonopozense* extract was tested 72 hours following an STZ injection. A blood glucose level was measured at 0, 0.5, 1, 2, 4, 6, 8, 10, 12, and 24 hours after a 14-hour overnight fast.

2.6.2. Repeated Dose Study

Diabetic rats were administered *Bombax buonopozense*, a standard drug, for 4 weeks in repeated dose experiments, depending on their grouping. FBG was then measured twice a week to assess the extract's ability to reduce blood glucose. The Blood Glucose level of diabetic rats was assessed after a 6-hour fast (Abdul *et al.*, 2024)

2.6.3. Determination of body weight and biophysical parameters

A digital balance was used to assess how STZ affected body weight loss and how extract and standard improved body weight change (Al-Attar and Alsalmi, 2019). Before administering STZ, the rats in the control group and all treated groups had their baseline body weight measured (Fajarwati *et al.*, 2023). In repeated dosage research, daily measurements of food intake, water intake, faecal output, urine, and body weight change were made for 28 days.

2.6.4. Measurement of blood glucose level

The tip tails of the animals were cut and the blood samples were taken to measure the blood glucose level. Accu Chek glucometer standard strip was used for checking the blood glucose level. The measurement was repeated twice and the average

was recorded, to prevent the occurrence of infection in the tails of rats, 70 % ethanol was applied to the tail using cotton (Abdul *et al.*, 2024).

2.6.5. Collection preparation of blood sample

The rats were sacrificed after 24 hours of the last treatment. The blood was collected into a sterilized tube. For the biochemical analysis, it was then centrifuged at 3000 rpm for 10 mins. The serum was collected using a Pasteur pipette (Daniel *et al.*, 2022)

2.6.7. Hematological Parameter Evaluation

WBCs ($\times 10^3 \mu\text{L}^{-1}$), lymphocytes, RBCs ($\times 10^6 \mu\text{L}^{-1}$), hemoglobin concentration (g/dL), hematocrit (HCT), and platelets were among the hematological parameters that were evaluated using an Automated Hematological System Analyzer at the Department of Pharmacology and Toxicology, NIPRID, Nigeria (Fagbohun *et al.*, 2020).

2.6.8. Assessment of Biochemical Parameters

The serum obtained from centrifugation was used to assess the liver enzymes such as alkaline phosphatase aspartate (ALP), alanine aminotransferase (ALT), and aspartate aminotransferase (AST) activities and the content of the total protein was assessed using the method described by (Enechi *et al.*, 2023), as described by (Abdul *et al.*, 2024). The Lactate dehydrogenase (LDH) activity was determined. According to method described by Enechi *et al.*, 2023, the serum electrolytes, including potassium, sodium, and chloride ions, bicarbonate, were assayed

2.7. Statistical analysis

Graph Pad Prism version 8.0 for Windows was used for the statistical study. Values were presented as mean \pm SED and one-way analysis of variance (ANOVA) was used to evaluate group differences. Statistical significance was defined as P-values below 0.05.

3. Results and Discussion

3.1. Results

3.1.1. Effect of *Bombax buonopozense* methanol leaf extract on Body Weight

On the 28th day of observation, the treatment groups showed a not significantly increased weight, whereas the diabetic control group experienced a decrease in weight, as shown in Table 1. The alteration is not significant.

3.1.2. *Effect of Bombax buonopozense* Methanol Leaf Extract on Streptozotocin-Induced Diabetic Rats' Blood Glucose Levels in the Short-Term

In the 24-hour diabetes study, there was a significant ($P < 0.05$) increase in blood glucose level in the untreated diabetic group at 0 to 24 hours compared to the non-diabetic group, at 0, 0.5, 1 and 24 hours, increase in blood glucose level was observed in the untreated group when compared with metformin. Among the treatment groups, there is a significant reduction of blood glucose level at 6, 8, and 10 hours when treated with 400 mg/kg as compared with the untreated diabetic group. The standard control with the treatment of metformin also showed a decline in blood glucose level, while the diabetic control showed an increase in the blood glucose level as shown in Table 2

3.1.3. *The short-term Effect of the Methanol Leaf Extract of Bombax buonopozense on the Decrease in the Percentage of blood glucose level for 24 hours.*

Table 3 shows a percentage inhibition decrease in blood glucose at 4, and 10, 24 hours in the non-diabetic group compared with the metformin-treated group. At 4, 6, 8, 10, and 12 hours, a decrease in percentage inhibition was observed in the group treated with 100 mg/kg compared to the untreated diabetic group. There was a percentage inhibition decrease in the group treated with 400 mg/kg when compared with the untreated diabetic group. At day 10, a significant decrease in percentage inhibition is shown in the metformin-treated group when compared with the untreated diabetic group

3.1.4. *Effect of methanol leaf extract Bombax buonopozense on Fasting Plasma Glucose Concentrations of Diabetic Rats for 28 days*

After administering *Bombax buonopozense* extract repeatedly for 28 days, as shown in Table 4, a notable significant reduction ($P < 0.05$) was observed in the untreated diabetic rats at 0 to 24 days when compared with the non-diabetic group. At 0 and 1 day a significant increase was observed in the metformin-treated group when compared with the non-diabetic group and also at 14, 17, 21, and 24 days, a significant decrease was observed in the metformin-treated group when compared with the untreated diabetic group. A significant decrease was observed in 4, 21 and 24 days when treated with 100 mg/kg, 1, 4, 10, 14, 21, and 24 days when treated with 200 mg/kg, 4, 10, 14, 21, and 24 when treated with 400 mg/kg and metformin as compared with the untreated diabetic group

3.1.5. *Effect of methanol leaf extract Bombax buonopozense on decrease in percentage inhibition of Plasma Glucose Concentrations of Diabetic Rats for 28 days*

The results of Table 5 showed a significant decrease in percentage inhibition on the 4th and 24th day of the group treated with metformin, the 4th, 21st, and 24th day of the group treated with 100 mg/kg, the 1st, 4th, and 28th day of the group treated with 200 mg/kg, and the 10th, 14th, and 21st day of the group treated with 400 mg/kg as compared to the untreated diabetic group.

3.1.6. *Effect of Bombax buonopozense methanol leaf extract on food consumption*

During the 28-day treatment period, as shown in Figure 1, no significant difference was observed between the treated diabetic groups and the untreated diabetic groups, and also no significant difference was observed between the treated diabetic and the nondiabetic groups

3.1.7. *Effect of Bombax buonopozense leaf methanol extract on faecal Output.*

The result of the study as shown in figure 2 showed at day 12, a significant decrease was observed in the group treated with 400 mg/kg when compared with the untreated diabetic and metformin group. At days 16, 22, and 23, a significant decrease is shown in the group treated with 200 mg/kg when compared with diabetic untreated groups. A significant reduction is observed in the metformin group on the 18th day compared to the untreated diabetic group. At day 19, a significant decrease in the faecal output was shown when treated at 400 mg/kg as compared with the untreated diabetic group. A significant decrease of faecal output was also observed on the day 25 when treated at 100 mg/kg as compared with the untreated group

3.1.8. *Effect of Bombax buonopozense methanol leaf extract on water consumption*

The result of the study as shown in Figure 3 showed at day 21 a significant decrease was observed in the group treated with 400 mg/kg when compared with the untreated diabetic and metformin group. On day 9, a significant reduction is shown in the group treated with 200 mg/kg compared to diabetic untreated groups. A significant decrease is observed when treated with metformin on the 25th day compared to the untreated diabetic group.

3.1.9. *Effect of Bombax buonopozense leaf methanol extract on urine Output.*

The result of the study as shown in Figure 4 showed at day 20, a significant increase was observed in the untreated diabetic group when compared with the metformin group. On days 21 and 25, a significant increase was shown in the untreated diabetic group when compared with the non-diabetic group.

3.1.10. Effect of *Bombax buonopozense* on Relative Organ Weight

The result of Table 6 showed a significant decrease in liver and testes weight in the untreated groups when compared with the non-diabetic group.

3.1.11. Effect of 28 days administration of *Bombax buonopozense* leaf extract on hematology parameters

The result of Table 7 revealed a significant increase in platelet (PLT) in the non-diabetic group, metformin, and the treated group (100mg/kg and 400 mg/kg) when compared with the untreated diabetic group

3.1.12. Effect of 28 days administration of *Bombax buonopozense* leaf extract on lipid profiles

The treated groups showed a decrease, but not significantly in blood cholesterol and LDL concentrations and an increase in HDL in the treated

group when compared to the untreated group. No significant difference was shown in either the treated group or the non-diabetic group when compared with the negative control as shown in Table 8

3.1.13. Effect of 28 days administration of *Bombax buonopozense* on liver enzymes

The enzyme Alkaline Phosphatase exhibited significantly decreased concentrations in the treated groups and non-diabetic groups when compared to the untreated diabetic group, as shown in Table 9

3.1.14. Effect of 28 days administration of *Bombax buonopozense* leaf extract on kidney indices

When compared to the non-diabetic group, the untreated group had considerably higher levels of kidney markers such as urea and creatinine; however, when compared to the untreated group, oral treatment of the extract and metformin did not show a significant decline in these serum kidney function indicators, as shown in Table 10.

Table 1: Effect of *Bombax buonopozense* methanol leaf Extract on Body weight

	Non-diabetic	Diabetic Untreated	Metformin	100 mg/kg	200 mg/kg	400 mg/kg
D0.	157.17±10.86	232.17±23.96	236.33±20.54	213.00±18.75	220.50±26.12	231.33±22.17
D7	161.00±9.46	234.83±22.94	231.17±20.42	203.43±19.82	212.50±21.76	234.50±21.33
D14	176.50±6.58	228.80±22.32	240.67±29.04	214.14±22.05	222.00±25.88	244.50±23.94
D21	172.17±10.73	230.00±22.91	241.67±26.04	215.14±22.98	231.00±28.36	249.83±23.05
D28	172.00±12.05	218.80±21.44	240.60±26.34	209.86±22.11	223.50±30.59	247.17±21.99

Values are represented as mean value ± standard error of the mean (SEM) n= 6; *leaf extract* treated groups (100mg/kg, 200mg/kg, and 400 mg/kg), untreated diabetic group, and Metformin group. Two-way ANOVA was used for mean differences, followed by Dunnett's test for multiple comparisons. No significant difference from the untreated diabetic group was observed.

Table 2: Effect of *Bombax buonopozense* methanol Leaf Extract on Blood glucose level for 24 hrs.

	Non-diabetic	untreated diabetic	100 mg/kg	200 mg/kg	400 mg/kg	Metformin
0 hr	7.47±0.52 ^a	21.12±1.70	21.37±1.29	21.18±1.67	20.72±2.84	20.88±1.84
0.5 hr	7.37±0.54 ^a	20.58±0.46	17.20±2.47	17.38±2.98	16.48±2.96	16.88±2.04
1 hr	7.05±0.78 ^a	20.63±0.78	16.52±2.31	16.47±2.58	13.78±2.70	16.33±2.31
2 hr	6.83±0.43 [*]	17.92±0.58	14.99±3.23	14.00±2.61	12.25±2.39	12.10±2.90
4 hr	5.98±0.38 [*]	16.87±1.70	12.11±3.02	12.45±3.16	9.40±2.06	9.92±3.15
6 hr	5.95±0.33 [*]	16.32±2.28	10.39±2.88	10.80±2.69	7.95±1.81 [*]	9.27±2.59
8 hr	5.10±0.28 [*]	14.58±2.59	10.04±2.74	10.43±2.70	6.08±0.85 [*]	9.32±2.50
10 hr	5.82±0.33 [*]	14.68±2.47	8.81±2.52	10.07±2.46	5.75±0.68 [*]	8.75±2.71
12 hr	4.98±0.19 [*]	13.28±2.30	8.91±2.80	9.17±2.31	5.45±0.67	8.97±2.57
24 hr	6.47±0.48 ^a	23.98±1.08	17.48±1.96	13.88±3.20 [*]	16.78±2.51	17.20±3.58

Values are represented as mean value ± standard error of the mean (SEM) n= 6; *leaf methanol extract* treated groups (100 mg/kg, 200mg/kg, and 400 mg/kg), untreated diabetic group, Metformin. * p<0.05 compared to untreated diabetic group. ^a p<0.05 compared to metformin

Table 3: Effect of *Bombax buonopozense* Leaf Extract on Percentage Inhibition Decrease on blood glucose level for 24hrs.

Time (hours)	Non-diabetic	untreated diabetic	100 mg/kg	200 mg/kg	400 mg/kg	Metformin
0.5 hr	1.43±0.67	-0.29±7.25	21.18±7.45	19.78±10.33	19.84±10.54	18.59±8.57
1 hr	3.70±10.82	0.24±5.96	24.21±6.64	23.41±9.29	34.58±8.53	22.80±9.67
2 hr	5.96±9.32	13.47±4.58	42.39±9.77	35.96±8.55	41.74±7.22	41.25±13.54
4 hr	17.28±8.81 ^a	16.97±11.09 ^a	55.81±8.58 [*]	43.79±11.88	55.16±7.02 [*]	60.06±9.00

6 hr	18.62±6.96	19.18±13.17	63.76±7.60*	51.32±9.84	61.83±6.49*	54.82±11.87
8 hr	29.37±7.30	25.89±15.30	64.56±6.96*	53.28±9.64	68.19±5.55*	53.76±12.26
10 hr	19.75±7.65	25.59±14.68 ^a	68.82±6.73*	54.23±8.94	69.84±4.90*	57.00±12.92*
12 hr	31.15±6.47	31.51±14.88	70.51±6.16*	58.58±8.12	71.65±4.51*	55.72±12.31
24 hr	11.97±7.94	-15.89±7.38 ^a	18.64±7.39	34.33±14.56*	4.95±27.33	28.53±18.86

Values are represented as mean value ± standard error of the mean (SEM) n= 6; *leaf methanol extract* treated groups (100 mg/kg, 200 mg/kg, and 400 mg/kg), untreated diabetic group, Metformin. * p<0.05 compared to untreated diabetic group. ^a p<0.05 compared to metformin

Table 4: Effect of *Bombax buonopozense* Leaf Extract on Blood Glucose Level for 28 days

	Non-diabetic	untreated diabetic	100 mg/kg	200 mg/kg	400 mg/kg	Metformin
0	7.47±0.52* ^a	21.12±1.70	21.37±1.29	21.18±1.67	20.72±2.84	20.88±1.84
1	6.47±0.48* ^a	23.98±1.08	17.48±1.96	13.88±3.20*	16.78±2.51	17.20±3.58
4	6.67±0.39*	24.37±0.94	14.67±2.80*	14.95±2.33*	12.92±2.77*	12.57±2.11*
7	6.35±0.62*	16.93±2.66	9.74±2.78	12.20±1.68	11.82±3.90	9.77±2.25
10	5.73±0.48*	21.36±3.87	13.16±3.28	11.80±2.60*	6.67±0.49*	10.87±2.71*
14	5.40±0.46*	19.78±2.58 ^a	14.47±3.34	9.92±1.26*	6.87±0.50*	9.37±1.82*
17	6.23±0.22*	16.08±4.65 ^a	13.89±3.86	10.33±2.52	6.33±1.24*	6.40±0.38*
21	5.73±0.30*	20.74±3.21 ^a	8.73±2.75*	8.63±0.67*	5.72±1.31*	10.62±3.21*
24	6.52±0.32*	19.68±3.29 ^a	9.86±3.71*	7.22±1.23*	8.68±2.30*	7.23±2.82*
28	6.02±0.74	9.66±2.09	7.34±2.91	5.30±0.57	5.35±0.48	6.62±2.62

Values are represented as mean value ± standard error of the mean (SEM) n= 6; *leaf extract* treated groups (100 mg/kg, 200 mg/kg and 400 mg/kg), untreated diabetic group, Metformin. * p<0.05 compared to untreated diabetic group.

^a p<0.05 compared to metformin

Table 5: Effect of *Bombax buonopozense* methanol Leaf Extract on Percentage Inhibition Decrease on Blood Glucose Level for 28days

Time (Days)	Non-diabetic	untreated diabetic	100 mg/kg	200 mg/kg	400 mg/kg	Metformin
1	11.97±7.94	-15.89±7.38	18.64±7.39	34.33±14.56*	4.95±27.33	28.53±18.86
4	9.31±6.43	-19.05±10.37 ^a	40.76±9.06*	27.52±11.02*	24.23±26.02	37.77±11.77*
7	14.09±8.88	16.77±14.67	67.04±1.66	41.42±8.09	45.99±10.37	52.14±11.55
10	22.12±7.35	12.48±24.01	51.07±9.86	43.90±10.68	63.86±6.66*	45.40±15.11
14	25.49±8.77	19.97±20.07	43.53±11.68	52.14±5.77	62.07±8.60*	50.36±13.23
17	13.77±8.28 ^a	34.06±23.12	44.76±16.16	51.34±10.08	68.87±4.92	68.67±2.22
21	21.36±6.72	14.12±23.48	61.20±9.60*	58.63±3.24	72.49±5.35*	47.54±14.37
24	11.54±4.93 ^a	18.29±23.00 ^a	69.77±5.92*	64.18±7.01	47.68±20.76	64.41±12.21*
28	17.17±12.15 ^a	60.03±12.49	78.76±2.66	74.25±2.94*	71.24±5.50	74.53±10.13

Values are represented as mean value ± standard error of the mean (SEM) n= 6; *leaf extract* treated groups (100mg/kg, 200 mg/kg, and 400 mg/kg), untreated diabetic group, Metformin. * p<0.05 compared to the untreated diabetic group.

^a p<0.05 compared to metformin

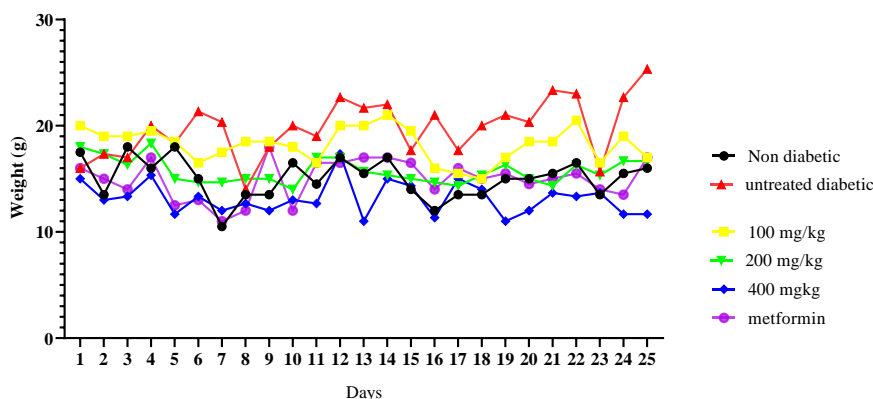


Figure 1: Effect of *Bombax. Buonopozense* Methanol Leaf Extract on Food Consumption. Values are represented as mean value ± standard error of the mean (SEM) n= 6; *leaf extract* treated groups (100 mg/kg, 200mg/kg, and 400 mg/kg), untreated diabetic group, Metformin. No significant difference from the untreated diabetic group was observed

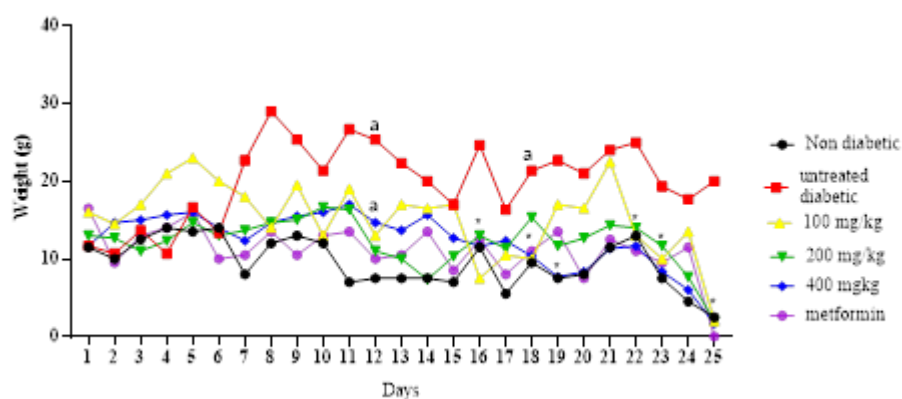


Figure 2: Effect of *Bombax buonopozense* Methanol Leaf Extract on faecal Output. Values are represented as mean value \pm standard error of the mean (SEM) $n=6$; leaf extract treated groups (100mg/kg, 200 mg/kg, and 400 mg/kg), untreated diabetic group, Metformin. * $p<0.05$ compared to the untreated diabetic group. ^a $p<0.05$ compared to metformin

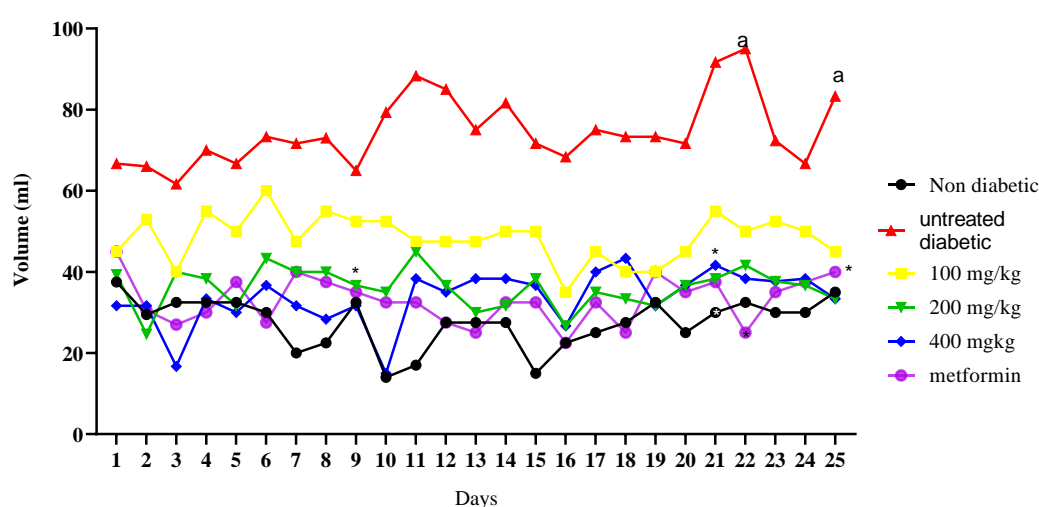


Figure 3: Effect of *Bombax buonopozense* Methanol Leaf Extract on water consumption. Values are represented as mean value \pm standard error of the mean (SEM) $n=6$; leaf extract treated groups (100mg/kg, 200mg/kg, and 400 mg/kg), untreated diabetic group, Metformin. * $p<0.05$ compared to the untreated diabetic group. ^a $p<0.05$ compared to metformin.

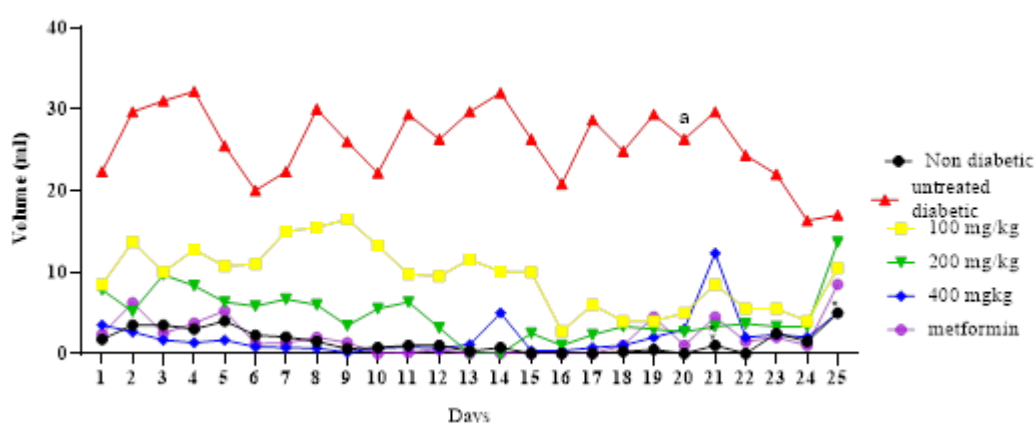


Figure 4: Effect of *Bombax buonopozense* Methanol Leaf Extract on urine output. Values are represented as mean value \pm standard error of the mean (SEM) $n=6$; leaf extract treated groups (100mg/kg, 200mg/kg, and 400 mg/kg), untreated diabetic group, Metformin. * $p<0.05$ compared to the untreated diabetic group. ^a $p<0.05$ compared to metformin.

Table 6: Effect of *Bombax buonopozense* Leaf Extract on Relative Organ Weight

	Non-diabetic	Untreated diabetic	100 mg/kg	200 mg/kg	400 mg/kg	metformin
LIVER	3.76±0.32	1.89±1.52***	4.14±0.16	4.11±0.30	4.11±0.56	4.24±0.23
BRAIN	0.71±0.08	0.31±0.23	0.86±0.07	0.73±0.10	0.74±0.07	0.93±0.10
SPLEEN	0.40±0.08	0.18±0.14	0.38±0.07	0.28±0.04	0.30±0.05	0.38±0.05
HEART	0.32±0.04	0.14±0.11	0.41±0.04	0.34±0.02	0.34±0.04	0.34±0.04
LEFT KIDNEY	0.33±0.04	0.20±0.16	0.44±0.01	0.41±0.01	0.42±0.04	0.44±0.05
RIGHT KIDNEY	0.33±0.04	0.20±0.16	0.44±0.02	0.43±0.01	0.40±0.05	0.43±0.04
PANCREASE	0.24±0.05	0.05±0.04	0.17±0.01	0.12±0.02	0.16±0.04	0.14±0.01
LUNGS	0.70±0.12	0.77±0.72	0.81±0.04	0.66±0.03	0.88±0.14	0.77±0.25
SMALL INTESTINE	0.23±0.03	0.15±0.13	0.34±0.06	0.20±0.03	0.23±0.04	0.25±0.03
TESTES	1.34±0.14	0.50±0.05*	0.45±0.45	1.16±0.12	0.83±0.31	0.73±0.46

Values are represented as mean value ± standard error of the mean (SEM) n= 6; leaf extract treated groups (100mg/kg, 200mg/kg and 400 mg/kg), untreated diabetic group, Metformin. Two-way ANOVA was used for differences in mean followed by Dunnett's test for multiple comparison

Table 7: Effect of Methanol leaf extract of *Bombax buonopozense* on Hematology parameters

	WBC (x10 ⁹ /L)	LYM (x10 ⁹ /L)	RBC (x10 ¹² /L)	HGB (g/L)	HCT (%)	PLT (10 ⁹ /L)
Non diabetic	3.85±0.88	3.12±0.75	7.36±0.13	139.20±2.96	44.82±0.99	703.60±20.96***
Untreated diabetic	4.28±0.44	3.47±0.45	7.41±0.15	143.80±3.88	44.38±0.98	480.40±42.27
100 mg/kg	6.57±0.85	4.51±0.73	7.62±0.59	148.20±11.35	48.74±4.01	590.20±38.31***
200 mg/kg	4.12±0.31	3.20±0.34	6.66±0.41	132.83±10.12	42.78±3.21	519.67±48.83
400mg/kg	5.03±1.22	4.17±0.75	7.02±0.32	137.83±2.63	42.23±0.97	761.50±59.68***
Metformin	5.01±3.02	2.54±1.13	5.63±0.87	107.80±17.23	34.02±4.93	775.40±151.79***

WBC, LYM, RBC, HGB, HCT, PLT represent white blood count, lymphocytes, red blood cell count, haemoglobin, hematocrit, and platelete, respectively. Values are represented as mean value ± standard error of the mean (SEM) n= 6; methanol leaf extract treated groups (100mg/kg, 200mg/kg and 400 mg/kg), untreated diabetic and Metformin group. Two-way ANOVA was used for mean differences followed by Dunnett's test for multiple comparison *p<0.05 significantly different from Normal and #p<0.05 substantially different from the untreated diabetic group.

Table 8: Effect of *Bombax buonopozense* Methanol Leaf Extract on Lipid profile

	Non-diabetic	untreated diabetic group	100 mg/kg	200 mg/kg	400 mg/kg	metformin
T-Chol(mg/dl)	91.92±7.05	105.55±16.94	103.72±9.45	101.02±10.78	102.07±9.52	94.06±9.99
Trig (mg/dl)	74.34±12.86	93.75±14.25	82.24±17.06	75.55±10.87	81.02±14.42	77.44±17.52
HDL-C(mg/dl)	78.29±6.97	71.68±7.41	79.27±5.71	73.79±6.39	83.32±8.94	87.87±9.89
LDL-C(mg/dl)	21.68±2.63	30.52±2.12	27.13±4.05	20.79±5.77	11.45±1.96	13.08±2.63

Values are represented as mean value ± standard error of the mean (SEM) n= 6; leaf extract treated groups (100mg/kg, 200mg/kg and 400 mg/kg), untreated diabetic group, and Metformin. Two-way ANOVA was used for differences in mean followed by Dunnett's test for multiple comparison *p<0.05 significantly different from the untreated diabetic group

Table 9: Effect of *Bombax buonopozense* Methanol Leaf Extract on liver function parameters

	Non-diabetic	untreated diabetic group	100 mg/kg	200 mg/kg	400 mg/kg	metformin
T-Protein g/dl	7.81±0.35	8.47±0.59	8.29±0.53	8.30±0.33	8.30±0.20	7.46±0.48
Albumin g/dl	4.34±0.56	3.65±0.66	3.95±0.40	3.93±0.64	4.20±1.13	5.74±2.26
T-Bil mg/dl	0.94±0.13	0.58±0.08	0.73±0.11	0.39±0.06	0.60±0.11	0.56±0.07
D-Bil mg/dl	1.81±0.37	0.92±0.10	1.31±0.20	0.84±0.15	1.16±0.29	0.74±0.16
ALP u/l	261.74±28.74*	711.90±220.29	199.64±19.77*	175.26±41.71*	339.643±12.50*	234.05±76.08*
ALT u/l	40.22±4.05	27.52±2.52	69.00±13.03	33.55±4.93	49.10±13.03	26.64±1.65
AST u/l	20.41±3.32	20.76±1.09	22.80±2.29	21.11±4.05	21.60±1.29	16.98±1.73
LDH u/l	251.06±25.19	278.99±21.33	269.40±23.30	254.27±21.76	259.28±21.13	255.87±29.89

Values are represented as mean value ± standard error of the mean (SEM) n= 6; leaf extract treated groups (100mg/kg, 200mg/kg and 400 mg/kg), untreated diabetic group, and Metformin. Two-way ANOVA was used for differences in mean followed by Dunnett's test for multiple comparison *p<0.05 significantly different from the untreated diabetic group

Table 10: Effect of *Bombax buonopozense* Methanol Leaf Extract on Kidney Function Parameters

	Non-diabetic	untreated diabetic group	100 mg/kg	200 mg/kg	400 mg/kg	Metformin
Urea mg/dl	11.45±0.62	12.73±0.64	12.13±0.74	10.82±0.67	11.43±0.69	10.74±0.59
Creatinine mg/dl	1.63±0.13	1.92±0.20	1.68±0.08	1.29±0.11	1.41±0.14	1.37±0.14
Sodium mmol/l	148.93±1.67	141.26±8.36	139.14±11.52	129.60±9.18	146.48±8.97	155.00±12.18
Potassium mmol/l	14.54±1.01	11.80±1.63	9.96±1.44	8.71±1.14	9.48±0.49	13.18±1.38
Chloride mmol/l	54.70±3.39	44.19±4.78	50.31±3.05	49.88±4.12	47.64±2.32	56.57±3.41
Calcium mmol/l	1.97±0.18	1.58±0.11	2.12±0.14	1.68±0.12	1.90±0.14	1.69±0.14
Phosph mmol/l	34.25±1.70	30.03±3.03	31.19±2.54	27.58±2.38	30.69±2.45	31.71±1.63
Bicarb mmol/l	50.70±5.73	33.86±1.12	39.33±1.24	32.21±3.06	35.23±1.24	39.16±1.99

Values are represented as mean value ± standard error of mean (SEM) n= 6; Crude extract treated groups (100mg/kg 200mg/kg and 400 mg/kg), Negative control, positive control (Metformin). Two way ANOVA was used for differences in mean followed by Dunnett's test for multiple comparison *p<0.05significantly different from untreated diabetic group

3.2. Discussion

Diabetes mellitus (DM) can seriously harm all bodily components, including the heart, kidneys, blood vessels, nerves, and eyes (Zhao *et al.*, 2021). Natural bioactive chemicals are a broad category of molecules from marine life, fungi, plants, and other natural sources (Narayanankutty *et al.*, 2024). Because of their accessibility, low cost, and lack of side effects, plants are well-known for their therapeutic qualities and can be used locally (Alsarayreh *et al.*, 2022). Even with the tremendous advancements in diabetes care in recent decades, the best possible patient outcomes are still unachievable (Kooti *et al.*, 2016). As a result, ethnomedicinal plants must be evaluated and developed as substitutes for the present hypoglycemia medications, which are frequently expensive and linked to negative side effects (Daniel *et al.*, 2022). Many bioactive substances found in ethnomedical plants may help control diabetes by lowering blood glucose levels (Aker *et al.*, 2024). *Bombax buonopzense* has historically been used to help diabetics lower their blood glucose levels. The plant also possesses high antioxidant qualities (Tilouri *et al.*, 2021). The bioactive compound of *Bombax buonopzense* was found to have phenols, saponins, terpenes, steroids, and cardiac glycosides, which may be the cause of its anti-diabetic effects. Because of its selective cytotoxicity to the beta cells in the pancreas that produce insulin, streptozotocin (STZ), a nitrosourea antibiotic produced from *Streptomyces achromogenes*, is widely used to induce diabetes in laboratory animals (Rehman *et al.*, 2018). Several treatment groups were assessed during 24 hours in our study, and the treated groups' blood glucose levels were significantly lower than those of the untreated diabetic group. *Bombax buonopzense*'s antihyperglycemic action was linked to elevated plasma insulin levels, indicating insulinogenic activity. Compared to their untreated diabetic counterparts, diabetic rats treated with *Bombax*

buonopozense extract showed a significant decrease in fasting blood glucose levels after 28 days of administration. Furthermore, all the treated groups showed a significant decrease in ALP when compared with the untreated diabetic group. Hepatotoxic effects were evident even in the absence of hyperglycemia since STZ treatment was linked to an increase in liver enzyme levels in diabetic rats (Lucchesi *et al.*, 2015). Untreated diabetic rats also showed elevated urea and creatinine levels in comparison to controls. However, a drop in LDL levels as well as an increase in HDL levels were noted in the treated groups. These changes are consistent with recent research showing that *Bombax .buonopozense* can alter lipid profiles, most likely via blocking insulin-inactivating lipolytic pathways (Gobinath *et al.*, 2022). Enzyme activity in the tissues is frequently used as "markers" when administering the extract to experimental animals to identify the early detrimental effects. This leads to a significant increase in ALP activities in the untreated diabetic group when compared to the non-diabetic group. According to Daniel *et al.* (2022), elevated serum levels of the markers indicate cellular leakage and a deterioration of the liver's functional cellular membrane integrity. The finding of (Ramesh & Rani, 2019) found that elevated liver enzyme levels in untreated diabetic animals, a known complication of diabetes, were reduced in the therapeutic groups, suggesting that with continued use, the plant extract may stabilize the plasma membrane and aid in healing the injury to the hepatic tissue (Fajarwati *et al.*, 2023). Additionally, elevated creatinine and urea levels in diabetic animals indicate nephrotoxicity, which *Bombax buonopozense* treatment mitigated. Diabetes mellitus has been shown to impair lipid metabolism because hyperglycemia is associated with a significant increase in LDL-cholesterol levels, which leads to the development of atherosclerosis and other cardiovascular diseases. The administration of the extract slightly reduced the elevated serum

levels of these parameters compared to the untreated diabetic group. Because of the plant's antihyperglycemic properties, *Bombax buonopozense*, at 400 mg/kg bwt, was able to lower LDL cholesterol levels, although not significantly. Diabetic symptoms in an untreated group, such as weight loss, polyuria, polyphagia, and polydipsia, deteriorated over time, supporting earlier findings (De Carvalho *et al.*, 2019). Diabetes-induced hyperglycemia decreases glucose absorption into the satiety regions in the brain, resulting in chronic hunger (Watts *et al.*, 2022). As a result, untreated diabetic subjects usually lose weight because of excessive polyphagia and impaired glucose utilization, which triggers the gluconeogenic pathway. Serum protein analysis showed that diabetic rats had lower levels of albumin, a primary plasma protein necessary for cell function, indicating increased protein catabolism in the untreated group. In the current study, there were significant increases in platelet count in the 100 mg/kg, 400 mg/kg, metformin, and non-diabetic groups compared to the untreated diabetic group, while the untreated diabetic group experienced a decrease in platelets. This is in line with previous studies that have established the incidence of anaemia in individuals with diabetes (Daniel *et al.*, 2022). The relative organ weight of the untreated diabetic showed decreases in the liver and testes. Consistent with the findings of (Watts *et al.*, 2022) diabetic rats exhibited atrophy of the seminiferous tubules and a decrease in testicular weight, indicating that apoptotic cell death plays a significant role in the loss of testicular function in the experimental group of diabetic rats. Normal plasma albumin levels in the therapy groups suggested that the *Bombax buonopozense* extract was having a protective effect (Singh *et al.*, 2022). The extract's potency raises the prospect of creating new medication that might serve as innovative diabetic treatment solutions. Thus, it was verified by this investigation that *Bombax buonopozense* has antidiabetic effects.

4. Conclusion

While there has been significant progress in diabetes treatment, a fully effective medication for diabetes mellitus remains elusive. Medicinal plants hold promise as complementary therapies for managing diabetes mellitus and its complications. The findings of this study indicate that *Bombax buonopozense* leaf extract exhibits antidiabetic properties, providing baseline data for future research to characterize the extract further and validate its traditional use in ethnomedicine.

Authors' Contributions

Samira Abdullahi conceptualized and designed the research idea under the supervision of Aminu Ibrahim. All the authors approved the manuscript.

Conflict of interest

The authors declare no conflict of interest.

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Availability of data and material:

The datasets utilized and/or analyzed in the present study are available from the corresponding author upon reasonable request.

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