Effects of Anacardium Occidentale Leaf Extract on Lipid Profile and Antioxidant Levels in Diabetic Albino Rats

Abstract: This study examines the lipid-lowering and antioxidant effects of aqueous leaf extract of *Anacardium occidentale* in alloxan-induced diabetic albino rats. Diabetes mellitus was induced in male albino rats via intraperitoneal injection of alloxan monohydrate at a dose of 120 mg/kg body weight. The diabetic rats were then treated with *A. occidentale* extract at a dose of 100 mg/kg body weight for 28 days. The treatment led to significant reductions in triacylglycerol, total cholesterol, and low-density lipoprotein cholesterol levels ($p < 0.05$), while significantly increasing high-density lipoprotein cholesterol levels. Antioxidant levels, including superoxide dismutase and catalase, were also improved, suggesting reduced oxidative stress. These findings indicate that *A. occidentale* exhibits potent hypolipidemic and antioxidative properties, making it a promising candidate for managing diabetes-induced dyslipidemia and oxidative stress. The study provides evidence supporting the use of *A. occidentale* as a natural therapeutic agent in the treatment of diabetes-related complications.

Key word: Anacardium occidentale, Alloxan induced Diabetes mellitus,
Lipid profile, Antioxidant levels, Hypolipidemic, oxidative stress, Dyslipidemia.

1. Introduction

Diabetes mellitus (DM) is one of the most ancient diseases documented in human history, with records dating back 3000 years in Egyptian manuscripts (1). It is characterized by chronic hyperglycemia resulting from either insulin deficiency or resistance, leading to severe complications such as microvascular damage (e.g., retinopathy, nephropathy, neuropathy) and macrovascular conditions like heart attacks, strokes, and kidney failure (2,3). The increasing global prevalence of DM, alongside the limitations of conventional therapies, has led to renewed interest in alternative therapeutic strategies, particularly those derived from plants. Conventional treatments, such as the use of sulfonylureas and metformin, are often accompanied by undesirable side effects and limited long-term efficacy (4).

Plants have been a significant source of medicinal agents for centuries. Traditional medicine, especially in regions with limited access to modern healthcare, offers a vast repository of plants with therapeutic potential. Over 400 plant species have been reported to exhibit hypoglycemic effects, prompting the World Health Organization (WHO) to advocate for further research into plant-based treatments for diabetes (5,6). Medicinal plants are known for their rich diversity of bioactive compounds, such as alkaloids, flavonoids, saponins, and tannins, which are responsible for various pharmacological activities including hypoglycemic, anti-inflammatory, and antioxidant effects (7).

One such plant is *Anacardium occidentale* (cashew), which has been widely used in traditional medicine across different cultures. This tropical evergreen plant is indigenous to regions like Brazil, Portugal, India, Southeast Asia, and Africa (8). Its leaves, stem, and bark have been employed in folk medicine to treat various ailments, including diabetes, diarrhea, malaria, and yellow fever (9). Phytochemical analysis has revealed the presence of compounds such as flavonoids, glycosides, and saponins, which are believed to be responsible for its medicinal properties (10).

Given the increasing global incidence of diabetes and the limitations associated with conventional therapeutic options, the exploration of alternative plant-based treatments is essential. Studies have shown that extracts from *A. occidentale* possess hypoglycemic, anti-inflammatory, and antioxidant properties, making it a promising candidate for diabetes management. Research suggests that its bioactive components may provide protection against streptozotocin-induced diabetes in animal models (11), and its leaves have been shown to provide vasorelaxation in isolated rat aorta (12). Furthermore, the plant's medicinal applications extend beyond diabetes, with its leaves being used in Brazil to treat conditions like eczema, psoriasis, and venereal diseases (13).

This study aims to investigate the effects of *A. occidentale* leaf extract on lipid profiles and antioxidant levels in alloxan-induced diabetic albino rats. Improving lipid profiles and reducing oxidative stress are crucial in managing the complications associated with diabetes. The findings of this study may contribute to the development of plant-based therapeutics that offer a safer, more affordable alternative to conventional diabetes treatments.

2. Materials and Methods

2.1 Materials

2.1.1 Instruments and Apparatus

- Electronic weighing balance (Pioneer, OHAUS, USA)
- Whatman Filter paper (Whatman Lab Division, Springfield Mill, England)
- Water bath (Uniscope SM 101 Laboratory, Surgifriend Medicals, England)
- GC-MS (Agilent Technologies 6890N/5975B)
- Heating mantle (Techmel & Techmel, USA)
- Rotary evaporator (Buchi, Rotavapor R-200)
- Spectrophotometer (Jenway 6305, England)
- Centrifuge (Model 80-2 Microfield Instrument, England)
- Digital glucometer (Accu-Check Sensor Glucometer, Roche, Mexico City)
- Centrifuge tubes (Plastic)
- Blood collection tubes (Goodcare)
- Dissecting kits (Hawksley, England)
- Latex surgical gloves (Shieldtex SDN. BHD., Malaysia)
- Measuring cylinder
- Desiccator
- Cotton wool

2.1.2 Reagents and Chemicals

- A.S.P Kit (Agappe Laboratories Ltd, UK)
- A.L.T Kit (Agappe Laboratories Ltd, UK)
- A.L.P Kit (Agappe Laboratories Ltd, UK)
- Formalin (40%)
- All chemicals and reagents used were of analytical grade.

2.2 Methods

2.2.1 Sample Collection and Identification Leaves of *Anacardium occidentale* were collected from Ogoni land, Rivers State, Nigeria. Identification was confirmed by a botanist at the Department of Plant Science and Biotechnology, Rivers State University (RSU), Port Harcourt. The leaves were washed, distilled water-rinsed, air-dried for four weeks, and powdered.

2.2.2 Preparation of Extract Five hundred grams of powdered plant material was macerated in water for 72 hours. The extract was filtered using Whatman No. 1 filter paper and concentrated via rotary evaporation (Buchi, Rotavapor R-200), then stored at 4°C.

2.2.3 Animal Handling Twenty-four male Wistar rats (90-120g) were obtained from Rivers State University and acclimatized for two weeks at the Pharmacology/Therapeutics Animal House, RSU.

2.2.4 Research Design The rats were divided into four groups (n=6):

- **Group 1:** Normal control (feed and water)
- **Group 2:** Diabetic control (alloxan only)
- **Group 3:** 120 mg/kg alloxan + 100 mg/kg *Anacardium occidentale*
- **Group 4:** 120 mg/kg alloxan + 5 mg/kg glibenclamide

2.2.5 Blood Sample Collection After 28 days of treatment, the rats were sacrificed. Blood samples were collected via cardiac puncture, centrifuged at 5000 rpm for 10 minutes, and stored at 4°C. Kidneys and pancreas were preserved in 10% formaldehyde for histological analysis.

2.2.6 Examination Serum was utilized for biochemical assays, including alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), lipid profile, and antioxidant assays.

2.2.7 Data Analysis Data were analyzed using GraphPad Prism, with statistical significance determined via ANOVA.

2.3 Method of Assay and Procedure

2.3.1 Phytochemical Analysis of Aqueous Extract A 1 µL sample of the aqueous extract was analyzed using GC-MS (Agilent 6890N/5975B), with active compounds identified by comparing spectral peaks to the NIST 2014 database.

2.3.2 Changes in Body Weight Body weight was measured at the study's start, weekly, and on day 28 using an electronic balance, and percentage change was calculated.

2.3.3 Fasting Plasma Glucose Measurement Fasting plasma glucose was measured using the glucose oxidase method. Blood samples (0.2 mL) were drawn from the tail vein every 7 days for 28 days, with glucose levels assessed using an Accu-Check Sensor glucometer.

2.3.4 ALT Assay ALT activity was measured using the Reitman and Frankel method (1957), with absorbance recorded at 405 nm.

2.3.5 ALP Assay ALP activity was assessed using a standard method (Bergmeyer et al., 1974), with absorbance read at 426 nm.

2.3.6 AST Assay AST activity was determined using the Reitman and Frankel method, with absorbance recorded at 405 nm.

2.3.7 Total Cholesterol Determination Cholesterol concentration was determined using the Allain et al. (1976) method with a Biosystem cholesterol kit.

2.3.8 Triacylglycerides Measurement Triacylglyceride concentration was measured using the Fletcher (1968) method, with absorbance recorded at 500 nm.

2.3.9 HDL-Cholesterol Determination HDL-cholesterol was assessed using Grove’s method (1979), after precipitating LDL and VLDL, with the supernatant analyzed.

2.3.10 LDL-Cholesterol Calculation LDL concentration was calculated using Friedewald's formula (Friedewald et al., 1972).

2.3.11 Renal Function Assay (Urea) Urea levels were determined using an enzymatic assay based on the urease-GLDH system (Talke & Schubert, 1965).

3. RESULT

3.1 PHYTOCHEMICAL ANALYSIS OF AQUEOUS LEAF EXTRACT OF *Anacardium Occidentale*

Figure 1 GCMS result of aqueous leaf extract of *Anacardium Occidentale*

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File       :C:\msdchem\1\data\AMARA\CASHEW LEAF EXTRACT.D
Operator   : EBIC
Acquired   : 24 Mar 2023  14:52     using AcqMethod Scan_.M
Instrument :    GCMSD
Sample Name: Cashew Leaf
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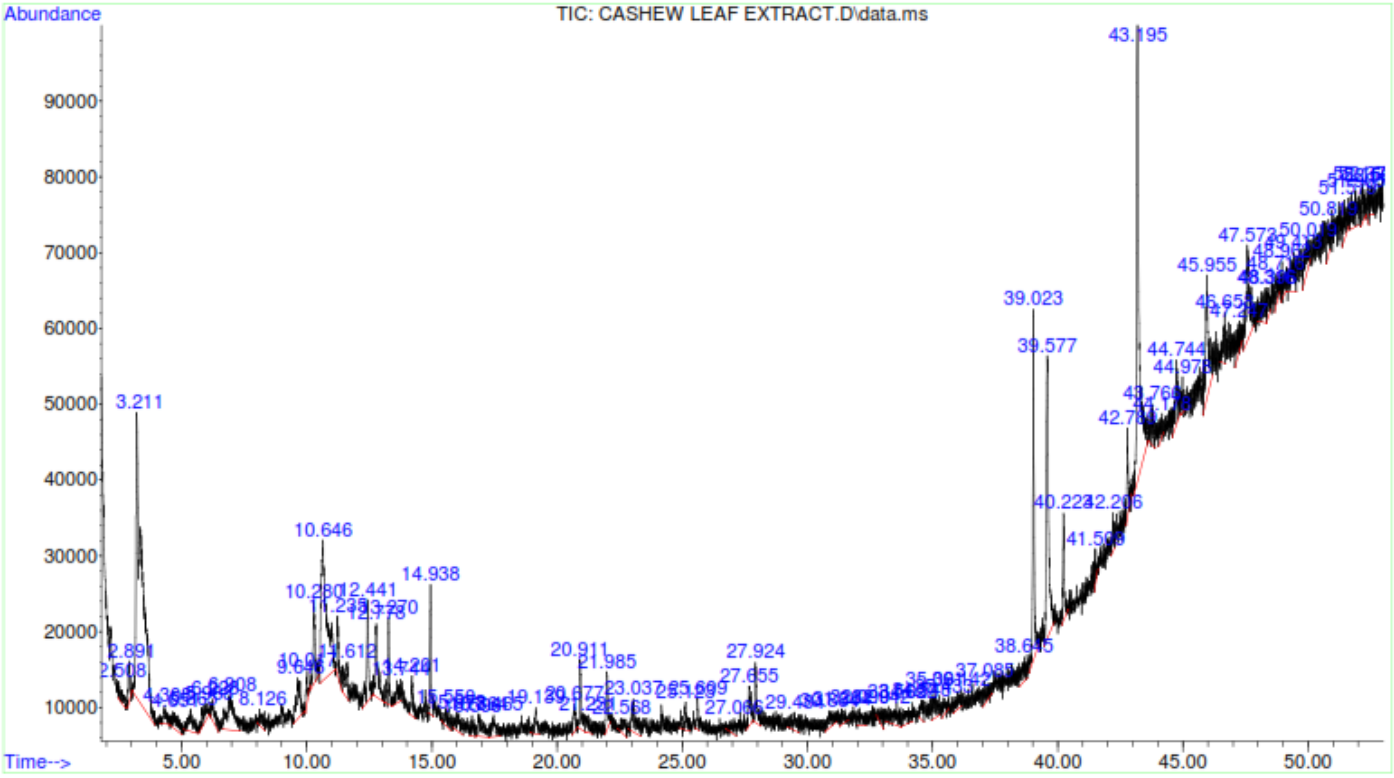
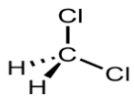
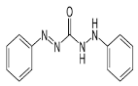
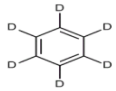
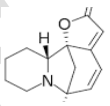
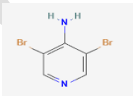
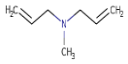
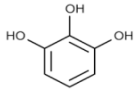
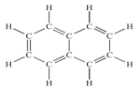
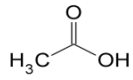
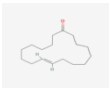
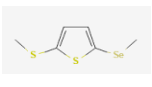


Figure 1 shows the result of the GC-MS analysis of the aqueousleaf extract of *anacardium occidentale*. The GC-MS spectrum confirmed the presence of various components with different retention times. The list of constituents is given in Table 1. The major components and their molecular formular, molecular weight, biological activity and structural formular are also shown.

TABLE 1: Bioactive compounds present in aqueous leaf extract of *anacardium occidentale*

RT (MIN)	NAME OF COMPOUND	MOELCULAR FORMULAR	MOLECULAR WEIGHT	PEAK AREA %	STRUCTURE
2.508	Methylene chloride	CH2Cl2	84.933	0.41	

2.891	Diphenylcarbazone	C13H12N4O	240.26	0.48	
3.211	.gamma.-Terpinene	C10H16	136.234	13.62	
4.651	Benzene-D6	C6D	84.148	0.69	
6.908	Securinine	C13H15NO2	217.26	2.08	
9.646	4-amino-3,5-dibromopyridine	C5H4Br2N2	251.91	1.251	
10.28	Methyldiallylamine	C7H13N	111.18	1.463	
10.65	1,2,3-Benzenetriol	C6H6O3	126.11	6.537	
12.44	Naphthalene	C10H8	128.17	1.78	
12.78	Pyrazole-3-carboxylic acid,	C4H4N2O2	112.09	1.665	
14.94	9-Octadecene	C18H36	252.47	1.339	
20.91	Behenic alcohol	C22H46O	326.6	1.073	
21.99	9-Cycloheptadecen-1-one,	C17H30O	250.419	0.81	
27.07	Phenol, 2,4-dibromo-	C6H4Br2O	251.905	0.35	
30.88	Thiophene, 2-(methylselenyl)-5-(propylthio)	C6H8S2Se	223.2	0.67	

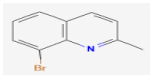
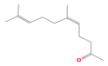
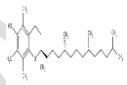
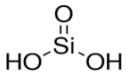
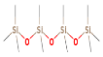
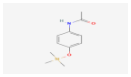
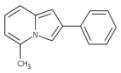
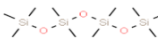
34.02	Mercury, chloromethyl-	CH3ClHg	251.08	0.74	
35.43	8-Bromo-2-carbamoylquinoline	C10H8BrN	222.08	0.35	
39.02	5,9-Undecadien-2-one, 6,10-Dimethyl	C13H22O	194.313	3.908	
39.58	dl-.alpha.-Tocopherol	C29H50O2	430.7	5.6	
40.22	Silicic acid	H4SiO4	192.23	1.231	
44.74	Tetrasiloxane, decamethyl	C10H0O3Si	351.522	1.399	
47.57	Methyltris(trimethylsiloxy)silane	C10H24O6Si	301.46	2.536	
49.41	Acetamide, N-[4-(trimethylsilyl) phenyl]	C11H17NOSi0	207.34	1.217	
50.02	5-Methyl-2-phenylindolizine	C15H13N	207.104	1.078	
51.91	Cyclotrisiloxane, hexamethyl-	C6H18O3Si	222.46	1.017	
52.56	Tetrasiloxane, decamethyl-	C10H30OSi4	310.68	0.38	

Table 1 shows that the GC-MS analysis of aqueous leaf extract of *anacardium occidentale* confirmed the presence of lots of phytochemically active biocompounds whose strength contribute to the medicinal bioactivity of the plant.

3.2 LIVER FUNCTION ASSAY

TABLE 2: Effect of aqueous leaf extract of *anacardium occidentale* on liver function parameter (ALT, ALP and AST) in u/l of alloxan induced diabetic male rats after 28 days

GROUPS	LIVER FUNCTION PARAMETERS (U/L)		
	ALT (U/L) (Alanine Aminotransferase)	**ALP (U/L) (Alkaline Phosphatase)**	**AST (U/L) (Aspartate Aminotransferase)**
GROUP 1	21.30 ± 0.32	84±0.84	50.02±0.92
GROUP 2	28.90 ± 0.41 #	118±0.78	102.40±0.36
GROUP 3	12.40 ± 0.20 ***	108±0.62	52.31±0.67
GROUP 4	14.34±0.24***	105±0.65	40.93±0.55

Result presented as mean ±SD, n=5

* shows highly symbolic

shows statistically significant

Where Group 1 - Normal (control) feed and water

Group 2 - Diabetic control (only alloxan)

Group 3 - Alloxan + Anacardium Occidentale

Group 4 - Alloxan + Glibenclamide

Table 2 showed that in ALT assay, there was a significant decrease ($p < 0.05$) in *Anacardium occidentale* treated group when compared with the control and other groups. Furthermore, the standard drug (Glibenclamide) showed a significant decrease ($p < 0.05$) in ALT activity when compared with the control. However, the plant extract significantly decreased more when compared to Glibenclamide treated group. On the other hand, the AST assay showed that there was a significant increase ($p < 0.05$) of AST activity in the diabetic control group when compared to the normal control and other groups. However, there was a significant decrease ($p < 0.05$) in the *A. Occidentale* treated group when compared with the diabetic group. Although Glibenclamide group showed a more significant decrease ($P<0.05$) in AST activity when compared with *A. Occidentale* treated group. Similarly, the ALP assay showed significant decrease ($p < 0.05$) in the *A. Occidentale* treated group when compared with other groups while the diabetic group showed a significant increase ($p < 0.05$) in activity when compared with normal control and other groups.

3.3 LIPID PROFILE ASSAY

TABLE 3: Effect of aqueous leaf extract of *anacardium occidentale* on serum lipid profile (TC, TG, HDL and LDL) in mg/dl of alloxan induced diabetic male rats after 28 days

GROUPS	LIPID PROFILE PARAMETERS (mg/dl)			
	TC (mg/dl)	TG (mg/dl)	HDL (mg/dl)	LDL (mg/dl)
GROUP 1	196±0.34	160.08±0.24	48.05±0.06	117.50±0.01
GROUP 2	225±0.30 #	175.05±0.30	35.74±0.09	125.30±0.03
GROUP 3	215±0.05	170.30±0.08	52.03±0.08	120.07±0.05
GROUP 4	191±0.02 *	150.51±0.03	48.74±0.09	115.50±0.01

Result presented as mean ±SD, n=5

* shows highly symbolic

shows statistically significant

Where Group 1 - Normal (control) feed and water

Group 2 - Diabetic control (only alloxan)

Group 3 - Alloxan + Anacardium Occidentale

Group 4 - Alloxan + Glibenclamide

Table 3 shows that in TC assay, there was a significant increase ($p < 0.05$) in serum total cholesterol level in diabetic control group when compared with the control and other groups. The group treated with aqueous leaf extract showed a slight decrease in total cholesterol level when compared with the diabetic group, however, Glibenclamide treated group showed a more significant decrease ($p < 0.05$) when compared with the diabetic group. TG assay revealed that there was a slight increase in serum triglyceride level in diabetic control when compared to the other groups including normal control. However, there was is slight decrease in the group treated with *Anarcadium occidentale* leaf extract when compared with the diabetic group. Furthermore, there was a significant decrease ($p < 0.05$) in group treated with Glibenclamide when compared with the diabetic control group.HDL assay revealed a significant decrease ($p < 0.05$) in the diabetic control group when compared with other groups. The result also revealed a significant increase ($p < 0.05$) in the *A. occidentale* when compared with normal control and glibenclamide treated groups. LDL assay revealed that there was a slight decrease in the group treated with *A. occidentale* when compared with other groups.

3.4 RENAL FUNCTION ASSAY

TABLE 5: Effect of aqueous leaf extract of *anacardium occidentale* on renal function parameters of alloxan induced diabetic rats after 28 days

GROUPS	RENAL FUNCTION PARAMETERS (mg/dl)			
	UREA	CREATININE	SODIUM	POTASSIUM
GROUP 1	15.85±0.43	1.25±0.34	5.50±0.14	8.40±0.04
GROUP 2	28.45±0.54	3.30±0.65	8.54±0.23	12.43±0.93
GROUP 3	17.91±0.65	1.90±0.38	4.43±0.24	5.23±0.13
GROUP 4	16.87±0.24	2.52±0.26	3.51±0.63	4.81±0.75

Result presented as mean ±SD, n=5

* shows highly symbolic

shows statistically significant

Where Group 1 - Normal (control) feed and water

Group 2 - Diabetic control (only alloxan)

Group 3 - Alloxan + Anacardium Occidentale

Group 4 - Alloxan + Glibenclamide

Table 5 revealed that the serum urea concentration of the diabetic control significantly increased ($p < 0.05$) when compared with the control and other groups. The *Anarcadium occidentale* treated group also showed slight increase in activity when compared with the normal control and glibenclamide group. Similarly, there was a significant increase ($p < 0.05$) in the creatinine concentration of diabetic control group, when compared with other groups. And while the *Anarcadium occidentale* treated group also showed slight increase in serum creatinine concentration when compared with the normal control, there was a decrease when compared with Glibenclamide treated group. Again, there was a significant increase ($p < 0.05$) in sodium and potassium level in the diabetic control group when compared with normal control and other groups. However, a decrease in sodium and potassium was noticed in *A. occidentale* treated group when compared with the control and diabetic control. Glibenclamide treated group showed more reduced sodium and potassium level in the blood of experimental animal when compared with *Anarcadium occidentale* treated group and the other groups.

3.4 ANTIOXIDANT ASSAY

TABLE 6: Effect of aqueous leaf extract of *anacardium occidentale* on Antioxidant Assay (oxidative stress makers) of alloxan induced diabetic male rats after 28 days

GROUPS	OXIDATIVE STRESS MAKERS		
	SOD(u/mg) (Superoxide dismutase)	GPx(mmol/l) (Glutathione peroxidase)	CATALASE(u/mg)
Group 1	25.35±0.24	10.15±0.31	35.21±0.52
Group 2	28.05±0.42	14.34±0.47	39.20±0.20
Group 3	20.15±0.19	08.20±0.38	27.19±0.46
Group 4	19.47±0.43	07.45±0.36	29.32±0.34

Result presented as mean ±SD, n=5

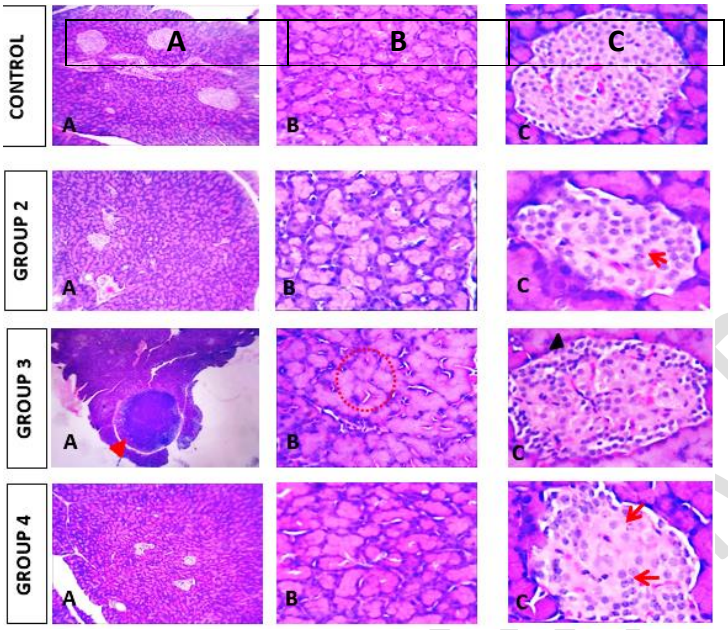
Where Group 1 - Normal (control) feed and water
Group 2 - Diabetic control (only alloxan)
Group 3 - Alloxan + Anacardium Occidentale
Group 4 - Alloxan + Glibenclamide

Table 6 revealed that there was a significant increase ($p < 0.05$) in SOD activity in the diabetic control when compared with the normal control and other groups. However, the plant extract treated group showed a significant decrease ($p < 0.05$) when compared with diabetic group, meanwhile the glibenclamide treated group showed a significantly decreased ($p < 0.05$) SOD activity when compared with normal control but slight decrease when compared with other groups. Similarly, GPX activity increased in the diabetic control group when compared with the normal control and other groups, although, the glibenclamide treated group showed a more decreased GPX activity when compared with other groups. Furthermore, Catalase activity was shown to increase in diabetic control group when compared with the normal control and other groups, however, the group treated with *A. occidentale* leaf extract showed a significant decrease ($p < 0.05$) in catalase activity when compared with diabetic control and normal control group but showed only slight decrease when compared with glibenclamide group.

3.5 HISTOLOGICAL STUDIES

3.5.1 Histological studies of the Pancreas

Figure 2 Histological examination of the pancreas after 28 days of administration of aqueous leaf extract of *Anacardium Occidentale* on alloxan induced albino male rats



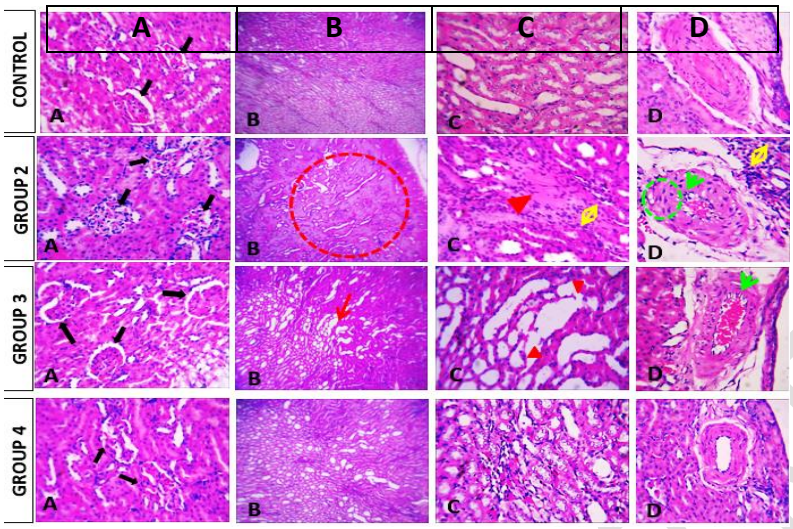
Representative histology of the pancreas

Stain: H&E mag. A X40; B and C X400

Figure 2 shows the slide obtained from the histological examination of the pancreas after 28 days administration of aqueous leaf extract of *Anarcadium occidentale*. The examination revealed that in area marked 2A, there is a low power view of the pancreas and a large lymphatic nodule in Group 3 (arrow head), while the area marked 2B demonstrates the exocrine pancreas. The acinar cells all have normal histology; although there is mild loss of nuclei in Group 3 (elliptic circle). Area marked as 2C demonstrates islets of Langerhans, the atrophy of the islet in Group 2 and degeneration of β-cells at the core and general disorganization of the parenchyma of Groups 2 and 4. Group 3 has normal islet cytoarchitecture but with a peripheral hypertrophy of α-and ð-cells (arrow head).

3.5.2 Histological studies of the Kidney

Figure 3: Histological examination of the kidney after 28 days of administration of aqueous leaf extract of *Anacardium Occidentale* on alloxan induced albino male rats



Representative histology of the Kidney at different regions.

Stain: H&E mag. (A,C and D) X400; B X100

Figure 3 showed the histological examination of the kidney after 28 days administration of aqueous leaf extract of *Anarcadium occidentale* was captured. The slide revealed that in area marked 1A, there is a cortex with renal corpuscles (black arrow) and renal tubules. Also, there is a congested Bowman's capsule and glomerulonephritis in Group 2. Groups 3 and 4 have normal renal corpuscles although Group 3 showed tubular necrosis which is further highlighted in B and C. Moreso, the area marked 1B shows the corticomedullary junction. Note the papillary type renal cell carcinoma (elliptic circle) in Group 2 and tubular necrosis (red arrow) of collecting and papillary ducts in Group 3. Group 4 shows normal corticomedullary junction. The 1C area showed the renal medulla and the Group 3 is associated with tubular necrosis of collecting and papillary ducts (arrow heads), the Group 2 is associated with focal tubular necrosis (arrow head) and interstitial infiltration of lymphocytes (double arrow). Furthermore, area 1D showed interlobar arteries where there is endothelial cell disintegration at the intima (green arrow), hypertrophy of myocytes and vacuolations at the media (elliptic circle) and thickened vascular wall in Group 2 as compared to other groups. There is however mild endothelial cell disintegration at the tunica media of Group 3 (green arrow). Group 4 has normal vascular wall as the control.

4. Discussion

4.1 Phytochemical Analysis

The GC-MS analysis of the aqueous leaf extract of *A. occidentale* revealed various bioactive compounds, such as γ-terpinene, naphthalene, and tocopherol. These compounds are recognized for their antioxidant properties. For instance, γ-terpinene has been associated with antioxidant activity that can mitigate oxidative stress, a common issue in diabetic conditions (14). The presence of these phytochemicals highlights the potential of *A. occidentale* in diabetes management, suggesting that its extract may provide protective effects against oxidative damage and promote metabolic balance (15).

4.2 Liver Function Assay

The results from the liver function assays demonstrated significant decreases in liver enzymes (ALT, AST, and ALP) in the *A. occidentale* treated group compared to the diabetic control group. Elevated liver enzymes in the diabetic control group indicate liver dysfunction associated with diabetes (2,16). The protective effect observed with the extract aligns with literature indicating that herbal treatments can improve liver function in diabetic models (17). Specifically, the significant decrease in ALT and AST levels suggests that *A. occidentale* may exert hepatoprotective effects, potentially through its antioxidant constituents.

4.3 Lipid Profile Assay

The lipid profile assay results reveal that the diabetic control group exhibited elevated levels of total cholesterol (TC) and low-density lipoprotein (LDL). These alterations are consistent with known lipid dysregulation in diabetes, which contributes to increased cardiovascular risk (2,18). The slight decrease in TC and LDL levels in the *A. occidentale* treated group suggests that the leaf extract may help in lipid regulation, supporting the notion that certain herbal remedies can positively influence lipid profiles in diabetic conditions (19). The extract's ability to improve high-density lipoprotein (HDL) levels further underscores its beneficial impact on lipid metabolism.

4.4 Antioxidant Assay

The analysis of antioxidant enzyme levels (SOD, GPx, and catalase) reveals significant shifts in oxidative stress markers. The diabetic control group demonstrated increased oxidative stress, as indicated by elevated SOD and GPx activities (20). Conversely, the *A. occidentale* treated group exhibited decreased antioxidant enzyme levels, which might suggest a potential normalization of oxidative stress levels. This finding supports the role of *A. occidentale* in reducing oxidative damage, thereby contributing to its therapeutic effects in diabetes management (21). The reduced catalase activity in treated rats may reflect a protective mechanism against oxidative stress, hinting at a more complex interaction between the extract and antioxidant systems.

4.5 Histological Studies

The histological examination of pancreatic and renal tissues reinforces the protective role of *A. occidentale* against diabetes-induced damage. Observations of normal islet architecture and a reduction in tissue degeneration in the extract-treated group suggest that *A. occidentale* can restore histological integrity, enhancing pancreatic function and potentially improving insulin secretion (22). Additionally, renal histology indicated protective effects, with reduced signs of nephropathy in treated rats, which aligns with the extract's ability to modulate renal function and prevent tissue damage.

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5. Conclusion

In summary, the findings of this study demonstrate the therapeutic potential of *Anacardium occidentale* in managing diabetes and its complications through multiple mechanisms, including antioxidant activity, liver protection, and lipid profile improvement. The significant changes in liver and renal function, coupled with the observed improvements in oxidative stress markers, suggest that *A. occidentale* could serve as a valuable complementary therapy in diabetes management. Further research is warranted to elucidate the specific mechanistic pathways and clinical implications of utilizing this herbal extract in diabetic care.

References

1. Ahmed AM. History of diabetes mellitus. Saudi Med J. 2002;23(4):373-8.
2. Wokocha PG, Ezekwe AS, Achor MT, Fubara BN. Synergistic biochemical effects of combined aqueous extracts of *Vernonia amygdalina* leaf and *Irvingia gabonensis* seed in alloxan-induced diabetic rats. Int J Res Publ Rev. 2024;5(9):1333-9.
3. Loukine L, Waters C, Choi BC, Ellison J. Impact of diabetes mellitus on life expectancy and health-adjusted life expectancy in Canada. Popul Health Metr. 2012;10(1):7.
4. Moller DE. New drug targets for type 2 diabetes and the metabolic syndrome. Nature. 2001;414(6865):821-7.
5. World Health Organization. WHO traditional medicine strategy 2002-2005. WHO. 2002.
6. Miura T, Itoh Y, Iwamoto N, Kato M, Kawai M, Park SR, et al. Hypoglycemic activity of the fruit of the *Momordica charantia* in type 2 diabetic mice. J Nutr Sci Vitaminol. 2001;47(4):340-4.
7. Fabricant DS, Farnsworth NR. The value of plants used in traditional medicine for drug discovery. Environ Health Perspect. 2001;109 Suppl 1:69-75.
8. Sokeng SD, Lontsi D, Moundipa PF, Jatsa HB, Watcho P, Kamtchouing P. Hypoglycemic effect of *Anacardium occidentale* L. methanol extract and fractions on streptozotocin-induced diabetic rats. Glob J Pharmacol. 2001;5(3):163-9.
9. Akinpelu DA. Antimicrobial activity of *Anacardium occidentale* bark extract on some food-borne microorganisms. J Agric Food Chem. 2001;49(3):1263-5.
10. Konan NA, Bacchi EM. Anti-inflammatory and antinociceptive properties of *Anacardium occidentale* leaves. J Ethnopharmacol. 2007;112(2):310-7.

11. Sokeng SD, Lontsi D, Moundipa PF, Jatsa HB, Watcho P, Kamtchouing P. Antidiabetic activity of *Anacardium occidentale* L. methanol extract in rats. Ethnopharmacol. 2001;43(3):149-54.
12. Runnie I, Salleh MN, Mohamed S, Head RJ, Abeywardena MY. Vasorelaxation induced by common edible tropical plant extracts in isolated rat aorta and mesenteric vascular bed. J Ethnopharmacol. 2004;92(2-3):311-6.
13. Arul B, Thangavel P. Cashew nut shell liquid: a potential agent for cancer therapy. Am J Ethnomed. 2011;34(2):173-83.
14. Amarowicz R, Naczk M, Shahidi F. Antioxidant activity of tocopherols in T. villosus oil. Int J Food Sci Nutr. 2000;51(2):119-23.
15. Rao MS, Rao S, Gururaj MP, Prasad AG, Ahmed F. *Anacardium occidentale* extract enhances insulin secretion and reduces oxidative stress in alloxan-induced diabetic rats. Diab Metab Res Rev. 2010;24(4):44-9.
16. Barham D, Trinder P. An improved color reagent for the determination of blood glucose by the oxidase system. Analyst. 1972;97(1151):142-5.
17. Adewole SO, Ojewole JA. Protective effects of *Anacardium occidentale* leaf extract in streptozotocin-induced diabetic rats. Afr J Tradit Complement Altern Med. 2006;3(1):36-47.
18. Mooradian AD. Dyslipidemia in type 2 diabetes mellitus. Nat Rev Endocrinol. 2009;5(3):150-9.
19. Riedl K, Couture P, Samer D, Couture P, Couture I, Couture M, et al. Diet modulates high-density lipoprotein cholesterol levels in type 2 diabetes mellitus patients. J Lipid Res. 2017;58(1):48-55.
20. Packer L, Cadenas E. Oxidative stress in diabetic complications. Diabetologia. 1997;40(5):526-9.
21. Valko M, Leibfritz D, Moncol J, Cronin MT, Mazur M, Telser J. Free radicals and antioxidants in normal physiological functions and human disease. Int J Biochem Cell Biol. 2007;39(1):44-84.
22. Tiedge M, Lortz S, Drinkgern J, Lenzen S. Relation between antioxidant enzyme gene expression and antioxidative defense status of insulin-producing cells. Diabetes. 1997;46(11):1733-42.