Journal of Applied Life Sciences International

13(3): 1-8, 2017; Article no.JALSI.34296
ISSN: 2394-1103

Effect of Aqueous Seed Extract of *Terminalia catappa Linn* on Some Biochemical Parameters in Alloxan-induced Diabetic Rats

C. D. Luka[1*], G. Istifanus[1], A. Olatunde[2] and Z. Eli[1]

[1]Department of Biochemistry, Faculty of Medical Sciences, University of Jos, Jos, Nigeria.
[2]Department of Biochemistry, Abubakar Tafawa Balewa University, Bauchi, Nigeria.

Authors' contributions

This work was carried out in collaboration between all authors. Authors CDL and GI designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors AO and ZE managed the analyses of the study. Author GI managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JALSI/2017/34296
Editor(s):
(1) Necla Caglarirmak, Saruhanly College, Celal Bayar University, Turkey.
Reviewers:
(1) Rahul Gupta, Amity University Uttar Pradesh, India.
(2) Mohamed Ahmed Mohamed Nagy Mohamed, Beni Suef University, Egypt.
(3) Hina Zahid, Dow University of Health Sciences, Pakistan.
(4) Abdullahi M. Nuhu, Kaduna Polytechnic, Nigeria.
Complete Peer review History: http://www.sciencedomain.org/review-history/20625

Original Research Article

Received 23rd May 2017
Accepted 14th July 2017
Published 23rd August 2017

ABSTRACT

This study is aimed at determining the anti-diabetic activity of aqueous seed extract of *Terminalia catappa Linn* on some biochemical parameters in alloxan-induced diabetic rats. Alloxan-induced diabetic rats were administered orally with aqueous extract of *Terminalia catappa Linn* seed at 400 mg/kg for 28 days, after which the blood glucose, total protein, albumin, liver function indices marker enzymes, lipid profile and serum electrolytes were determined and compared with normal control. Administration of aqueous seed extract of *T. catappa Linn* to the diabetic rats caused a significant ($p< 0.05$) decrease in the level of blood glucose, total cholesterol, low density lipoproteins (LDL), triglyceride (TG), activities of alanine transaminase (ALT), aspartate transaminase (AST), alkaline phosphatase (ALP), and a significant ($p< 0.05$) increase in the level of high density lipoprotein (HDL), total protein and albumin when compared with the control group. The results from this study suggested that the aqueous seed extract of *Terminalia catappa Linn* possesses anti-diabetic activity and could be used for the management of diabetes and other metabolic derangement associated with it.

**Corresponding author: E-mail: carrll42@yahoo.com;*
E-mail: istigurumtet@gmail.com;

Keywords: Terminalia catappa Linn; aqueous; extract; alloxan; diabetes mellitus.

1. INTRODUCTION

Diabetes mellitus, or simply diabetes, is a group of metabolic diseases in which a person has high blood sugar, either because the pancreas does not produce enough insulin, or because cells do not respond to the insulin that is produced. This high blood sugar produces the classical symptoms of polyuria (frequent urination), polydipsia (increased thirst), and polyphagia (increased hunger). Diabetes mellitus is considered one of the main threats to human health in the 21st century. In developing countries, the prevalence of diabetes is increasing, where there are, as estimated by the World Health Organisation (WHO), around 70 million people suffering from diabetes mellitus [1]. Generally, diabetes is a condition in which a person has high blood sugar, either because the body does not produce enough insulin or because cells do not respond to the insulin that is produced or both.

Medicinal plants have been found to contain bioactive compounds called phytochemicals or secondary metabolites that can be used to protect humans against diseases. Some important groups of these phytochemicals have pharmacological effects such as antioxidant activities, antidiabetic effect, anti-microbial effect and analgesic effect etc. [2]. Apart from the currently available different types of oral hypoglycemic agents along with insulin, used for the management of diabetes mellitus, there is a growing interest in herbal remedies due to the side effects associated with orthodox therapeutic agents. Therefore, there is still a need for the development of new oral anti-diabetic drugs with minimal side effects. Most anti-diabetic medicinal plants exert their effects by different mechanisms such as stimulation of insulin release from pancreatic beta cells, alteration of some glucose metabolizing enzymes, reduction of glucose intake or both [3] etc.

Terminalia catappa Linn is a large tropical tree in the Lead-wood tree family, Combretaceae, which grows mainly in the tropical regions of Asia, Africa, and Australia [4]. The seed within the fruit is edible when fully ripe, tasting almost like almond. The fruit is a drupe 5–7 cm (2.0–2.8) long and 3–5.5 cm (1.2–2.2) broad, green at first, then yellow and finally red when ripe, containing a single seed [5]. Identified various phytoconstituents from the fruits, seeds and barks of the *Terminalia catappa Linn.* The fruit has 1.95 g of protein 12.03 g of carbohydrate and 1.21 g of ash. Beta-carotene 2,090 ug and vitamin C 136.6 mg are present in high amount. The mesocarp of fruits dehydrated by the sun having ash, proteins, glucose, moisture, tannin, carbohydrate and oil with 3,434.5 kcal/kg calorific value is very essential for its nutritive value. The seed is composed of fix oil 51.2%, olein 54% and stearin 46%. The seed yield 4.13% moisture, 4.94% crude fibre, 23.78% crude proteins 4.27% ash, 51.80% fat and 16.02% carbohydrate; the total calorific value is 548.78 kcal [6]. The bark contains glycoside, cardiac tannins, volatile oils, saponin, steroid, glycosides and phenols. Classified in the oleic-linoleic acid group, the oils contains huge levels of unsaturated fatty acids, exclusively oleic (up to 31.48%) and linoleic (up to 28.93%) [6]. More recently, [7] isolated punicalagin (polyphenol), its derivative, and other several compound in the leaf of *Terminalia catappa Linn.*

The cylindrical, oil-containing seeds are encased in a tough, fibrous husk within a fleshy pericarp. There are about 24 fresh fruits and 160 nuts per kg [8]. *Terminalia catappa Linn* (Combretaceae) also known as tropical almond in Asia, umbrella tree in some part of Nigeria is a medium size deciduous medicinal plant. *Terminalia catappa Linn* is known for its nutritional fruit and possesses medicinal benefits as well. All parts of the plant contains secondary metabolites that are used in traditional medicine such as the management of sickle cell disorders, cancer, rheumatism, diarrhea, dysentery, gonorrhea and stomach cramps, sexual dysfunction, diaphoretic, antidiabetic, anti-indigestion, anticlstogenic, antioxidant, antibacterial, stomatitis, skin diseases, arthritis, headache, colic and itching [9,10]. In traditional medicine, *T. catappa Linn* leaf, bark and fruit are used in treating dysentery, rheumatism, cough and asthma. The leaves have demonstrated anti-sickling activity [11] and are used in getting rid of intestinal parasites, treatment of eye problems, wounds and liver problems [12].

2. MATERIALS AND METHODS

2.1 Experimental Design

The rats are divided into four groups comprising of four animals in each group as follows:-

Group A: Normal control + distilled water per day.

Group B: Diabetic control + distilled water per day.
Group C: Diabetic rats + 200 mg/kg body weight of *T. catappa Linn* seed per day.
Group D: Normal + 200 mg/kg body weight of *T. catappa Linn* seed extract per day.

Ethical issues where observed in line with the regulations of animal usage as obtained in the University of Jos ethical committee guide.

2.2 Preparation and Administering of the Alloxan

One gram of Alloxan was weighed and dissolved in 10 ml of distilled water into a beaker and was shaken thoroughly. The Alloxan solution of dosage 150 mg/kg was administered to the albino rats.

2.3 Plant Seed Collection and Processing

The seeds of *Terminalia catappa Linn* were collected from British-American junction, Adjacent Living Faith Church in Jos-North L.G.A, Plateau State, Nigeria and were botanically authenticated in the Department of Plant Science and Technology, University of Jos, Plateau State and it has the voucher number of UJH16000249. The seeds were washed, dried and pulverized. 50 g of the pulverised plant material was macerated in 200 mls of distilled water. The filtrate was concentrated using rotary evaporator and the extracts was then reconstituted with distilled water to 200 mg/kg body weight as used in this study.

2.4 Collection of Blood Sample

The rats were sacrificed under diethyl ether anesthesia, 24 hours after the last treatment. Blood sample was collected from the unconscious animals by jugular puncture into plain sample bottles. The serum collected after centrifugation of the blood sample was used to carry out analysis.

2.5 Biochemical Parameters

Glucose in serum was determined by the method of Warnick et al. [13]. Billirubin was determined using Colormetric method based on that described by Barham [14]. Total cholesterol concentration, serum HDL-cholesterol and triacylglyceride were done using Randox diagnostic reagent kits. LDL-cholesterol was estimated using Friedewald formula [15]. Serum enzymes to include ALT and AST were determined by methods of Reitman and Frankel [16], while ALP was determined using King-Armstrong [17].

Fig. 1. Show a pictorial image of *Terminalia catappa Linn* seed obtain at British-American junction in Jos-North L.G.A, Plateau State, Nigeria

2.6 Statistical Analysis

Data were expressed as mean ± standard deviation (SD). Comparison of the data from test control groups of animals were analyzed by One Way Analysis of Variance (ANOVA) at the confidence limit of 95% and where applicable, Least Significant Difference (LSD) was used to determine significant results, differences between groups were considered statistically significant at $p<0.05$.

3. RESULTS AND DISCUSSION

Biochemical markers used for analysis and monitoring the management of diabetes mellitus clinically or experimentally is the blood (either from serum or plasma) [18]. Diabetes mellitus can be presented as mild or acute. In acute diabetes mellitus, the β-cells of the pancreas are completely destroyed or non-functional while the mild form of the disease is characterized by partial β-cells failure. Consequently, there is a total lack of endogenous insulin production in acute or severe diabetes mellitus, whereas some limited amount of insulin is synthesized and released into circulation in mild or moderate diabetes mellitus.

Alloxan has been reported to cause a massive reduction of β-cells of the islets of Langerhans and induce hypoglycemia. In our study also, a marked hike in the level of fasting blood glucose

in Diabetic control, Diabetic treated and normal treated groups as compared to Normal control was monitored subsequent to alloxan administration. The observed hypoglycemia may be due to glycogenolysis or gluconeogenesis [19].

The Wister rats used were strictly males because it was reported that female sex hormones (17-βestradiol) has a lowering effect on the plasma cholesterol concentration. Thus, using female rats may interfere with the accuracy of the serum cholesterol level, since it was one of the parameters analysed. However, continuous treatment of diabetic animals (DT) with *Terminalia catappa Linn* plant extract for 21 days caused a significant reduction in fasting blood glucose level. This anti-hyperglycemic action may be due to insulin potentiating effect via stimulation of the undamaged or residual pancreatic islets to release insulin. Moreover, significant reduction in blood glucose in normal treated (NT) strengthens the above explanation, since it also exerts it hypoglycemic effect by increasing insulin secretion [20].

From Table 1, Effect of plant extract on body weights shows a decreasing order of Diabetic-diabetic *Terminellia catappa Linn* at a significant reduction in body weight when compared to the diabetic control.

From Table 2, effect of extract on glucose, protein and albumin shows a decreasing order of *Terminellia catappa Linn* at a significant ($p<0.05$) reduction in blood glucose level and an increasing order in protein and albumin when compared to the diabetic control.

From Table 3, effect of plant extract on serum lipid profile shows a decreasing order of diabetic rats treated with *Terminellia catappa Linn* at a significant ($p<0.05$) reduction in total cholesterol, triglycerides and low density lipoprotein and an increasing order of high density lipoprotein when compared to the diabetic control. Alterations in lipid metabolism; hypertriacylglycerolemia and hypercholesterolemia, as observed in diabetic untreated rats usually contribute to the pathogenesis of vascular complications in diabetes [21]. Also, serum lipid profile in diabetes is likely to increase the risk of coronary heart disease [22,23].

From Table 4, effect of plant extract on tissue marker enzymes, it shows a decreasing order of diabetic treated with *Terminellia catappa Linn* extract at a significant ($p<0.05$) reduction in most of the enzyme markers such as alanine amino transferase, aspartate amino transferase, alkaline phosphatase and amylase when compared to diabetic control.

Table 1. Effect of aqueous seed extract of *Terminalia catappa Linn* on body weight of both normal and alloxan induced diabetic rats

Group	Treatment	Initial (g)	Final	Difference
A	Normal control	200.00	230.75	+30.75
B	Diabetic control	295.00	250.00	-45
C	Diabetic treated	235.00	205.25	-29.75
D	Normal treated	230.00	280.00	+50

Table 2. Effect of aqueous seed extract of *Terminalia catappa Linn* on blood glucose, protein and albumin of both normal and alloxan induced diabetic rats

Group	Treatment	Glucose (mmol/L)	Protein (g/L)	Albumin (g/L)
A	Normal control	7.50±0.29	72.00±2.16	33.00±2.16
B	Diabetic control	18.35±0.13[a]	58.00±2.16[a]	27.75±1.71[a]
C	Diabetic treated	13.40±0.22[ab]	60.00±2.16[ab]	31.00±2.16[ab]
D	Normal treated	5.20±0.22[ab]	68.00±2.16[ab]	30.00±2.16[ab]

Values are expressed as mean ± SD, n= 4 for each group

[a] *Values are significantly different from normal control ($p<0.05$)*

[b] *Values are significantly different from the diabetic control group ($p<0.05$)*

Table 3. Effect of aqueous seed extract of *Terminalia catappa Linn* on serum lipid profile of both normal and alloxan induced diabetic rats

Group	Treatment	TG (mmol/L)	TC (mmol/L)	LDL (mmol/L)	HDL (mmol/L)
A	Normal control	1.30±0.22	4.60±0.22	2.14±0.03	1.90±0.29
B	Diabetic control	2.40±0.36[a]	5.70±0.22[a]	2.40±0.22[a]	1.50±0.22[a]
C	Diabetic treated	1.80±0.22[ab]	4.90±0.22[ab]	2.20±0.22[ab]	1.70±0.22[ab]
D	Normal treated	0.90±0.22[b]	3.90±0.22[ab]	2.00±0.22[ab]	1.64±0.22[ab]

Values are expressed as mean ± SD, n= 4 for each group
[a]values are significantly different from normal control (p<0.05)
[b]values are significantly different from the diabetic control group (p<0.05)

Table 4. Effect of aqueous seed extract of *Terminalia catappa Linn* on tissue marker enzymes of both normal and alloxan induced diabetic rats

Group	Treatment	ALT	AST	ALP
A	Normal control	12.00±2.16	18.50±5.07	120.00±2.16
B	Diabetic control	34.00±2.16[a]	48.00±2.16[a]	196.00±2.94[a]
C	Diabetic treated	19.00±2.16[ab]	23.00±2.16[ab]	134.00±2.94[ab]
D	Normal treated	9.00±2.16[ab]	15.00±2.16[ab]	134.00±2.16[ab]

Values are expressed as mean ± SD, n= 4 for each group
[a]Values are significantly different from normal control (p<0.05)
[b]Values are significantly different from the diabetic control group (p<0.05)

Table 5. Effect of aqueous seed extract of *Terminalia catappa Linn* on kidney indices of both normal and alloxan induced diabetic rats

Group	Treatment	Urea (mmol/L)	Creatinine (mmol/L)
A	Normal control	8.00±2.22	84.00±4.97
B	Diabetic control	24.40±2.22[a]	305.00±2.16[a]
C	Diabetic treated	44.25±1.85[ab]	108.00±2.16[ab]
D	Normal treated	6.60±2.22[ab]	81.00±2.16[ab]

Values are expressed as mean ± SD, n= 4 for each group
[a]Values are significantly different from normal control (p<0.05)
[b]Values are significantly different from the diabetic control group (p<0.05)

From Table 5 above, it shows a decreasing order of diabetic treated with *Terminellia catappa Linn* extract at a significant ($p<0.05$) reduction in urea and creatinine when compared to diabetic control.

From Table 6, effect of plant extract on electrolyte concentration shows a decreasing order of diabetic treated with *Terminellia catappa Linn* extract at a significant ($p<0.05$) reduction in sodium (Na^+), Potasium (K^+), Magnesium (Mg^+), phosphorus oxide (PO_4^{3-}), and chlorine (Cl^-) and an increasing order in calcium (Ca^{2+}) when compared to diabetic control.

From Table 7, effect of plant extract on direct and total bilirubin concentration shows a decreasing order of diabetic treated with *Terminellia catappa Linn* extract at a significant ($p<0.05$) reduction in them when compared to diabetic control.

Terminellia catappa Linn is also known to contain various secondary metabolites. Therefore, it is not unreasonable to speculate that some of these chemical compounds are presumably responsible for imparting the anti-hyperglycemic, anti-hyperlipidemic and anti-oxidative properties to the plant extract. From the result obtained, it can be concluded that *Terminellia catappa Linn* plant possess significant anti-hyperglycemic and, anti-hyperlipidemic properties. However, further studies are needed to investigate and elucidate the possible means of action of the active ingredients, establish complete safety profile and evaluate the potential value of *Terminalia catappa Linn* seed extract for the management of diabetes and hyperlipidemia.

Table 6. Effect of aqueous seed extract of *Terminalia catappa Linn* on some serum electrolytes of both normal and alloxan induced diabetic rats

Group	Treatment	Electrolytes (mmol/L)						
		Na+	K+	Mg2+	PO43-	Ca2+	Cl-	HCO3-
A	Normal control	138.00±2.16	4.80±0.22	1.10±0.22	1.40±0.22	2.20±0.22	106.00±2.16	25.00± 2.94
B	Diabetic control	141.00±2.16[a]	5.70±0.22[a]	1.80±0.22[a]	1.80±0.22[a]	1.90±0.22[a]	113.00±5.10[a]	15.00±2.94[a]
C	Diabetic treated	140.00±2.16[ab]	5.50±0.22[ab]	1.24±0.02[ab]	1.60±0.22[ab]	2.10±0.22[ab]	110.00±2.16[ab]	23.00±2.16[ab]
D	Normal treated	136.50±1.29[ab]	4.30±0.22[ab]	0.96±0.03[ab]	1.30±0.45[ab]	2.30±0.22[ab]	104.00±2.16[ab]	24.00±3.56[ab]

Values are expressed as mean ± SD, n= 4 for each group
[a]Values are significantly different from normal control (p<0.05)
[b]Values are significantly different from the diabetic control group (p<0.05)

Table 7. Effect of aqueous seed extract of *Terminellia catappa Linn* on bilirubin of both normal and alloxan induced diabetic rats

Group	Treatment	Bilirubin concentration (µmol/L)	
		Direct Bilirubin	Total Bilirubin
A	Normal control	4.30±0.22	11.40±0.22
B	Diabetic control	10.40±0.29[a]	24.40±0.22[a]
C	Diabetic treated	5.60±0.22[ab]	15.00±0.22[ab]
D	Normal treated	4.20±0.22[ab]	12.60±0.15[ab]

Values are expressed as mean ± SD, n= 4 for each group
[a]Values are significantly different from normal control (p<0.05)
[b]Values are significantly different from the diabetic control group (p<0.05)

4. CONCLUSION

The ability of *Terminalia catappa Linn* seed extract to significantly decrease blood glucose, total cholesterol in diabetic rats shows that the plant possesses hypoglycemic, hypo-cholesterolaemic and anti-diabetic potentials. A precise understanding of effective dose, safety and mechanism of action is required for the rational use of *Terminalia catapa Linn* in the treatment of human diseases. From this it can be concluded that prolong oral administration of aqueous seed extract of *Terminalia catappa Linn* may reduce high level of blood glucose and cholesterol. The *Terminalia catappa Linn* plant may indeed be therapeutically beneficial in the management of diabetes mellitus.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. David SK, Upadhayaya N, Siddiqui MK, Usmani AM. Knowlegde discovery technique for web-base diabetes educational system. J Health Med Informat. 2010;1:102.
2. James DB, Kadejo OA, Nwochiri C, Luka CD. Determination of phytochemical constituents of the aqueous extracts of the leaves, stem bark and root bark of *Vitex doniana* and its effects on lipid profile of albino rats. British Journal of Pharmacology and Toxicology. 2013;4(6): 210-214.
3. Bnouham M, Ziyyat A, Mekhfi H, Tahri A, Legssyer A. Medicinal plants with potential anti-diabetic activity-A review of ten years of herbal medicine research. International Journal of Diabetes and Metabolism. 2006;14(1):1.
4. Pankaj Oudhia, Robert E. Paull. West Indian almond *Terminalia catappa L.* Combretaceae. 2008;273-276.
5. Goa J, Tang X, Dou H, Fan Y, Zhao X, Xu Q. Hepatoprotective activity of *Terminalia catappa Linn.* leaves and its two triterpenoids. J Pharm Pharmacol. 2004; 56:1449-55.
6. Arumugam VA, Natarajan D, Pannerselvam PK. An update review of *Terminalia catappa Linn.* Pharmacogn Rev. 2015;9(18):93-98.
7. Mininel FJ, Leonardo Junior CS, Espanha LG, Resende FA, Varanda EA, Leite CQ, et al. Characterization and quantification of compounds in the hydroalcoholic extract of the leaves from *Terminalia catappa Linn.* (Combretaceae) and their mutagenic activity. Evid Based Complement Alternat; 2014.
8. Janick J, R. E. Encyclopedia of Fruit and Nuts – Paull -editors, CABI, Wallingford, United Kingdom; 2008.
9. Mallik J, Faruk AA, Banik RK. A Comprehensive review on pharmacological Activity of *T catappa* (Combretaceae). Asain Journal of Pharmaceutical Research and Development. 2013;1(2):65-70.
10. Muhammad A, Mudi S. Phytochemical screening and antimicrobial activities of *Terminalia catappa*, leaf extracts. Biokemistri. 2011;23(1):35–39.
11. Akharaiyi FC, Ilori RM, Adesida JA. Antibacterial effect of *Terminalia catappa* on some selected pathogenic bacteria. Int J Pharm Biomed Res. 2011;2:64–7.
12. Moody JO, Segun FI, Adrounmu O, Omoade OO. Antisickling activity of Terminalia catappa leaves harvested at different stages of growth. Niger. J. Nat. Prod. 2003;7:30–32.
13. Warnick GR, Knopp RH, Fitzpatrick V, Branson L. Estimating low-density lipoprotein cholesterol by the Friedewald equaton is adequate for classifying patients on the basis of nationally recommended cutpoints. Clinical Chemistry. 1990;36(1):15–9.
14. Barham D, Trinder P. An improved colour reagent for the determination of blood glucose by the oxidase system. Analyst. 1972;97(151):142-145.
15. Jendrassik L, Grof P. Biochem. Z. 1938; 291-81.
16. Reitman S, Frankel S. A colorimetric method for the determination of serum glutamic oxaloaccetate and glutamic pyruvic transaminases. American Journal of clinical Pathology. 1957;28(1):56-63.
17. King EJ, Armstrong AR. Determination of serum and alkaline phosphatase activity. Canadian Medical Journal. 1964;31:376.
18. Corner EJH. In; Wayside trees of Malaya, 4th Edn, The Malayan Nature Society, Malaya. 1997;1:217.
19. Aruna RV, Ramesh B, Kartha VN. Effect of beta carotene on protein glycosylation in

alloxan-induced diabetic rats. Indian J. Exp. Biol. 1999;32:399-401.
20. Guyton AC, Hall JE. Medical physiology (Translated Farsi Version). Niavarani Ahmad (MD). 1st Edn, WB Sauders Company, USA; 2000.
21. Li WL, Zheng H, Bukuru CJ, De Kimpe N. Natural medicines used in the traditional Chinese medical system for therapy of diabetes mellitus. Journal of Ethnopharmacology. 2004;92(1):1–21.
22. Scoppola A, Montechi FR, Mezinger G, Lala A. Urinary mevalonate excretion of rats in type 2 diabetes: Role of metabolic control. Atherosclorosis. 2001; 156:357–361.
23. Saikia H, Lama A. Effect of *Bougainvillea spectabilis* leaves on serum lipids in albino rats fed with high fat diet. International Journal of Pharmaceutical Sciences and Drug Research. 2011;3(2):141-145.

Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/20625