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Antidiabetic Activity of *Pistia strateotes* L.Aqueous Extract in Alloxan-induced Diabetic Rats

Mudassir Lawal[1], Abdulaziz Suleiman[1], Nasiruddin U. Matazu[1], Fatima A. Dawud[2], Aminu Mohammed[3], Ismaila A. Umar[1,3]*

[1]*Department of Biochemistry, Umaru Musa Yar'adua University, Katsina, Nigeria.*
[2]*Department of Human Physiology, Ahmadu Bello University, Zaria, Nigeria.*
[3]*Department of Biochemistry, Faculty of Life Sciences, Ahmadu Bello University, Zaria, Nigeria.*

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ABSTRACT

Pistia strateotes L. (Araceae) commonly known as water lettuce is used traditionally for the treatment of diabetes mellitus in Nigeria. The present study was designed to validate these antidiabetic claims in alloxan-induced diabetic rats. Wister rats (weighing 150-200g) were divided into five groups of seven animals each, three of which were made diabetic by intraperitoneal injection of alloxan monohydrate (160 mg/kg body weight). All rats in the diabetic groups had initial fasting blood glucose (FBG) levels ≥200 mg/dL, but after treatment for three weeks with extract or glibenclamide (0.08 mg/kg body weight), the FBG significantly ($p<0.05$) reduced by 68.6 and 60.6%, respectively. Diabetes also caused a significant ($p<0.05$) elevationof serum total cholesterol (TC), triacylglycerols (TG) and low-density lipoproteins (LDL) and reduction of high-density lipoprotein (HDL)-cholesterol Treatment with *P. strateotes* extract ($p<0.05$) reverted these alterations to near normal. The serum levels of urea, creatinine, alanine transaminase (ALT), aspartate transaminase (AST), total and direct bilirubin were significantly increased above normal in untreated diabetic rats; treatment significantly ($p<0.05$) prevented these elevations. It is concluded that the aqueous extract of *P. strateotes* possesses antihyperglycaemic and hypolipidemic effects and ameliorated hepatic and renal alterations in alloxan-induced diabetic rats.

Keywords: Antidiabetic, *Pistia strateotes*, Diabetes, Rats.

Introduction

Diabetes mellitus (DM) is a metabolic disorder characterized by chronic hyperglycaemia with multiple etiological complications and is associated with alterations in the metabolisms of carbohydrate, fat and protein.[1]The alterations in the utilization of complex biomolecules by the most affected tissues (liver, muscle and adipose tissue) due to hyperglycemia initiate a sequence of oxidative processes that cause dysfunction and failure of other organs in the body. Long-term complications may affect the organs such as kidneys, eyes, nerves, heart and blood vessels, and in absence of effective treatment result into death.[2]Recent information showed the global prevalence of DM to be 415 million people and is estimated to double by 2040.[3] This placed DM as a global public health challengeand thus, requires anintegrated approach to fully come up with the best treatment.[4]Generally, the two major types of DMare the type 1 or insulin dependent diabetes mellitus (IDDM) and type 2 or non-insulin dependent diabetes mellitus (NIDDM).[5] The present conventional drugs (sulphonylureas, glucosidase inhibitors, dipeptidyl peptidase-4 (DPP-4) inhibitors and biguanide) are known to present with unwanted adverse consequences such as aggressive hypoglycaemia, diarrhea and stomach discomfort.[6]This is in addition to being rather costly and not affordable by the majority of people in developing countries especially for African populations. For this reason, coupled with an exponential increase in the prevalence of diabetes motivate researchers to scientifically validate the folkloric use of a number of medicinal plants and/or their isolated bioactive compounds as possible alternative therapies for diabetes. The prime target for such research is to pave the way for the development of newer plant-derived antidiabetic compounds that could be used to ameliorate the diabetes associated complications. This can subsequently be standardized and be used as drug for the treatment of the DM. In this regard, several studies are ongoing to discover plant-derived extracts or active ingredients with antidiabetic potential, since fewer side effects were reported for the use of plant-derived products in treatment of various diseased.[7]

Pistia stratiotes (Family, Araceae) is commonly known as water lettuce and as "Kainuwa" in Hausa. It floats on the surface of the water with its hanging roots submersed beneath floating leaves. The leaves are pale-green of about 10-20 cm long and 10 cm wide, spathulate to obovate with a rounded to truncate apex withthe lower surface covered with whitish hairs. Inflorescence is axillary, solitary, spathulate with a single pistillate flower at base, and 2-8 staminate flowers above. Flowers are unisexual, staminate with two stamens, pistillate with unilocular ovary having numerous, ovules, a slender style and penicillate stigma, the fruit with many thin seeds.[8] *P. stratiotes* plant extracts have been shown to contain various alkaloids, glycosides, flavonoids and phytosterols.[9] It has been used traditionally in the treatment of various diseases such as diabetes, eczema, leprosy, ulcers, piles, stomach disorder, throat and mouth inflammation, to mention a few.[10] Previous studies have shown that various extracts from *P. stratiotes* possessed anti-inflammatory,[11] antioxidant,[12]

*Corresponding author. E mail: iaumar2003@yahoo.co.uk
Tel: +2348162060162

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antimicrobial[13,14] and antidiarrheal[15] activities. However, the antidiabetic potential of *P. stratiotes* has not been adequately documented. Therefore, the present study was designed to investigate the antidiabetic activity of *P. stratiotes* aqueous extract in alloxan-induced diabetic rats.

Materials and Methods

Plant material and extraction
The whole plant sample was freshly collected in May, 2017, from Mai Ruwapond, Funtua Local Government Area, Katsina State, Nigeria. The sample was identified and authenticated at the herbarium unit of the Biological Science Department, Ahmadu Bello University, Zaria, Nigeria by Mr. Sunusi Namadi and a voucher specimen number (1102) was deposited accordingly.The plant was shade dried and grinded to a fine powder. The dried powdered sample (100g) was then extracted with distilled water (1 L) by maceration at room temperature for 24h, with intermittent shaking. The filtrate obtained was then evaporated in a hot-air oven set at 50°C until a constant weight was obtained.

Experimental animals
The 35 Wister rats (of both sexes, weighing 150-200 g) used were first acclimatized for two weeks before commencement of experiments. They were kept in well ventilated cages and maintained on a brand of poultry feed (Vital Feeds, Jos) and drinking water *ad libitum*. Animals were maintained according to the rules and regulations of the Animal Research Ethical Committee of the Ahmadu Bello University, Zaria, Nigeria.

Induction of diabetes
Diabetes was induced by intraperitoneal administration of 160 mg/kg body weight of freshly prepared alloxan monohydrate in normal saline to rats fasted overnight. The rats were allowed access to 10% aqueous glucose as drinking water for four hours after injection of alloxan. After 72 h, the fasting blood glucose (FBG) of the rats was assayed and animals with FBG $\geq$ 200 mg/dL were considered diabetic.

Experimental design
The rats were randomly distributed into 5 groups of 7 rats each and the animals were treated daily for the period of three weeks. The extract and standard drug were given orally. Groups 1 and 2 were normal and untreated diabetic control groups, respectively and received a vehicle throughout the study. Groups 3 and 4 were diabetic and treated with glibenclimide (5 mg/kg) and 200 mg/kg of aqueous extract, respectively. Group 5 was normal group and received 200mg/kg of aqueous extract.

Sample collection
Blood for determination of FBG was obtained weekly by nipping the tip of the tail and a drop of blood placed onthe strip. After 21 days of experiment, the rats were humanely sacrificed and blood collected by cardiac puncture; serum was prepared and stored at -20°C until needed for analysis.

Biochemical analysis
Fasting Blood Glucose (FBG) was determined using automated Glucometer (Accu-chek active). The high-density lipoprotein (HDL), triacylglycerols (TG), total cholesterol (TC), serum aspartate aminotransferase (AST), alanine aminotransferase (ALT), direct and total bilirubin, urea and creatinine were assayed using wet reagent kits according to the guidelines. The low-density lipoprotein (LDL) was calculated according to Friedewald *et al*.[16] equation as shown below:

LDL-Cholesterol(mg/dL) = [TC-HDL-(TG/5)]

Statistical analysis
All data are presented as the mean ± SD of seven replicates. Data were analyzed by using a statistical software package (SPSS) for Windows, version 22, IBM Corporation, NY, USA) using Tukey's-HSD multiple range post-hoc test. Values were considered significantly different at $p<0.05$.

Results and Discussion

The result of the effect of *P. stratiotes* aqueous extract on blood glucose levels is presented in Tables 1 and 2. The blood glucose level of the untreated diabetic group was significantly ($p<0.05$) elevated compared to normal control group. This is due to the cytotoxic effect of alloxan to the pancreatic *β*-cells and is mediated by reactive oxygen species (ROS), which lead to damage and loss of *β*-cells that eventually result into sustain elevated blood glucose levels in diabetes.[17] Oral administration of *P. stratiotes* aqueous extract significantly ($p<0.05$) reduced FBG by 68.6% compared to untreated diabetic rats. The reduction was similar to the group treated with glibenclamide (60.6%). Furthermore, treatment with *P. stratiotes* aqueous extract of non-diabetic rats did not significantly ($p>0.05$) affect the blood glucose level of the treated group (Tables 1 and 2). Though the mechanism by which the extract reduced blood glucose is unclear at the moment, *P. stratiotes* extract has been shown to possess potent antioxidant activity[18,19] and this could help to reduce ROS production, improve the regeneration of pancreatic *β*-cells and hence facilitate the blood glucose uptake and utilization.
The data on the effect of *P. stratiotes* aqueous extract on lipid profile is presented in Table 3.Studies have shown that dyslipidemia is a crucial feature of diabetes.[20-22]The key components of diabetic dyslipidemia include alterations on the plasma lipid profiles (LDL-cholesterol, TG and lowered HDL-cholesterol), which were evidently observed in the present study (Table 3). The TC, TG and LDL-cholesterols of the untreated diabetic group were significantly ($p<0.05$) elevated while the HDL-cholesterol was significantly ($p<0.05$) lowered compared to the normal untreated group (Table 3). However, treatment with *P. stratiotes* aqueous extract significantly ($p<0.05$) ameliorated the alterations to near normal and were comparable to the glibenclamide treated group (Table 3). It is therefore suggested that administration of *P. stratiotes* extract regenerated pancreatic *β*-cells and thereby produced more circulating insulin which apparently stimulated lipogenesis, hence ameliorated the dyslipidemia.

Table 1: Effect of *Pistia stratiotes* on Fasting Blood Glucose Level (mg/dL) of Normoglycemic and Alloxan-induced Diabetic Rats.

Groups	Week 0	Week 1	Week 2	Week 3
Normal control	105.69±22.01[a]	104.70±16.93[a]	107.10±12.72[a]	94.50±19.71[a]
Diabetic control	355.89±96.08[b]	384.94±95.41[c]	503.70±153.6[d]	582.44±103.0[d]
Diabetic + Glibenclimide	334.54±98.30[b]	315.14±70.03[b]	211.89±60.40[b]	112.80±22.38[b]
Diabetic +extract	327.29±29.51[b]	319.37±73.31[b]	231.94±53.44[c]	145.80±37.97[c]
Extract control	112.37±23.56[a]	102.34±14.86[a]	93.86±16.84[a]	88.43±17.10[a]

Each value represents the mean ± standard deviationof 7 determinations. Values in a column with superscripts[a-d] are significantly different from control ($P<0.05$).

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Table 2: Percentage changes in Fasting Blood Glucose (FBG) of Normal and Alloxan-induced Diabetic Rats Treated with Aqueous Extract of *Pistia stratiotes*.

Groups	Percentage change in FBG (%)
Normal control	- 5.73 ± 23.61[a]
Diabetic control	+ 68.94 ± 35.10[d]
Diabetic + Glibenclimide	- 60.61 ± 14.44[c]
Diabetic + extract (200mg/kg)	- 68.62 ± 38.40[c]
Extract control	- 17.88± 24.59[b]

Each value represents the mean ± standard deviation of 7 determinations. Values in a column with superscripts [a-d] are significantly different from control (P<0.05).

In addition to this basis, correction in glucose homeostasis as seen in the data may also lead to spontaneous correction of the dyslipidemia. This assumption was further supported by the significant amelioration of hepatic and renal degeneration seen in treated diabetic groups.

Table 4 and 5 present the data on the effect of *P. stratiotes* aqueous extract on the biochemical markers of hepatic and renal functions. The levels of serum AST, ALT, total and direct bilirubin and urea and creatinine of the untreated diabetic group were significantly ($p<0.05$) increased compared to the normal control group. These accord with previous studies.[23,24] However, treatment with the *P. stratiotes* extract for 3 weeks was able to amelioratethese alterations to near normal status. This implies the potential of *P. stratiotes* extract to ameliorate hepatic and renal diabetes-associated complications.

Table 3: Effect of Aqueous Extract of *Pistia stratiotes* Extract on Lipid Profile (mg/dL) of Normal and Alloxan-induced Diabetic Rats.

Groups	Total Cholesterol	Triglycerides	HDL-Cholesterol	LDL-Cholesterol
Normal control	161.47 ± 11.24[b]	146.95 ± 10.82[a]	49.94.05 ± 6.40[b]	82.04 ± 4.08[b]
Diabetic control	214.59 ± 16.39[c]	211.49 ± 12.43[c]	38.30 ± 6.69[a]	133.99 ± 22.43[c]
Diabetic + Glibenclimide	178.59 ± 8.32[b]	156.35 ± 13.48[b]	73.08 ± 11.86[d]	74.31 ± 20.36[b]
Diabetic+ extract	165.77 ± 12.94[b]	169.55 ± 8.74[b]	54.44 ± 6.77[b,c]	77.99 ± 14.03[b]
Extract control	147.31 ± 11.66[a]	163.34 ± 7.12[b]	58.88 ± 6.79[c]	55.77 ± 15.48[a]

Each value represents the mean ± standard deviation of 7 determinations. Values in a column with superscripts [a-c] are significantly different from control (P<0.05).

Table 4: Effect of Aqueous Extracts of *Pistiastratiotes* on Some Biochemical Indices of Liver Functionin Normal and Alloxan-induced Diabetic Rats.

Groups	ALT (u/L)	AST (u/L)	Total bilirubin (µmol/L)	Direct bilirubin (µmol/L)
Normal control	11.52 ± 2.09[b]	9.50 ± 2.95[a]	8.51 ± 2.11[a]	2.84 ± 0.70[a]
Diabetic control	20.00 ± 6.22[c]	19.75 ± 6.37[c]	21.46 ± 5.05[c]	7.15 ± 1.68[c]
Diabetic + Glibenclimide	10.40 ± 3.81[a,b]	11.50 ± 3.97[b]	14.06 ± 2.11[b]	4.69 ± 0.70[b]
Diabetic+ extract	8.00 ± 4.13[a]	9.00 ± 2.75[a]	13.26 ± 3.40[b]	4.41 ± 1.11[b]
Extract control	9.333 ± 3.71[a,b]	11.08 ± 5.61[b]	10.17 ± 6.27[a]	3.39 ± 2.08[a]

Each value represents the mean ± standard deviation of 7 determinations. Values in a column with superscripts [a-c] are significantly different from control (P<0.05).

Table 5: Effect of aqueous extract of *Pistia stratiotes* on some biochemical indices of kidney function in normal and alloxan-induced diabetic rats.

Groups	Serum urea (mg/L)	Serum creatinine (mmol/L)
Normal control	37.80 ± 2.76[a]	56.54 ± 5.50[a]
Diabetic control	67.21 ± 7.22[b]	112.42 ± 23.53[b]
Diabetic + Glibenclimide	38.02 ± 8.52[a]	61.398 ± 9.32[a,c]
Diabetic+ extract	37.69 ± 9.57[a]	59.94 ± 8.41[a]
Extract control	31.92 ± 11.47[a]	56.10 ± 5.33[a]

Each value represents the mean ± standard deviationof 7 determinations. Values in a column with superscripts (*) are significantly different from control (P<0.05).

Conclusion

Administration of *P. stratiotes* extract was shown to reduce FBG, attenuate dyslipidemia, renal and kidney complications and thus, validated the traditional claim for use of *P. stratiotes* in the treatment of diabetes. Further mechanistic details, toxicity and clinical studies are recommended to support the present data.

Conflict of interest

The authors declare no conflict of interest.

Authors' Declaration

The authors hereby declare that the work presented in this article is original and that any liability for claims relating to the content of this article will be borne by them.

References

1. American Diabetes Association (ADA). Diagnosis and classification of diabetes mellitus. Diabetes Care. 2014; 37:S81-S90.
2. McCrindle BW, Rowley AH, Newburger JW, Burns JC, Bolger AF, Gewitz M, Kobayashi T. Diagnosis, treatment, and long-term management of Kawasaki disease: a scientific statement for health professionals from the American Heart Association. Circulation.2017;135:e927-e999.
3. Nasli-Esfahani E, Farzadfar F, Kouhnavard M, Ghodssi-Ghassemabadi R, Khajavi A, Peimani M, Razmandeh R, Vala M, Shafiee G, Rambod C, Aalaa M, GhodsiRazi MF, Bandarian F, Sanjari M. Iran diabetes research roadmap (IDRR) study: a preliminary study on diabetes research in the world and Iran. J Diabetes MetabolDisord.2017; 16:9.
4. Zimmet PZ, Alberti KGM. Epidemiology of diabetes—status of a pandemic and issues around metabolic surgery. Diabet Care.2016;39: 878-883.
5. Zaccardi F, Webb DR, Yates T, Davies MJ. Pathophysiology of type 1 and type 2 diabetes mellitus: a 90-year perspective. Postgrad Med J.2016; 92:63-69.
6. Naveen J, Baskaran V. 2017. Antidiabetic plant-derived nutraceuticals: a critical review. Eur J Nutri. 2017; [Epub ahead of print].
7. Atanasov AG, Waltenberger B, Pferschy-Wenzig EM, Linder T, Wawrosch C, Uhrin P, Temml V, Wang L, Schwaiger S, Heiss EH, Rollinger JM, Schuster D, Breuss JM, Bochkov V, Mihovilovic MD, Kopp B, Bauer R, Dirsch VM, Stuppner H. Discovery and resupply of pharmacologically active plant-derived natural products: A review. Biotechnol Adv.2015; 33:1582-1614.
8. Bhuiyan MIH, Alam MK, Khan MF, Chowdhury MHM, Islam MM, Hossain MI, Chowdhury KAA. In silico molecular docking studies of some isolated compounds from *Pistia stratiotes* for α-amylase inhibitory activity. World Res J Pharm Res. 2016; 5:1240-1247.
9. Khare CP. Encyclopedia of Indian medicinal plants. Berlin Heidelberg, Germany: Springer-Verlag. 2005. 372p.
10. Khan MA, Marwat KB, Gul B, Wahid F, Khan H, Hashim S. *Pistia stratiotes* L. (Araceae): Phytochemistry, use in medicines, phytoremediation, biogas and management options. Pak J Bot. 2014; 46(3): 851-860.
11. Koffuor GA, Kyei1S,WoodeE, EkuadziE, Ben IO. Possible mechanism of anti-inflammatory activity and safety profile of aqueous and ethanolic leaf extracts of *Pistia stratiotes* L. J Ghana Sci Ass. 2012; 14(1):69-81.
12. Jha M, Ganesh N, Sharma V. *In vitro* evaluation of free radical scavenging activity of *Pistia stratiotes*. Asian Pac J Trop Dis. 2010; 2(1): 180-184.
13. Ibrahim TA, OpawaleBO,OyinloyeJMA. Antibacterial activity of herbal extracts against multi drug resistant strains of bacteria from clinical origin. Life Sci Leaflets.2011;15:490-498.
14. Obeidat M, Shatnawi M, Al-alawi M, Enas A, Hanee A, Masia A, El-QuadahA,Otr I. Antimicrobial activity of crude extracts of some plant leaves. Res J Microbiol. 2012; 7:59-67.
15. Rahman MA, Haque E, Hasanuzzaman M, Muhuri SR, Shahid IZ. Evaluation of antinociceptive and antidiarrhoeal properties of *Pistia stratiotes* (Araceae) leaves. J PharmacolToxicol. 2011; 6:596-601.
16. Friedewald WT, Levy RI, Fredrickson DS. Estimation of the concentration of low-density lipoprotein in plasma, without use of the preventive ultra-centrifuge. Clin Chem.1972; 18: 499-502.
17. Szkudelski T. The mechanism of alloxan and streptozotocin action in β cells of the rat pancreas. Physiol Res. 2001; 50(6):537-546.
18. Tyagi T and Parashar P. Antimicrobial and antioxidant activity of *Pistia stratiotes* (L.). Int J PharmBioSci. 2017; 8(3):391-399.
19. Thuong PT, Na MK, Dang NH, Hung TM, Ky PT, Thanh TV, Nam NH, Thuan ND, Sok DE, Bae KH. Antioxidant activities of Vietnamese medicinal plants. Nat Prod Sci. 2006;12: 29-37.
20. Khavandi M, Duarte F, Ginsberg HN, Reyes-Soffer G. Treatment of dyslipidemias to prevent cardiovascular disease in patients with type 2 diabetes. CurrCardiol Rep. 2017; 19(1):7.
21. Kowluru RA, Mishra M, Kowluru A, Kumar B. Hyperlipidemia and the development of diabetic retinopathy: Comparison between type 1 and type 2 animal models. Metab.2016; 65(10):1570-1581.
22. Wang YH, Liu YH, He GR, Lv Y, Du GH. Esculin improves dyslipidemia, inflammation and renal damage in streptozotocin-induced diabetic rats. BMC ComplAltern Med. 2015; 15(1):402.
23. Uyar A, Yaman T, Keles OF, Alkan EE, Celik I, Yener Z. Protective effects of *Bryonia multiflora* extract on pancreatic beta cells, liver and kidney of streptozotocin-induced diabetic rats: histopathological and immunohistochemical investigations. Indian J Pharm Edu Res. 2017; 51(3): S403-S411.
24. King RJ, Harrison L, Gilbey SG, Santhakumar A, Wyatt J, Jones R, Bodansky HJ. Diabetic hepatosclerosis: another diabetes microvascular complication? Diabet Med. 2016; 33(2):e5-e7.