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Ameliorative Effects of *Adansonia digitata* on Diabetes in Albino Rats: Enhanced Biochemical Responses

Dhuha W. Salih[1], Husamuldeen S. Alnajar[1], Dakheel H. Hadree[1], Buthina A. Abdullah[1], Muthanna Sultan[2]*

[1]Department of Physiology, Biochemistry, and Pharmacology, College of Veterinary Medicine, Tikrit University, Tikrit, Iraq, [2] Department of Microbiology, College of Veterinary Medicine, Tikrit University, Tikrit, Iraq.

Abstract

Objective of current explore is to determine protective effect of baobab plant (*Adansonia digitata*) and metformin by examining several biochemical and biochemical indicators on the kidneys and liver of rats treated with alloxan to induce diabetes. Seventy adult Albino rats divided to 7 groups: The study involved diabetic rats in different groups, each receiving different treatments. The control group received alloxan monohydrate, while the group with Baobab received 500 mg/kg orally. The group with metformin received 100 mg/kg orally. The treatments were administered orally for 15 and 30 days. The baobab intake, alone or in conjunction with metformin, on different parameters in a diabetic animal model. The results looked good. Treatment with baobab has improved renal function, as demonstrated by lower urea and creatine levels. Lipid profile research revealed a decrease in triglyceride levels as well as fluctuations in HDL and cholesterol levels, all of which have a good effect on lipid control. In conclusion D.M. in male rats increased kidney function markers and hepatic enzymes, but baobab plant treatment reduced these levels, indicating potential to mitigate adverse effects and increase beneficial fat levels.

Keywords:
Baobab, Biochemical analysis, Diabetic, Liver, Kidney, Rat model

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*Corresponding Author: Muthanna Sultan E-mail: muthanna.sultan@tu.edu.iq
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Introduction

Medicinal herbs, also known as plants or herbal remedies, have been crucial for human health for centuries due to their therapeutic properties, utilized by various cultures worldwide (Kitcher et al., 2021; Kumar et al., 2017; Yu et al., 2006).

Medicinal herbs, including baobab fruit pulp, possess bioactive compounds like alkaloids, flavonoids, terpenes, and phenolics, which promote healing, relieve symptoms, and restore balance. These compounds also exhibit antioxidant, hepatoprotective, cardioprotective, antidiabetic, and antitumor properties (Elsaid, 2013).

The dried baobab is low in fat, high in the fiber with low in sugar, produce it an optimal adding to food. It includes lower sugar and is a good origin of amino acid, production it a low glycemic index and satiating ingredient (Chanda, 2014; Rana et al., 2022).

The pulp of the baobab fruit is high in vitamin C, calcium, iron, and magnesium (Murai et al., 2017). The pulp of the baobab fruit is high in polyphenols, which likely act as antioxidants (Vesa and Bungau, 2023). Various secondary metabolites have been identified and/or isolated from A. digitata. The leaf and stem bark have been reported to contain beta-sitosterol, scopoletin, betulinic acid, and tara (Ghoneim et al., 2016).

Because of their heavy concentrate of typical products, medicinal plants have traditionally been used to treat diabetes. Research studies have shown that baobab plants have these antidiabetic characteristics, which cover improving insulin susceptibility and hypoglycemic action (Salleh et al., 2021).

Diabetes is a metabolic disease that causes loud blood sugar levels and requires common overseeing and monitoring. It damages pancreatic beta cells, which products insulin to absorb energy. Type 1 with type 2 diabetes are usual, with T1DM causing failure of insulin manufacture due to T-cell-mediated autoimmunity (Gharravi et al., 2018). Type 2 diabetes is associated with insulin resistance, decreased making, decreased life expectancy, and higher cardiovascular disease and metabolic disorder (Wise, 2016). The aim of this study was to examine the protective effects of baobab on liver and kidney damage in rats with induced diabetes mellitus (D.M.). Analysis of changes in the biochemical index related with the lipid profile, liver enzymes, and the kidney function in D.M. Rats.

Material and methods

Ethical approval

Ethical approval No. 7/18/44/46 on 3/14/2019, and scientific and humane methods were followed in ethical dealing with animals, according to the instructions of the Ministry of Higher Education and Scientific Research in Iraq.

Animals:

Number of Seventy adult Rat gained from the animal house of the College of Veterinary Medicine / University of Mosul. Animals aged (8-10 week) and whose weight ranged (250-300 gr) used in this study, with mean of 50 grams. The rats sited in regular plastic cages. They were kept under appropriate conditions ranging between 20-25 degrees Celsius in College of Veterinary Medicine / University of Mosul, with free access to water and food and exposed to light for 12 \hours daily

Induction of Diabetes:

Rats injected by alloxan a single dose of to induce diabetes at a dose (100 mg/kg/day) overnight for fasted rats. Before fixing this dose, there were many experiments and experimental studies that were used to reach the suitable dose, where alloxan was dissolved in 1 ml of normal saline solution. Rats allowed to drink a 5%

glucose- solution overnight. Animals were kept until being diabetic for 1 week.

Drugs and materials used:

Baobab fruit pulp powder 100% organic (Sudan), Alloxan solution (100 mg/kg) to induce diabetes (Biomedicine and Pharmacotherapy), and Metformin (Sun Pharmaceutical Industries Ltd.)

Biochemical parameters:

ALT and AST levels were measured using ALT and AST kits (Biolabo France), ALP levels were measured using ALP and kits (Biolabo France), Urea levels were measured using Urea kits (BioMerieux, France) and Creatinine levels were measured using Creatinine kits (BioMerieux, France).

Preparation of *Adansonia Digitata* Dose:

The study used Sudanese *A. digitata* fruit shells, separated into fine powder, and administered to rats at a dose of 500 mg/kg/day via oral gavage.

Preparation of Metformin Dose:

The study used Samara Company's metformin, a medication with a Molecular Weight of 165.62 and a melting point of 222 C0 to 226 C0, for oral administration.

Blood Collection:

Blood collection was performed using the Retro-orbital bleed technique, involving a direct withdrawal of 2-3ml from the eye and centrifugation at 1500 rpm for 15 minutes.

General Experimental group:

The rats divided to 7 groups, each included 10 mice and were as follows: G1: receiving a standard laboratory diet daily, G2: diabetic by Alloxan. Monohydrate 100 mg. /kg, G3: received only 500 mg/kg/bw of raw *A. digitata* for 4 weeks, G4: received only metformin 100 mg /kg/body weight for 4 weeks:, G5: given *A. digitata* Cruds 500 /kg/body weight for 4 weeks, G6: given Metformin 100 mg/kg/body weight orally daily for 4 weeks G7: received 500 mg/kg/body weight orally raw *A. digitata* and metformin 100 mg/kg/body weight Orally for 4 weeks.

The animals sacrificing at the end of experiment. Blood collected after doses were completed. Menstrual cycle and blood serum were obtained to measure the level of the biochemical parameters.

Statistical Analysis:

The data obtained from the study will be presented as mean ± standard error of the mean (SEM). Statistical analysis will be conducted using computer by one-way analysis of variance (ANOVA), followed by post-hoc tests, specifically the Duncan test. A p-value less than 0.05 will be considered statistically significant, while a p-value less than 0.001 will be regarded as highly significant.

Results

Table 1 shows Urea levels changes in different treatment groups, with G1 group maintaining stable levels, G2 group showing significant increases, G3 group experiencing gradual decreases, and G4 group maintaining stable levels. Individual treatments with baobab or metformin showed initial increases followed by decreases.

Table 2 for the changes in creatinine across the different groups, with G1 showing non-significant changes, G2 showing high levels, G3 and normal metformin showing stable levels, and diabetic baobab and the metformin showing initial increased and decreases.

Table 3 for the impact of various treatments on triglyceride in diabetic rats. The G1 group appeared stable levels, while G2 group appeared a substantial increase. Baobab and metformin treatments initially increased, but combined treatments showed a significant decrease, suggesting potential positive effects.

Table 4 for the impact of the treatments on HDL in diabetic rats. G1 showed stable levels, while G2 had lower levels. Baobab and metformin increased HDL levels, with the diabetic+ Baobab group showing the highest at 6 weeks.

Table 5 shows cholesterol levels in a diabetic model, with stable G1 and G2 groups, increased G2 and G4 groups, decreased G1 and G4 groups, and increased G6 groups. Baobab, metformin, and their combination may help manage cholesterol levels.

Table (1): Baobab impacts on Urea in Diabetic model:

Sampling day / Groups	Urea (mg /dl; mean ± SEM) (N=10 each group)				
	Day Zero	2 days after alloxan	Day 15	Day 30	*P Value*
G1	31.20± 1.43 (A,a)	30.3±1.30(A,a)	30.6±1.2(A,a)	29.0±1.52(A,a)	0.57
G2	29.2 ± 2.03 (A,a)	61.6±2.9 (B,b)	61.8±1.28(B,c)	55.0±6.82c(B,c)	0.00 **
G3	30.40 ± 1.4 (A,a)	30.75±1.8(A,a)	26.4±1.2(A,a)	27.0±0.7(A,a)	0.38
G4	29.00 ± 2.0 a (A,a)	29.5±2.5(A,a)	26.0±1.8(A,a)	28.2±1.1(A,a)	0.32
G5	33.20 ± 1.7 a (A,a)	59.4±3.50(B,a)	44.8±2.0(AB,b)	33.6±0.91(A,b)	0.00 **
G6	30.60 ± 1.8 a (A,a)	63.4±2.2(C,b)	46.6±0.7(B,b)	32.0±1.4(A,b)	0.00 **
G7	29.20 ± 1.2 a (A,a)	63.6±2.0(C,b)	39.4±2.3(B,ab)	27.6±0.8(A,a)	0.00 **
P Value	0.60	0.00 **	0.00 **	0.00 **	

The study used Kolmogorov-Smirnov and Shapiro-Wilk tests to fit data into normal distribution, and ANOVA and Post-Hoc Duncan's test to analyze differences. Significant differences were noted at $p<0.05$ or <0.01.

Table (2): Baobab Impacts on Creatinine (mg/dl) in Diabetic rats:

Sampling day / Groups	Creatinine (mg /dl; mean ± SEM) (N=10 each group)				
	Day Zero	2 days after Alloxan	Day 15	Day 30	*P Value*
G1	0.5 ±0.0 (A,a)	0.5±0.0 (A,a)	0.5 ± 0.0 (A,a)	0.5 ± 0.0 (A,a)	0.713
G2	0.5± 0.01(A,a)	0.8±0.03 (B,b)	0.9 ± 0.05 (B,c)	0.8± 0.04 (B,c)	0.00 **
G3	0.4 ±0.02 (A,a)	0.50± 0.0 (A,a)	0.5± 0.06 [a] (A,a)	0.4± 0.01 (A,a)	0.343
G4	0.5± 0.01 (A,a)	0.5 ± 0.04 (A,a)	0.5± 0.02 [a] (A,a)	0.4± 0.03 (A,a)	0.292
G5	0.5± 0.05(A,a)	0.9±0.07 (D,b)	0.7± 0.03 (C,b)	0.6 ± 0.06 (B,b)	0.00 **
G6	0.4 ± 0.03 (A,a)	0.9 ± 0.04 (C,b)	0.8 ± 0.03[bc] (B,b)	0.6 ± 0.01 (B,b)	0.00 **
G7	0.51 ± 0.03 [a] (A,a)	0.93 ± 0.05 (B,b)	0.54 ± 0.06 [a] (A,a)	0.44 ± 0.01 (A,a) [a]	0.00 **
P Value	0.90	0.00 **	0.00 **	0.00 **	

The study used Kolmogorov-Smirnov and Shapiro-Wilk tests to fit data into normal distribution, and ANOVA and Post-Hoc Duncan's test to analyze differences. Significant differences were noted at $p<0.05$ or <0.01.

Table (3): Baobab Impacts on Triglyceride in a Diabetic model:

Sampling day / Groups	Triglyceride (mg/dl; mean ± SEM) (N=10 each group)				
	Day Zero	2 daysafter alloxan	15 Day	30 Day	*P value*
G1	82.16 ±2.2 (A,a)	80.38±1.7 (A,a)	80.92 ± 0.66 (A,a)	80.84 ± 1.4 (A,a)	0.94
G2	8 .30 ±1.8 (A,a)	16 .64 ± 5.1 (B,b)	16 .28 ± 4.6 (B,b)	16 .38 ± 2.7 (B,b)	0.00 **
G3	80.94 ± 1.9 (A,a)	79.90±2.1 (A,a)	75.82 ± 2.2 (A,a)	69.44 ± 1.4 (A,a)	0.63
G4	82.22 ± 1.6 (A,a)	81.25±1.7 (A,a)	77.12 ± 1.9 (A,a)	68.86 ± 1.2 (A,a)	0.71
G5	82.72 ± 2.1 (A,a)	169.41 ± 4.0 (C,c)	131.6 ± 2.7 (B,b)	100.85 ± 3.1 (C,b)	0.00 **
G6	81.54 ± 1.7 (A,a)	162.58 ± 5.2 (C,c)	139.3±1.3 (B,c)	93.98 ± 4.8 (A,b)	0.00 **
G7	79.76 ± 2.7 (A,a)	165.06 ± 1.5 (C,c)	113.62± 4.5 (B,b)	72.243 ± 2.4 (A,a)	0.00 **
P value	0.85	0.00 **	0.00 **	0.00 **	

The study utilized Kolmogorov-Smirnov and Shapiro-Wilk tests to fit data into normal distribution, and ANOVA and Post-Hoc Duncan's test to analyze differences, identifying significant differences at $p<0.05$ or <0.01.

Table (4): Baobab Impacts on HDL in Diabetic rats:

Sampling day / Groups	HDL (mg /dl; mean ± SEM) (N=10 each group)				
	Day Zero	2 days after Alloxan	15 Day	30 Day	*p-value*
G1	54.320 ± 2.0 (A,a)	53.300 ±1.9 (A,b)	51.720 ± 1.3 (A,c)	50.320 ± 3 (A,b)	0.41
G2	50.801 ± 1.0 (B,a)	28.381 ± 1.7 (A,a)	29.718 ± 0.9 (A,a)	30.210 ± 1.1 (A,a)	0.00 **
G3	52.106 ± 2.2 (A,a)	54.00 ±1.31 (A,b)	53.961 ± 2.2 (A,c)	58.802 ± 2.2 (A,c)	0.37
G4	54.042 ± 2.2 (A,a)	53.232±2.6 (A,b)	58.662 ± 1.2 (A,c)	58.202 ± 2.3 (A,c)	0.40
G5	53.461 ± 1.3 (C,a)	27.201 ± 1.7 (A,a)	35.401 ± 1.0 (B,bc)	48.541 ± 1.6 (C,b)	0.00 **
G6	51.242 ± 1.0 (C,a)	29.78 ± 2.6 (A,a)	43.08` ± 1.3^{c}(B,b)	55.302 ± 2.7 (C,b)	0.00 **
G7	54.242 ± 2.2 (C,a)	29.882 ± 1.4 (A,a)	45.082 ± 1.3 (B,b)	66.622 ± 1.1 (C,c)	0.00**
P value	0.62	0.00**	0.00 **	0.00 **	

The study used Kolmogorov-Smirnov and Shapiro-Wilk tests to fit data into normal distribution, and ANOVA and Post-Hoc Duncan's test to analyze differences in vertical column, superscript small and horizontal mean letters.

Table (5): Baobab Impacts on Cholesterol in Diabetic rats:

Sampling day / Groups	Cholesterol (mg /dl; mean ± SEM) (N=10 each group)				
	Day Zero	2 days after Alloxan	15 Day	30 Day	*P value*
G1	91.58±4.2(A,a)	89.18±4.5(A,a)	88.72±4.1(A,a)	89.8±2.9(A,a)	0.89
G2	91.84±4.3^{a}(A,a)	175.5±5.1(B,b)	178.1±2.8(B,c)	174.0±2.9(B,c)	0.00 **
G3	87.5±2.8^{a}(A,a)	87.25±3.6(A,a)	77.96±3.2(A,a)	78.9±1.6(A,a)	0. 63
G4	92.4±5.9 (A,a)	90.1±7.0(A,a)	80.01±3.5(A,a)	76.4±1.8(A,a)	0.10
G5	91.6±3.0^{a}(A,a)	171.6±5.2(C,b)	144.1±2.7(B,b)	112.7±5.1(B,b)	0.00 **
G6	85.6±3.5(A,a)	171.3±7.8(C,b)	135.0±2.1^{b}(B,b)	122.7±3.8(B,b)	0. 01**
G7	90.02±4.9(A,a)	150.2±6.5(C,c)	130.2±4.7(B,b)	100.3±3.2(A,a)	0.00 **
P value	0.89	0.00 **	0.00 **	0.00 **	

The study used Kolmogorov-Smirnov and Shapiro-Wilk tests to fit data into normal distribution, and ANOVA and Post-Hoc Duncan's test were used to analyze the results. Significant differences were noted at $p<0.05$ and <0.01.

The study showed significant increases in G1LDL levels, while G2 LDL levels remained increased. Baobab LDL levels decreased after 2 days, while diabetic and Baobab LDL increased, then decreased (Table 6).

Table 7 shows the impact of the treatments on VLDL, including G1, G2, Baobab, metformin, and their combination, measured at four time points.

Table 8 showed changes in GOT over time were non- significant for negative control, normal Baobab, and normal metformin groups. G2 showed consistent increased. Diabetic rats with Baobab, metformin, and both displayed fluctuating levels.

Table 9 showed GPT levels remained stable for the negative control, normal Baobab, and normal metformin groups. G2 had difference. Diabetic rats with Baobab, metformin, and both showed fluctuating levels.

Observed ALK were stable for negative control, normal Baobab, and normal metformin groups. G2 exhibited increase, point out potential liver dysfunction or bone remodeling. Diabetic rats with Baobab, metformin, and both showed variable levels (Table 10)

Table (6): Effect of Baobab on LDL Levels in a Diabetic Model:

Sampling days / Groups	LDL (mg /dl; mean ± SEM) (N=10 each group)				
	Day Zero	2 days-after alloxan	15 Day	30 day	*p-value*
G1	20.47 ± 2.7 (A,a)	19.9 ±2.6 (A,a)	18.53 ± 5.5 (A,a)	20.53 ±3.5 (A,a)	0.82
G2	24.98 ± 4.4 (A,a)	114.8 ± 7.6 (B,b)	117.3 ± 1.5 (B,c)	110.5 ± 3.4 (B,c)	0.00 **
G3	19.23 ±1.8 (A,a)	18.75± 2.3 (A,a)	18.86 ± 2.7 (A,a)	16.66 ± 2.1 (A,a)	0.34
G4	21.94 ±6.1 (A,a)	24.75 ±7.0 (A,a)	18.39 ± 3.3 (A,a)	17.23 ± 2.4 (A,a)	0.00 **
G5	21.6 ± 3.8 (A,a)	111.6± 3.4 (C,b)	84.41 ± 2.1 (B,b)	45.04 ± 5.6 (B,b)	0.00 **
G6	18.03 ± 4.7 (A,a)	113.0 ± 8.9 (D,b)	72.05 ±1.8 (C,b)	49.5 ± 6.1 (B,b)	0.00 **
G7	19.81± 6.4 (A,a)	127.7 ± 6.2 (C,b)	66.2 ± 5.7 (B,b)	19.5±2.3 [a] (A,b)	0.00 **
P value	0.99	0.00 **	0.00 **	0.00 **	

The study used Kolmogorov-Smirnov and Shapiro-Wilk tests to fit data into normal distribution, and ANOVA and Post-Hoc Duncan's test to analyze differences. Significant differences were noted at $p<0.05$ and <0.01.

Table (7): Baobab Impacts on VLDL in a Diabetic Rats

Sampling days / Groups	VLDL (mg /dl; mean ± SEM) (N=10 each group)				
	Day Zero	2 days after alloxan	15 Day	Day 30	*p-value*
G1	16.43±0.4(A,a)	16.68± 0.4 (A,a)	16.2±0.13(A,a)	15.78±0.34 (A,a)	0.812
G2	16.06±0.3(A,a)	36.31 ± 1.0 (B,b)	39.9±0.92(B,c)	31.28±0.54 (B,c)	0.000**
G3	16.19±0.4(A,a)	15.94±0.5 (A,a)	15.16±0.4(A,a)	13.89±0.2 (A,a)	0.61
G4	16.44±0.3(A,a)	16.50±0.2 (A,a)	15.42±0.3(A,a)	13.73 ± 0.2 (A,a)	0.57
G5	16.5±0.4 (A,a)	33.8±0.8 (C,b)	26.3± 0.5 (B,b)	20.1 ±0.6 (B,b)	0.0 0**
G6	16.5±0.3 [a](A,a)	32.5±1.0 (C,b)	27.8±0.2 (B,b)	18.8±0.9 (B,b)	0.0 0**
G7	17.95±0.5(A,a)	36.61±0.3 (C,b)	26.92±0.9(B,a)	16.24 ± 0.4 (A,a)	0.002**
P value	0.92	0.00 **	0.00 **	0.00 **	

The study used Kolmogorov-Smirnov and Shapiro-Wilk tests to fit data into normal distribution, and ANOVA and Post-Hoc Duncan's test to analyze differences. Significant differences were noted at $p<0.05$ and <0.01.

Table (8): Baobab Impacts on GOT in a Diabetic rats

Sampling day / Groups	GOT (U/L; mean ± SEM) (N=10 each group)				
	Day Zero	2 days after alloxan	Day 15	Day 30	*p value*
G1	124.4± 2.9 (A,a)	130.3±2.6(A,a)	126.0± 4.4(A,a)	128.2±2.2(A,ab)	0.47
G2	126.8 ± 5.2 (A,a)	180.4 ± 3.0(B,b)	177.8 ± 4.9(B,c)	180.4 ± 3.4(B,c)	0.00**
G3	131.2 ± 4.3 (A,a)	128.0±3.8(A,a)	111.0 ± 4.6(A,a)	110.2±3.6(A,a)	0.92
G4	130.2 ± 3.5 (A,a)	127.5±2.9(A,a)	107.0 ± 4.5(A,a)	108.2± 5.1(A,a)	0.42
G5	134.4 ± 3.3(A,a)	180.8 ± 2.7(A,b)	140.8± 2.6(A,b)	120.6±3.6(A,ab)	0.00**
G6	137.2 ± 5.0(A,a)	180.2 ± 4.1(C,b	134.8 ± 3.8(B,b)	131.8± 5.1(B,b)	0.20
G7	139.0± 3.3(A,a)	199.8 ± 5.2(C,b)	121.8 ± 4.7(B,ab)	166.8±1.9(A,a)	0.00**
p value	0.66	0.00**	0.00**	0.00**	

The study used ANOVA and Post-Hoc Duncan's test to analyze differences in vertical column, horizontal mean superscript, and vertically mean superscript letters, with significant differences at $p<0.05$.

Table (9): Baobab Impact on GPT in a Diabetic rats

Sampling day / Groups	GPT (U/L; mean ± SEM) (N=10 each group)				
	Day Zero	2 days after alloxan	15 Day	30 Day	*P value*
G1	53.2±3.4(A,a)	53.5±4.3(A,a)	54.2± 1.7(A,a)	54.6±1.7(A,a)	0.53
G2	57.4±3.5(A,a)	134.2±3.3(B,b)	132.6±3.7(B,c)	129.6±2.2(B,c)	0.00**
G3	51.0±1.5(A,a)	54.2±1.7(A,a)	50.2±1.24(A,a)	50.8±1.28(A,a)	0.41
G4	55.8±2.3(A,a)	54.3±2.2(A,a)	48.6±1.1(A,a)	49.8±1.0(A,a)	0.37
G5	53.2±2.5(A,a)	133.0±3.2(B,b)	110.4±3.4(B,b)	89.4±5.6(BA,b)	0.00**
G6	52.8±1.1(A,a)	134.4±3.7(C,b)	96.4±5.5(B,b)	72.8±2.7(B,b)	0.000**
G7	55.2±2.6(A,a)	135.4±4.4(C,b)	92.60±2.8(B,b)	42.8±2.7(A,a)	0.000**
p-value	0.650	0.000**	0.000**	0.000**	

Table (10): Baobab Impacts on ALK in a Diabetic rats

Sampling day / Groups	ALK (U/L				
	Day Zero	2 days after alloxan	Day 15	Day 30	*P value*
G1	236.4±6.3(A,a)	232.0±5.8(A,a)	209.8±21.6(A,a)	231.0±3.8(A,a)	0.77
G2	238.2±8.8(A,a)	617.4±12.3(B,b)	595.0±9.0(B,c)	611.2±16.6(B,c)	0.00**
G3	229.4±4.0(A,a)	227.5±5.70(A,a)	221.8±5.8(A,a)	217.8±5.0(A,a)	0.44
G4	236.8±2.7(A,a)	235.8±3.2(A,a)	227.4±6.5(A,a)	220.8±3.9(A,a)	0.65
G5	235.6±8.6(A,a)	607.0±22.2(C,b)	411.2±16.7(B,a)	272.60±8.5(A,b)	0.00**
G6	233.0± 2.4(A,a)	624.2± 9.8(C,b)	440.0±16.9(B,b)	353.4±10.4(B,b)	0.00**
G7	225.0±3.9(A,a)	518.6±12.5(C,b)	360.0±3.9(B,b)	265.42±7.2(A,a)	0.00**
P value	0.69	0.00**	0.00**	0.00**	

Discussion

The current study investigates impact of the Baobab on urea level in diabetic rats over 30 days. Results show substantial variations in the urea levels among different groups, suggesting that Baobab's bioactive constituent may impact metabolic pathway connected to the urea production and the clearance, which is crucial for understanding their effects on diabetes (Ahmed et al., 2022).

A previous study found that Baobab treatment, a fruit rich in antioxidants, vitamins, and minerals, may improve kidney function in diabetics (Vertuani et al.,

2022). After 30 days, urea levels declined in most groups, suggesting it may positively impact nitrogen metabolism and kidney function. Baobab's antioxidant properties and anti-inflammatory compounds may mitigate inflammation, while certain compounds in baobab, like polyphenols and fiber, may have reno-protective effects, reducing kidney damage and improving function (Ferdek et al., 2022, Makena et al., 2022). Further research is needed to understand the specific pathways influenced by Baobab treatment.

Table 3 appear the effects of treatments on triglyceride levels in a diabetic model. Alloxan treatment initially increases triglyceride levels due to its toxic effects on pancreatic cells (Rasool et al., 2023). Baobab treatment, a combination of metformin and bioactive compounds, has been shown to lower triglyceride levels in both normal and diabetic models. Baobab and metformin may synergistically reduce triglyceride levels through different mechanisms, such as slowing fat digestion and enhancing insulin sensitivity (Drzewoski et al., 2021; Silva et al., 2023). Combining baobab with metformin may enhance metformin's moderate impact.

A study found that incorporating baobab powder into high-fat diets can lead to significant reductions in blood triglycerides, cholesterol, LDL, and HDL levels, and a decrease in body weight. Baobab's antioxidant and lipid-lowering properties may contribute to its synergistic effect on cholesterol regulation, potentially reducing oxidative stress and lipid imbalances in diabetes (Alnuaimi and Alabdaly, 2023; Barakat, 2021; Elamin et al., 2019). The combination of metformin and baobab interventions significantly reduced cholesterol levels, potentially improving lipid profiles. Baobab's antioxidant and fiber content may also help mitigate oxidative stress and improve cholesterol absorption, ultimately reducing VLDL levels. The study aligns with previous research indicating the therapeutic benefits of plant extracts in reducing serum lipid levels, particularly in addressing atherosclerosis, a common diabetes complication (Osman, 2004; Sahakyan et al., 2022; Suliman et al., 2020). Further research is needed to understand the exact mechanisms and effects on VLDL levels.

A study found that the methanolic extract of *A. digitata* fruit pulp reduces total cholesterol and increases HDL cholesterol levels in diabetic rats. This supports traditional diabetes management and highlights the potential of plant extracts in alleviating diabetes-related complications, particularly concerning atherosclerosis and lipid levels (Deshmukh and Manjalkar, 2021). Baobab fruit can reduce the harmful effects of diabetes by containing powerful antioxidants and can also restore the liver's normal function (Silva et al., 2016). While treatment with metformin causes some elevation in liver enzymes, especially GOT, and this is consistent with what was found in a previous study (Ibrahim et al., 2021).

Conclusion

Baobab plant extract can be used to reduce the harmful effects of diabetes associated with high liver and kidney function enzymes, as well as improving the composition of blood fats compared to metformin. It can be extracted from a good treatment for diabetics to reduce the harmful effects on the liver and kidneys).

Conflict of interest statement

The authors declare that they have no conflict of interest.

Availability of data and materials

The datasets are available from the corresponding author on reasonable request.

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References

Ahmed AM, Khabour OF, Yousuf A, Eweda SM, Mohammed-Saeed W, Daradka HM, Hassanein SF, Ibrahim AM. (2022). The beneficial effect of Adansonia digitata products success to modulate lipid profiles and inhibit LDL oxidation in-vitro: An associational study. Malawi Med J. 34(1): 25-30.

Alabbasi EH, Alabdaly YZ. (2022). Effect of boric acid on sodium fluoride toxicity in chicks. Iraqi Journal of Veterinary Sciences. 36(1): 123-131.

Alnuaimi SI, Alabdaly YZ. (2023). Neurobehavioral toxicity of copper sulfate accompanied by oxidative stress and histopathological alterations in chicks' brain. Iraqi Journal of Veterinary Sciences. 37(1): 53-60.

Barakat H. (2021). Nutritional and rheological characteristics of composite flour substituted with baobab (Adansonia digitata L.) pulp flour for cake manufacturing and organoleptic properties of their prepared cakes. Foods. 10(4): 716.

Chanda S. (2014). Importance of pharmacognostic study of medicinal plants: An overview. J Pharmacogn Phytochem. 2: 69–73.

Deshmukh A, Manjalkar P. (2021) Synergistic effect of micronutrients and metformin in alleviating diabetic nephropathy and cardiovascular dysfunctioning in diabetic rat. Journal of Diabetes & Metabolic Disorders. 20: 533–541.

Drzewoski J, Hanefeld M. (2021). The Current and Potential Therapeutic Use of Metformin-The Good Old Drug. Pharmaceuticals. doi: 10.3390/ph.

Elamin OF, Atti KAA, Dalia AM.(2019). Research Article Effect of Baobab (Adansonia digitata) Pulp Powder on Serum Lipid Profile of Rats Fed High Lipid Diets. Pakistan Journal of Nutrition. 18(11): 1053-1057.

Elsaid FG.(2013) The effect of seeds and fruit pulp of Adansonia digitata L.(Baobab) on ehrlich ascites carcinoma..

Ferdek PE, Jakubowski A, Gerasimenko OV, Gerasimenko JV, Petersen OH. (2022). When healing turns into killing–the pathophysiology of pancreatic and hepatic fibrosis. The Journal of Physiology. 600(11): 2579–2612.

Gharravi AM, et al. (2018) Current status of stem cell therapy, scaffolds for the treatment of diabetes mellitus. Diabetes Metab Syndr. 12(6): 1133–1139.

Ghoneim MA, Hassan AI, Mahmoud MG, Asker MS. (2016). Protective effect of *Adansonia digitata* against isoproterenol-induced myocardial injury in rats. Anim Biotechnol. 27: 84–95.

Ibrahim SI, Nasir AA, Muhammad AU, Usman R, Shehu HA. (2021). Complementary Therapeutic Effect of Polyherbal Supplement (Gasca DTM) on Newly Diagnosed Type 2 Diabetic Patients on Lifestyle Modification: A Randomised Cohort Clinical Trial. Journal of Phytomedicine and Therapeutics. 20(1): 518–528.

Kitcher C, Mireku-Gyimah NA, Bekoe EO, Sarkodie JA, Frimpong-Manso S, Tattah G. (2021). Crude drug analysis and elemental content of the leaves and stem bark of Adansonia digitata L.(Malvaceae), an indigenous Ghanaian medicinal plant. Plant Sci Today.8:264–272.

Kumar S, Dobos GJ, Rampp T. (2017). The significance of ayurvedic medicinal plants. J Evid-Based Complement Altern Med. 22: 494–501.

Makena W, Wanyonyi AW, Owino BO, Muniu EN, Kimwele CN, Oyaro N. (2022) Flavonoids fractions of Adansonia digitata L. fruits protect adult Wistar rats from mercury chloride-induced hepatorenal toxicity: histopathological and biochemical studies. Egyptian Journal of Basic and Applied Sciences. 9(1): 205–215.

Murai Y, Ohta T, Tadaki H, Miyajima K, Shinohara M, Fatchiyah F, Yamada T. (2017). Assessment of Pharmacological Responses to an Anti-diabetic Drug in a New Obese Type 2 Diabetic Rat Model. Med Arch. 71: 380.

Osman MA. (2004). Chemical and nutrient analysis of baobab (*Adansonia digitata*) fruit and seed protein solubility. Plant foods for human nutrition. 59: 29–33.

Rana H, Kumar R, Chopra A, Pundir S, Gautam GK, Kumar G. (2022). The Various Pharmacological Activity of Adansonia digitata. Res J Pharmacol Pharmacodyn. 14: 53–59.

Rasool S, Al Meslmani B, Alajlani M. (2023). Determination of Hypoglycemic, Hypolipidemic and Nephroprotective Effects of Berberis Calliobotrys in Alloxan-Induced Diabetic Rats. Molecules. 28(8): 3533.

Sahakyan G, Vejux A, Sahakyan N. (2022). The role of oxidative stress-mediated inflammation in the development of T2DM-induced diabetic nephropathy: possible preventive action of tannins and other oligomeric polyphenols. Molecules. 27(24): 9035.

Salleh NH, Zulkipli IN, Mohd Yasin H, Ja'afar F, Ahmad N, Wan Ahmad WAN, Ahmad SR. (2021). Systematic review of medicinal plants used for treatment of diabetes in human clinical trials: an ASEAN perspective. Evid Based Complement Alternat Med.

Silva EL, Lobo JFR, Vinther JM, Borges RM, Staerk D. (2016). High-resolution α-glucosidase inhibition profiling combined with HPLC-HRMS-SPE-NMR for identification of antidiabetic compounds in Eremanthus crotonoides (Asteraceae). Molecules. 21: 782.

Silva ML, Oliveira MIB, Pereira PS, Sousa DOB, Amaral LFA, Monteiro BD (2023). *Adansonia digitata* L.(Baobab) Bioactive Compounds, Biological Activities, and the Potential Effect on Glycemia: A Narrative Review. Nutrients. 15(9): 2170.

Suliman HM, Elsafi MAA, Abdelrazig HA, Mabrouk MA, Saad TMB, Mohamed HS. (2020). Ameliorative activity of Adansonia digitata fruit on high sugar/high fat diet-simulated Metabolic Syndrome model in male Wistar rats. Biomedicine & Pharmacotherapy. 125: 109968.

Vertuani S, Braccioli E, Buzzoni V, Manfredini S. (2002). Antioxidant capacity of Adansonia digitata fruit pulp and leaves. Acta phytotherapeutica. 2(5): 2-7.

Vesa CM, Bungau SG. (2023). Novel molecules in diabetes mellitus, dyslipidemia and cardiovascular disease. Int J Mol Sci. p. 4029.

Wise J. (2016). Type 1 diabetes is still linked to lower life expectancy. Br Med J. doi: 10.1136/bmj.i1988

Yu F, Takahashi T, Moriya J, Kawaura K, Yamakawa J, Kusaka K, et al. Traditional (2006). Chinese medicine and Kampo: a review from the distant past for the future. J Int Med Res.34: 231.