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Research Article
Effect of Baobab (*Adansonia digitata*) Pulp Powder on Serum Lipid Profile of Rats Fed High Lipid Diets

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Abstract

Objective: The study investigated the effects of dietary Baobab pulp powder on the serum lipid profile of rats fed high lipid diets. **Materials and Methods:** Twenty-four healthy male Wister albino rats were randomly assigned into three different basal diets of 0, 4 and 8% of Baobab powder. The basal diet was a high lipid diet contain 15 g egg yolk+45 g beef burger. **Results:** The Inclusion of 4 and 8% of baobab powder into the high lipid diets resulted in a significant ($p>0.001$) decrease of serum triglyceride, cholesterol, LDL and HDL levels compared to control group. Baobab powder resulted in a significant ($p>0.001$) reduction in the rat's body weight compared to the control group. **Conclusion:** In conclusion, dietary Baobab pulp powder as a natural photochemical antioxidant had a beneficial effect on the serum lipid profile of rats.

Key words: Baobab pulp, body weight, high lipid diet, hyperlipidemic rats, lipid profile

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Baobab (*Adansonia digitata*), is a well-known tree. The habitat of this tree is the hot, dryer regions of tropical Africa and it extends from Northern Transvaal and Namibia to Ethiopia, Sudan and Southern Fringes of Sahara[1,2]. Fruits are capsules, ellipsoid or globular of 20-30 cm long and up to 10 cm in diameter. The outside covered with greenish-brown felted hair. This shell contains numerous hard brownish seeds rounded or avoid, which are embedded in a yellowish-white floury acidic pulp. The brown seeds are arranged in rows in two to eight lobules per fruit. The seeds are attached to fibrous stands on the wall of the fruit[3]. The composition of the dry fruit pulp was reported as 2-2.6% protein, 7% ash, 0.2% fat, 9% fiber and 81% carbohydrates[3]. The baobab fruit pulp contains appreciable amounts of calcium (670 ppm) and consider a rich source of potassium and vitamin C[4].

The baobab has been used extensively since ancient times in traditional medicine, baobab bark is mainly used for its medicinal properties and its fibers[5]. The pulp is commonly used Among Hausa-Fulani in preparing plant made local yoghurt or as an additive to traditional yoghurt offered for sale by Fulani women. The study in Nigeria reported that feeding on high lipid diet induces hyperlipidemia and or dyslipidemia and the simultaneous feeding of the hyperlipidemic rats with the high-fat diet and aqueous extract of A. digitata may suppress the hyperlipidemic condition[2]. Therefore, the present study was designed to assess the effect of Baobab (*Adansonia digitata*) pulp powder as a natural antioxidant on the serum cholesterol, triglyceride, Low-density Lipoprotein (LDL) and High-density Lipoprotein (HDL) of rats fed high lipids diets.

MATERIALS AND METHODS

Preparation of fruit pulp baobab powder: The fruit of Adensonia digitata was collected from the local market. The collected fruit pulp was finely ground into powder form by using pestle and mortar. The seeds were separated from the pulp using a mesh. The fineness of the powdered pulp was achieved by sieving through a clean white muslin cloth allowing the fiber to be completely removed. The powder was stored in a clean air-tight plastic container at room temperature until use.

The proximate analysis of Baobab pulp powder (*Adansonia digitata*): Moisture, crude protein, fat, ash, crude fiber and mineral content of the baobab fruit pulp were determined according to AOAC[6] methods. Metabolizable energy values were calculated according to the following equation:

ME = 1.549+0.0102 CP+0.0275EE+0.0148NEE-0.0034 CF

Experimental animals: The experiment was carried out in a Research laboratory, Faculty of Veterinary Medicine, University of Khartoum. A total of twenty-four Wister albino male rats of 2- 2½ month old and 65±10 g body weight were used in this study. The animals were housed in well-ventilated cages. The rats were allotted randomly into three groups, 8 animals/group. Each group was divided into four sub-groups as replicates with two animals/cage. The rats had free access to food and water.

Experimental diets: Ingredients of the experimental diets were purchased from the local market. The basal diet composition includes wheat bran, maize corn, meat, NaCl, Dicalcium phosphate and premix (Table 1). The basal diet was formulated to meet the essential nutrients for rats according to NRC[7]. The basal diet was modified to be a high lipid diet by inclusion of 15 g egg yolk and 45 g beef burger as a lipid source. The experimental dietary treatments were as follow:

- **Treatment A:** High lipid basal diet supplemented with 0% of Baobab pulp powder (*Adansonia digitata*)
- **Treatment B:** High lipid basal diet supplemented with 4% of Baobab pulp powder (*Adansonia digitata*)
- **The treatment C:** High lipid basal diet supplemented with 8% of Baobab pulp powder (*Adansonia digitata*)

Blood sampling: Blood samples were collected at the end of the second week and the end of the experiment. Blood samples were taken from the orbital plexus of rats by the mean of capillary glass tubes. According to methods of Khanna *et al.*[8] blood was allowed to clot at room temperature for 20 min and serum was separated by centrifugation. Clear

Table 1: Ingredient composition of the basal diet (%)

Ingredients	A	B	C
Baobab level	0	4	8
Wheat flour	63	60	57
Corn (maize)	31	30	29
Meat	3.5	3.5	3.5
Premix*	0.5	0.5	0.5
Dicalcium phosphate	1.5	1.5	1.5
Salt	0.5	0.5	0.5
Total	100	100	100
CP	20.22	19.87	19.96
FAT	12.99	12.09	12.13
ME	2.279491	2.258555	2.23553

* Vit. A: 15000 IU, Vit. D3: 15000 IU, Vit. E: 2 mg, Riboflavin: 2.5 mg, Calcium D-pantothenate: 5.5 mg, Nicotin amid: 10 mg, Pyridosine HCl: 3 mg, Thiamine HCl: 2 mg, Vit. B12: 5 mg, Folic acid: 2 mg. ME: Calculated according to equation. Where ME = 1.549+0.0102 CP+0.0275EE+0.0148NEE-0.0034 CF

serum was stored at -20°C for cholesterol, triglyceride, low-density lipoprotein, high-density lipoprotein determination.

Serum lipid profile: Serum cholesterol, triglyceride, low-density lipoprotein, high-density lipoprotein, were determined by an analytical method using reagent (Roche digagnostic/Hitachi 902 analyzer) according to the description of Allain *et al.*[9].

Statistical analysis: A complete randomized design was used in this study, with three treatments of experimental diets. The data obtained from the experiment were subjected to analysis of variance of means according to SPSS program version 21 using Windows 7 Ultimate.

RESULTS

The proximate composition of the pulp of baobab: The proximate compositions of baobab fruit pulp are shown in Table 2. The baobab fruit pulp contains low protein (2.98 %), extremely low fat (0.3 %) and high content of NEF (72.47 %). The fiber content and ash were about 7.75 and 5.25% respectively.

Experimental rat's body weight: Table 3 shows the effect of dietary baobab powder on the rat's body weight at the end of the experiment. The inclusion of baobab powder into high lipid diets showed significant ($p>0.001$) effect on the rat's body weight. The control group of hyperlipidemic rats (A), showed the highest ($p<0.001$) body weight compared to baobab treated groups. However, the diet containing 8% baobab powder showed lower body weight compared to the diet of 4% and control group. Moreover, the body weight gains in the group B and C were lower than the group A, which indicates the ability of baobab powder to reduce and control the body weight.

Serum lipid profile: The serum lipid profile of rat's fed baobab powder for two weeks is shown in Table 4. There was significant ($p\leq0.01$) difference among experimented groups. Inclusion of 4 and 8% of baobab powder into the high lipid diets resulted in a significant decrease in serum triglyceride, cholesterol, LDL and HDL levels compared to the control group. In terms of baobab level, the data showed that inclusion of 8% of baobab powder in the rats' diet reduced the serum TG, CHOL, LDL and HDL levels more than 4%.

Table 5 shows the effect of baobab powder on the rat's serum lipid profile after four weeks of dietary supplementation.

Table 2: Proximate analysis powder of Baobab (*Adansonia digitata*)

Constitute	Percentage
DM	88.75
Fa%	0.3
CP	2.98
CF	7.75
Ash	5.25
NFE	72.47
ME*	2,961.66

ME: Calculated according to equation. Where ME = 1.549+0.0102 CP+0.0275EE +0.0148NEE-0.0034 CF

Table 3: Body weight of rats fed high lipid diets treated with Baobab powder (*Adansonia digitata*)

Parameters (g)	A (0%)	B (4%)	C (8%)	SEM
Initial weight	66.25^{a}	64.37^{a}	62.75^{a}	4.34
Final weight	142.125^{a}	131.71^{a}	116.5^{b}	6.93
Gain	75.875^{a}	67.34^{ab}	53.75^{b}	5.09

^{a,b,c}Means having different superscript along the same row are significantly different ($p>0.05$), SEM: Standard error of the mean, Group A: High lipid diet and 0% of baobab (*Adansonia digitata*), Group B: High lipid diet and 4% of baobab (*Adansonia digitata*), Group C: High lipid dietand 8% of baobab (*Adansonia digitata*)

Table 4: The effect of dietary Baobab *(Adansonia digitata*) on serum Lipid profile of rats at the second weeks of experiment

Treatments	A	B	C	±SEM
Triglyceride	202.50^{a}	158.33^{b}	125.50^{c}	15.38
Cholesterol	71.50^{a}	39.00^{b}	32.75^{c}	6.11
Low density lipoprotein	23.750^{a}	15.00^{b}	11.50^{c}	2.25
High density lipoprotein	119.75^{a}	97.33^{b}	67.00^{c}	5.28

^{a,b,c}Means having different superscript along the same row are significantly different ($p>0.05$), SEM: Standard error of the mean, Group A: High lipid diet and 0% of baobab (*Adansonia digitata*), Group B: High lipid diet and 4% of baobab (*Adansonia digitata*), Group C: High lipid diet and 8 %of baobab (*Adansonia digitata*)

Table 5: The effect of dietary Baobab *(Adansonia digitata*) on serum Lipid profile of rats after 4 weeks

Treatments	A	B	C	±SEM
Triglyceride	214.500^{a}	171.750^{b}	124.250^{c}	12.06
Cholesterol	76.750^{a}	70.000^{b}	64.000^{b}	0.92
Low Density lipoprotein	12.750^{a}	8.250^{b}	4.250^{b}	0.34
High Density lipoprotein	121.500^{a}	97.000^{b}	65.750^{c}	3.55

^{a,b,c}Means having different superscript along the same row are significantly different ($p>0.05$), SEM: Standard error of the mean, Group A: High lipid diet and 0% of baobab (*Adansonia digitata*), Group B: High lipid diet and 4% of baobab (*Adansonia digitata*), Group C: High lipid diet and 8 %of baobab (*Adansonia digitata*)

Both levels of baobab powder in the high lipid diet caused significant ($p\leq0.01$) reduction in the serum lipid parameters compared to the free baobab diet. The inclusion of a high percentage of baobab powder (8%) into the diet reduced the TG and HDL significantly than the 4% level, however, both levels showed no difference in the rat's serum CHOL and LDL.

DISCUSSIONS

The current study is conducted to evaluate the potential hypolipidemic activity of different levels of baobab fruit powder (*Adansonia digitata*) in induced hyperlipidemic rats fed a high-fat diet. The inducement of hyperlipidemia was evident by the differences in serum lipid profile indices between groups, in which they show significantly higher lipid profile indices compared to the former due to the intake of high lipid diets. This was well stated by Austin[10], who lamented that hyperlipidemic condition is presented with elevated serum total cholesterol, low-density lipoprotein, very low-density lipoprotein (LDL) cholesterol, or elevated hypertriglyceridemia. It is well documented that hypertriglyceridemia and hypercholesterolemia may be responsible for oxidative stress with spare production of free radicals and lipid peroxidation products[11], which represent major risk factors for ischemic heart diseases[12].

The current study revealed that baobab fruit pulp contains low protein, extremely low fat and high content of NEF. According to Osman[13], the baobab fruit pulp contains a high amount of carbohydrate (76.2), low protein (8.2) and extremely low fat (0.3), which is supported the finding of current study. A similar finding of baobab fruit proximate analysis was obtained by Nour *et al*.[3] This plant was known to have many proven biological activities with very valuable nutritional capabilities. The inclusion of baobab powder into high lipid diets showed lower body weight compared to the control group. Moreover, the body weight gains were lower than the hyperlipidemic group, which indicates the ability of baobab powder to control body weight. The ability of baobab powder in controlling the body weight may be due to lower accumulation of lipid in the rats.

In the present study, Inclusion of 4 and 8% of baobab powder into the high lipid diets resulted in a significant decrease of serum TG, CHOL, LDL and HDL levels compared to the control group. The inclusion of a high percentage of baobab powder (8%) into the diet reduced the TG and HDL significantly than the 4% level, however, both levels showed no difference in the rat's serum CHOL and LDL. This may be due to the anti-serum hyperlipidemic activity of the plant which was comparable with the pharmaceutical agent (atorvastatin), the effect could be due to some photochemical content of the Baobab powder that may influence lipids metabolism resulted in effect in the serum lipids profile. This finding is in agreement with the results of Nawar *et al*.[14] who reported that the *Adansonia digitata* suitable to be used as natural hypolipidemic agent, his data showed that, the high and low doses of baobab powder ethanolic extract was significantly decreased total serum cholesterol, triglycerides and LDL. The ability of baobab to reduce the hyperlipidemia may be due to the presence of pectin fiber, which is fermented in the colon. Pectin may help lower plasma and liver cholesterol, triglycerides and LDL either by inhibition of cholesterol and bile acid absorption or due to increased excretion of this natural and acidic sterols[15].

The decreased serum cholesterol in the groups of rats treated with powder might be due to increased activity of enzyme lecithin cholesterol acyltransferase involved in the desertification of cholesterol in the plasma[16]. The significant decrease in serum triglycerides (TG) could be due to decreased accumulation of lipoprotein that involved in the uptake of TG by extrahepatic tissue. These findings conclude that *Adansonia digitata* is an effective anti-hyperlipidemic agent.

CONCLUSION

Dietary lipids increase the levels of serum cholesterol, triglyceride, Low-density lipoprotein and high-density lipoprotein in rats. Dietary powder of Baobab (*Adansonia digitata*) appeared to decrease serum cholesterol, triglyceride and Low-density lipoprotein in and induced hyperlipidemic rats and decrease high-density lipoprotein. Powder of Baobab (*Adansonia digitata*) maybe uses as food additives for humans to reduce the risk of heart disease and atherosclerosis.

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