



Effect of Oral Intake of African Locust Bean on Fasting Blood Sugar and Lipid Profile of Albino Rats

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Authors' contributions

This work was carried out in collaboration among all authors. Author AIA designed the study, performed the statistical analysis and wrote the draft of the manuscript. Author EOA managed the analyses of the study. Authors EOO and UO managed the literature searches while author EUO wrote the protocol of the study. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJRB/2019/v4i430073

Editor(s):

(1) Dr. Khadiga Mohamed Abu-Zied, Professor, Department of Photochemistry, National Research Centre, Cairo, Egypt.

Reviewers:

(1) Dr. K. D. Mini, Mahatma Gandhi University, India.

(2) Moise Adela Ramona, University of Agricultural Science and Veterinary Medicine Cluj Napoca, Romania.

Complete Peer review History: <http://www.sdiarticle3.com/review-history/49210>

Original Research Article

Received 06 March 2019

Accepted 14 May 2019

Published 21 May 2019

ABSTRACT

Background: African locust bean is a condiment believed to be for the people of low class. Its health importance has not been fully known especially to the so-called high class.

Aim: This study is aimed at investigating the effect of African locust bean on fasting blood sugar and lipid profile of albino rats.

Methods: African locust bean (ALB) was purchased from a local market at Orita-Challenge area of Ibadan, Nigeria. They were sun dried and milled into powder using an electronic blender. The powder was extracted with n-hexane (40–60°C) in a soxlet extractor for 18 hours. The defatted, dried marc was repacked and then extracted with methanol. The dried marc was extracted with methanol in the soxlet apparatus for 10 hours. The methanol solution was subsequently concentrated in a rotatory evaporator at 40°C. Ten adult male albino rats with body weight between 100 and 120 g were purchased from the Animal Holding Unit of the Department of Physiology,

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University of Ibadan, Nigeria. They were allowed 7 days acclimatization period and were divided randomly into 2 groups of five rats each. Animals in group 1 were administered normal saline solution while those in group 2 were administered extract of African locust bean. The animals were exposed to the African Locust Bean and saline solution at a dose of 3 ml per 100 g body weight 12 hourly via oral route of administration. After fourteen days of administration, the animals were fasted overnight and anaesthetized using diethyl ether. Blood samples were collected by cardiac puncture.

Results: ALB was observed to significantly lower fasting blood sugar, total cholesterol and triglyceride but increased HDL-cholesterol significantly when compared to those of the control group at $p < 0.05$. LDL-cholesterol was not significantly different when animals treated with ALB were compared with those of the control group.

Conclusion: Increased blood sugar and hyperlipidemia has been implicated in diabetes. Cholesterologenesis is a major onset of atherosclerosis and subsequent cardiovascular diseases. Therefore, ALB can serve as prophylaxis and remedies for several diseases caused by hyperglycemia and hyperlipidemia such as diabetes and coronary heart disease.

Keywords: African locust bean; fasting blood sugar; lipid profile; diabetes; atherosclerosis.

1. INTRODUCTION

Africa locust bean (*Parkia biglobosa*) belongs to the family Fabaceae – pea family, of the order Fabaceae. It is popularly known as 'iru' by the Yorubas, 'Dorawa' by the Hausas and 'Origili' by the Ibos. The fermented seeds of African locust bean (ALB) are used in all parts of Nigeria and indeed the west coast of Africa for seasoning traditional soups. The yellow pulp is a high energy giving food with up to 60% sugar [1]. The trees are often grown as shade trees. *Parkia* species have found use traditionally as food and medicinal agent. The bark is employed in wound healing, treatment of bronchitis, pneumonia, skin infection, gores, ulcer, bilharziasis, malaria, diarrhea and hypertension. In Gambia, the leaves and roots are used in preparing a lotion for sore eyes. A decoction of the bark of *P. biglobosa* is also used as a bath for fever and as a hot mouth washes to steam and relieve toothache. The pulped bark used along with lemon for wound and ulcer. Fibres from pods and root are used as sponges and as string for musical instrument [1]. The powdered pods are used to paint traditional Hausa buildings in northern Nigeria. *Parkia* plants have been identified as source of tannin, saponins, gum, fuel and wood. Seeds of various species of *Parkia* have also been investigated for their protein and mineral content [2].

Lipids may be broadly defined as hydrophobic or amphiphilic small molecules; the amphiphilic nature of some lipids allows them to form structures such as vesicles, liposomes, or membranes in an aqueous environment [3]. Lipids are a large and diverse group of naturally occurring organic compounds that are related by

their solubility in nonpolar organic solvents (e.g. ether, chloroform, acetone & benzene) and general insolubility in water [4]. They constitute a group of naturally occurring molecules that include fats, waxes, sterols, fat-soluble vitamins (such as vitamins A, D, E, and K), monoglycerides, diglycerides, triglycerides, phospholipids, etc. [5]. Although the term lipid is sometimes used as a synonym for fats, fats are a subgroup of lipids called triglycerides [6]. Lipids also encompass molecules such as fatty acids and their derivatives (including tri-, di-, monoglycerides, and phospholipids), as well as other sterol-containing metabolites such as cholesterol [7]. Although humans and other mammals use various biosynthetic pathways to synthesize and break down lipids, some essential lipids cannot be made this way and must be obtained from the diet [8]. Lipids have been reported to have several roles in the body [9].

2. MATERIALS AND METHODS

2.1 Sample Preparation

African locust bean (ALB) was purchased from a local market at Orita-Challenge area of Ibadan, Nigeria. They were sun dried and milled into powder using an electronic blender (Moulinex). The powder was extracted according to the method described by Odetola et al. [10]. 2.5 kg powder of ALB was extracted with n-hexane (boiling point 40–60°C) in a soxhlet extractor (Sri Rudram Instrument, Chennai, India) for 18 hours. The defatted, dried sample was repacked and then extracted with methanol. Briefly, the dried marc was extracted with methanol in the soxhlet apparatus for 10 hours. The methanol solution

was subsequently concentrated in a rotatory evaporator at 40°C.

2.2 Animal Treatment

Ten adult male albino rats (*Rattus norvegicus*) with body weight between 100 and 120 g were purchased from the Animal Holding Unit of the Department of Physiology, University of Ibadan, Nigeria. They were housed in Imrat animal house, Ibadan. They were acclimatized for seven (7) days during which they were fed *ad libitum* with standard feed and drinking water and were housed in clean cages placed in well-ventilated housing conditions (under humid tropical conditions) throughout the experiment. They were randomly divided into two groups of five rats each. Animals in group 1 were administered normal saline solution while those in group 2 were administered African Locust Bean extract. The animals were exposed to the extract and saline solution at a dose of 3 ml per 100 g body weight 12 hourly via oral route of administration. After fourteen days of administration, the animals were fasted overnight and anaesthetized using diethyl ether. Blood samples were collected by cardiac puncture.

2.3 Determination of Fasting Blood Sugar

After the acclimatization period, animals used in this study were allowed to fast for twelve (12) hours before the administration of African locust bean and saline solution to groups 1 and 2 respectively. The blood glucose level were taken by sterilizing their tails with 10% alcohol, and cutting the tails using scissors then allowing the blood to touch the test strip which was inserted into a calibrated glucose meter (One touch Glucometer, Acon Laboratory INC. San Diego, USA). This gave direct reading after 5 seconds in mg/dL. The blood glucose level of the rats before the administration of locust bean was measured in order to know the normal blood glucose of the rats in each group. After the administration of locust bean on the last day, all the rats in the groups were fasted again for 12 hours and their fasting blood sugar was determined using glucose meter. This was done in order to check and observe the effect of ALB on blood glucose level when compared to their initial glucose level (before the administration).

2.4 Determination of Lipids

Lipids were determined by previously described methods [11,12].

2.5 Statistical Analysis

Data were subjected to analysis of variance using Graph Pad Prism. Results were presented as Mean \pm Standard Error of the Mean (SEM). 2-tailed t-test was used for comparison of the means. Differences between means was considered to be significant at $p < 0.05$.

3. RESULTS AND DISCUSSION

Diabetes mellitus (commonly called diabetes) is a group of metabolic disorders characterized by high blood sugar levels over a prolonged period [13]. Symptoms of high blood sugar include frequent urination, increased thirst, and increased hunger [14]. If left untreated, diabetes can cause many complications [14]. Acute complications can include diabetic ketoacidosis, hyperosmolar hyperglycemic state, or death [15]. Serious long-term complications include cardiovascular disease, stroke, chronic kidney disease, foot ulcers, and damage to the eyes [14]. Diabetes is due to either the pancreas not producing enough insulin, or the cells of the body not responding properly to the insulin produced [16]. An abnormal increase in glucose has been associated with hyperlipidemia in both clinical and experimental diabetes [17].

One major finding of this study was that ALB indeed unhinged and perturbed the concentrations of fasting blood sugar and lipids in the animals used. These perturbations were reflected as up/down regulation of the concentrations of these metabolites.

In this study, no significant difference was observed in the fasting blood sugar when animals in the ALB group were compared with those of control group prior to treatment (Fig. 1). After fourteen days of treatment, animals treated with ALB had significantly lowered fasting blood sugar when compared with control and pretreated groups (Figs. 2 and 3). This suggests that ALB may have an extrapancreatic anti-hyperglycemic mechanism of action. This is in agreement with the earlier suggestion of Jackson and Bressler [18]. A number of other plants and extracts have also been reported to have an anti-hyperglycemic and an insulin-stimulatory effect. [19,20,21]. Most of the plants with hypoglycemic properties have been found to contain metabolites such as glycosides, alkaloid, flavonoids etc. [22]. Chemical investigation of ALB has shown that they contain cardiac glycosides and alkaloids [23]. These chemical

substances may then be responsible for the hypoglycemic effect of ALB observed in this study.

Apart from the regulation of carbohydrate metabolism, insulin plays an important role in lipid metabolism. Insulin insufficiency, as in diabetes mellitus, is associated with hypercholesterolemia and hypertriglyceridemia, which have been reported to occur in

experimental diabetic rats [24,25,26]. Hypercholesterolemia could result in a relative molecular ordering of the residual phospholipids, resulting in a decrease in membrane fluidity [27]. Accumulation of triglycerides is one of the leading risk factors in coronary heart disease (CHD). Lipid and lipoprotein abnormalities have been shown to play a major role in the pathogenesis and progression of several disease conditions [28].

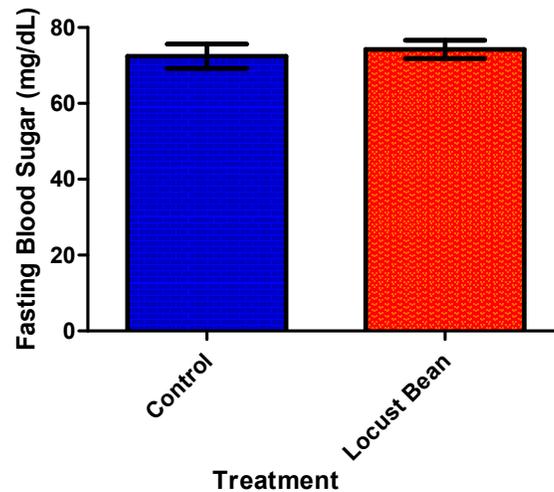


Fig. 1. Fasting blood sugar of animals before treatment
Results are presented as mean±SEM with n = 5

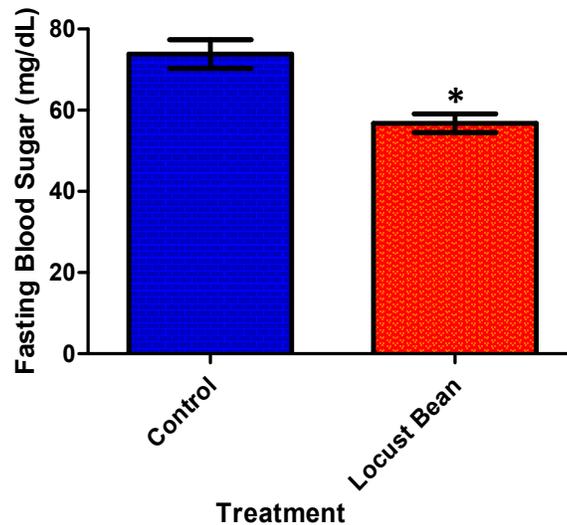


Fig. 2. Fasting blood sugar after 14 days treatment
Results are presented as mean ± SEM with n = 5. The significant difference between the African locust bean-treated animals and control group at $p < 0.05$ is represented by *

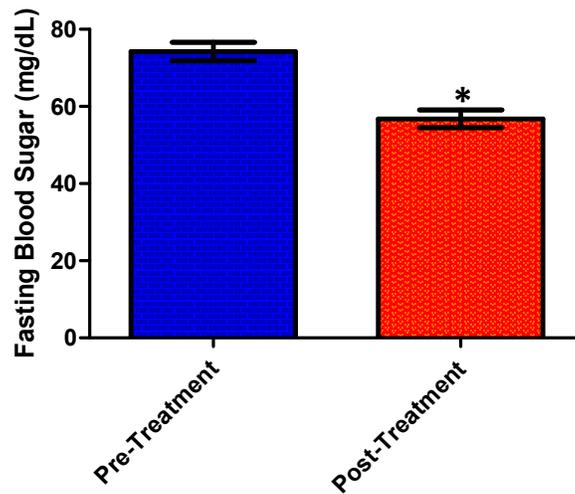


Fig. 3. Effect of African locust bean administration on the fasting blood sugar of animals after 14 Days

Results are presented as mean \pm SEM with $n = 5$. The significant difference between the African locust bean-treated animals and control group at $p < 0.05$ is represented by*

In this study, total cholesterol and triglycerides concentrations were observed to decrease significantly when animals treated with ALB were compared with those of the control group at $p < 0.05$ (Fig. 4 and 7 respectively). This could be that ALB may prevent the progression of CHD. Despite the availability of known anti-diabetic medications, remedies from medicinal plants are used with increasing success to treat this disease and manage its complications better [29]. Furthermore, it has been suggested that plant drugs and herbal formulations are less toxic and are free from side-effects compared with synthetic drugs, leading to an increasing preference for traditional plants over synthetic drugs [30,31,32,33]. Increased evidence of therapeutic effectiveness of herbal medicines may have influenced the interest of the WHO in hypoglycemic agents of plant origin used in the traditional treatment of diabetes [16].

HDL-Cholesterol and LDL-Cholesterol are two of the four main groups of plasma lipoproteins that are involved in lipid metabolism and the exchange of cholesterol, cholesterol ester and triglycerides between tissues [34,35]. Numerous population studies have shown an inverse correlation between plasma HDL-cholesterol levels and risk of cardiovascular disease, implying that factors associated with HDL-cholesterol protect against atherosclerosis. Some of these factors appear to have antioxidant and anti-inflammatory effects which may obviate processes that initiate atherogenesis [36,37].

Epidemiological studies have also shown that elevated concentrations of total cholesterol and/or LDL-cholesterol in the blood are powerful risk factors for coronary heart disease [38]. Most extra-hepatic tissues, although having a requirement for cholesterol, have low activity of the cholesterol biosynthetic pathway. Their cholesterol requirements are supplied by LDL, which is internalized by receptor-mediated endocytosis. A major function of HDL-cholesterol is to enhance reverse cholesterol transport by scavenging excess cholesterol from peripheral tissues followed by esterification through lecithin: cholesterolacyltransferase and delivering it to the liver and steroidogenic organs for subsequent synthesis of bile acids and lipoproteins and eventual elimination from the body [39,40]. This role of HDL-cholesterol has been shown to be responsible for its atheroprotective properties. HDL-cholesterol also regulates the exchange of proteins and lipids between various lipoproteins. In addition, HDL-cholesterol provides the protein components required to activate lipoprotein lipase which releases fatty acids that can be oxidized by the β -oxidation pathway to release energy [34,35]. Most importantly, HDL-cholesterol can inhibit oxidation of LDL-cholesterol as well as the atherogenic effects of oxidized LDL-cholesterol by virtue of its antioxidant property [40].

Interestingly, in this study, ALB administration caused a significant increase in the serum level of HDL-Cholesterol when compared with control

animals (Fig. 5). HDL-Cholesterol is usually referred to as the 'good cholesterol' [11]. Again, ALB administration decreased the concentration of LDL-Cholesterol (bad cholesterol) when compared with that of the control group at $p < 0.05$ (Fig. 6). The combined effect of increased HDL-Cholesterol ('good cholesterol') and decreased LDL-Cholesterol ('bad cholesterol') resulted in an increased HDL-C/LDL-C ratio in animals treated with ALB when compared with the control group. This strongly supports the

notion that dietary supplementation with the extract of ALB can lead to a reduction in the risk of developing heart diseases, because a high HDL-C/LDL-C ratio has been shown to be beneficial and is indicative of a lower risk of CHD [41]. Although, the activities of enzymes were not investigated in this study, but it is possible that ALB decreases the activity of 3-hydroxy-3-methylglutaryl coenzyme A (HMG CoA) reductase (the rate-limiting enzyme in cholesterol biosynthesis) [12].

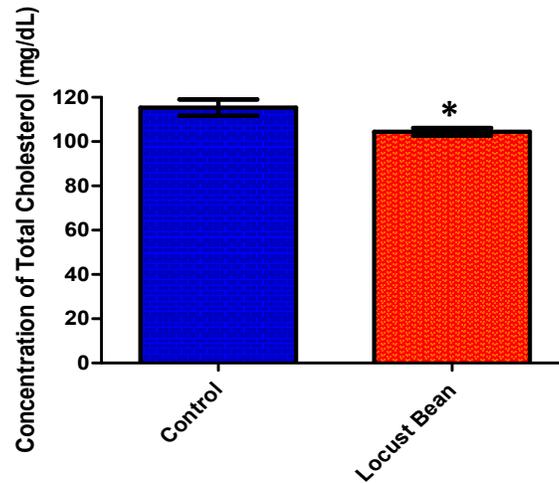


Fig. 4. Effect of African Locust bean administration on the total cholesterol of animals after 14 days

Results are presented as mean \pm SEM with $n = 5$. The significant difference between the African locust bean-treated animals and control group at $p < 0.05$ is represented by *

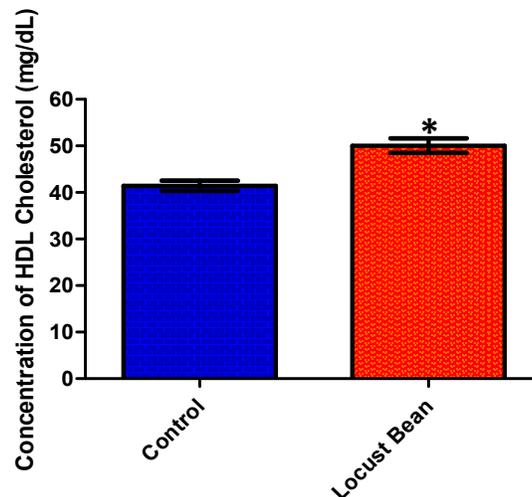


Fig. 5. Effect of African locust bean administration on the HDL-cholesterol of animals after 14 days

Results are presented as mean \pm SEM with $n = 5$. The significant difference between the African locust bean-treated animals and control group at $p < 0.05$ is represented by *

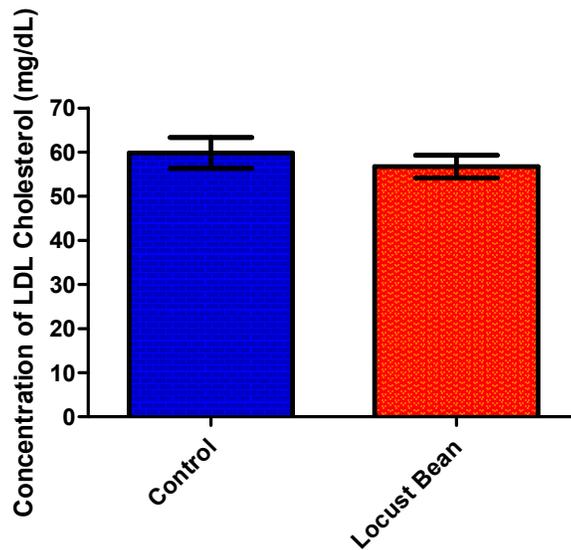


Fig. 6. Effect of African locust bean administration on the LDL cholesterol of animals after 14 days

Results are presented as mean \pm SEM with $n = 5$. The significant difference between the African locust bean-treated animals and control group at $p < 0.05$ is represented by *

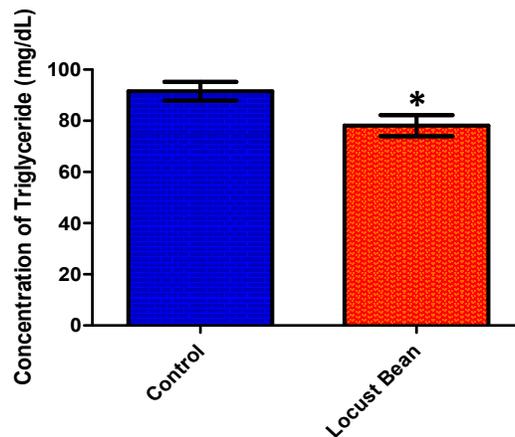


Fig. 7. Effect of African Locust Bean administration on the triglyceride level of animals after 14 days

Results are presented as mean \pm SEM with $n = 5$. The significant difference between the African locust bean-treated animals and control group at $p < 0.05$ is represented by *

4. CONCLUSION

African locust bean positively perturbed and unhinged fasting blood sugar and lipid profile in this study. Therefore, it can serve as prophylactic and remedies for several diseases caused by hyperglycemia and hyperlipidemia. Specifically, diabetic patients should consumed more of African locust bean to reduce their blood sugar level. Even non-diabetic individuals should also consume it for prevention of diabetes and other coronary heart diseases.

ETHICAL APPROVAL

As per international standard or university standard written ethical approval has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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