

## Investigation into the Lipidemic Potential of *Musa paradisiaca* (Plantain) Stem Juice in Alloxan Induced Diabetic Wistar Rats

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**Abstract**—The lipids including fats and oil are the integral part of living matter. Lipids primarily function as an energy reserve. Fats are packed together tightly without water and store for greater amount of energy in a reduced space. These fats when in excess in the body are converted to glucose by means of gluconeogenesis. Hence, this glucose can lead to diabetes if the patient has insulin problem, either because insulin production is inadequate or the body's cell do not respond properly to insulin or both. Typically, we see a progression from obesity to insulin resistance, from the insulin resistance syndrome and finally to diabetes. With regards to the high increase rate of people with diabetes and the claim by traditional medicine practitioners that plantain stem juice has beneficial effect against this health problem, this research work is carried out to ascertain the claim or otherwise, since there is a relationship between level of lipids in vivo and health problem, diabetes. This research work shows the significant positive effects of plantain stem juice on the lipids profile of the subjects which suggest that it has high hypolipidemic potential.

**Keywords**—Lipids; Fats & Oils; Diabetes; *Musa paradisiaca*; Stem juice; Rats.

### I. INTRODUCTION

Care of a person's health is significant in determining his/her length of existence as a human being. Estimation indicates that health and medical care contribute several years of life expectancy [1]. Lipids are naturally occurring molecules from plants and animals that are soluble in non polar organic solvents [2]. The lipids including fats and oil are the integral part of living matter. Triglycerides control the body's internal climate, maintaining constant temperature. They help the body produce and regulate hormones; fatty acids are required for proper reproductive health. Fats play important functional roles in sustaining nerve impulse transmission, memory storage and tissue structure; vital organs such as heart, kidney and liver are protected by visceral fat; the composition of the brain is outstanding 60 percent fats, demonstrating the major structural role that fat serves within the body [3]. The dietary fats in the food we eat break down in our digestive system. These fats when in excess in the body are converted to glucose by means of gluconeogenesis. Diabetes often referred to as diabetes mellitus, describes a group of metabolic disorder in which the person has high blood glucose (blood sugar) either because insulin production is inadequate or the body's cells do not respond properly to insulin or both. Diabetes is a long term condition that causes high blood sugar levels, and patients with high blood sugar will typically experience polyuria (frequent urination). They become increasingly thirsty (polydipsia) and hungry (polyphagia) [4]. Over the last few

decades, the role of medicinal plants as a primary tool in preservation of health and management of diseases are realized with great concern [5]. This is mainly due to the use of synthetic drug molecules that produces harmful side effect which are comparatively minimal in drugs of plant origin. The term medicinal plants include various types of plants used in herbalism, and some of these plants have medicinal activities. These medicinal plants are considered as rich sources of ingredients which can be used in drug synthesis [6]. Medicinal plants continue to be important therapeutic aid for alleviating ailments of human kind. Over the last 2500 years, there have been very strong traditional systems of medicines, such as Chinese practiced more in the eastern continent. These traditions are still flourishing since approximately 80 percent of the people in the developing countries rely on these systems of herbal medicine for their primary health care needs [7]. Plants that possess therapeutic properties or exert beneficial pharmacological effects on the human body are generally designated as medicinal plants. Medicinal plants naturally synthesize and accumulate some secondary metabolites like alkaloids, sterols, terpenes, flavonoids, saponins, glycosides, cyanogenics, tannins, resins, lactones, guinines, volatile oil etc. [8].

Nigerian medicinal plants are known to contain a large variety of phytochemical components in the search for potential new drugs against the illness. Inadequate production and knowledge of the medicinal uses of plantain stem juice and cultural attitudes toward certain

medicinal plants such as plantain stem juice has resulted to underutilization in our local society [9].

This study is aimed at evaluating the hypolipidemic potential of *Musa paradisiaca* stem juice on induced diabetic albino rats grown in their natural environment in Idah, Kogi State.

#### **Description of Plantain:**

*Musa paradisiaca* (Plantain) is a large perennial herbaceous plant that originated in Southeast Asia [10]. Existing in the world are 68 species and two primary hybrids of plantain. In the family of plantain *Musaceae* includes bananas (*Musa sapientum* and *Musa cavendishii*) which has the same growth pattern as plantain, but are differentiated from one another by stem and leaf color, fruit shape and storage of nutritional elements of which in the fruit (finger) of plantain it is carbohydrate, while in banana it is sugar [11].

#### **Taxonomy Classification of Plantain Plant:**

Kingdom: Plantae

Division: Magnoliophyta

Class: Liliopsida

Order Zingiberales

Family Musaceae

Genus *Musa*

Species: *Musa paradisiaca* [12].

#### **Production System of Musa Specie in Nigeria:**

In this system, plantain is planted alongside cocoa (*Theobroma cacao*), where it serves as nurse crop during the early stages of development. This is common in the Western states of Nigeria and in the Ikom area of Cross River state, where cocoa is an important cash crop. In most instances, plantain production increases with expansion of the cocoa plantation. This system is expected to expand with the recent cocoa rehabilitation program being embarked on by the government [13].

## **II. RELATED WORK**

In the last decade, special attention has been paid to the potential of extracts derived from different parts of the plantain plant in supporting the management of both type one [14] and type two diabetes mellitus [15]. Each part of *Musa* plant has several medicinal properties. The core of the stem is believed to be useful in stomach upset and diabetes. The extract of core of the stem is considered to be useful in dissolving the stones in the kidney and urinary bladder and reducing the weight. The flower of this plant is used to treat ulcers, dysentery, and bronchitis and cooked flowers are good food for diabetics. The sap is used to treat variety of ailments including leprosy and also used to treat insect bites [16].

The fruit of *M. paradisiaca* is traditionally used in diarrhoea (unripe), dysentery, intestinal lesions in ulcerative colitis, diabetes (unripe), in sprue, uremia, nephritis, gout, hypertension, cardiac disease [17].

The fruit of *M. paradisiaca* has a mild laxative property, It is used as a remedy for constipation in children, It is believed to be helpful in curing diarrhea and dysentery, the fruit is used to heal the intestine lesions, it forms the part of diets of children suffering from malnutrition, the core of the stem is believed to be useful in stomach upset and diabetes, the extract of core of the stem is considered to be useful in dissolving the stones in the kidney and urinary bladder and reducing weight. The inflorescence mixed with coconut oil and spices is used for flushing the urinary blocks. The fruit is believed to reduce worm problems in the kids [18].

## **III. METHODOLOGY**

**Sample Collection and Identification:** *Musa paradisiaca* (Plantain) which is grown at Okenya in Idah Local Government Area of Kogi State was used in the present study. The plant materials were procured from the local growers. Identification and authentication of the stem alongside the fruits and leaves was carried out by Mr. C.J. Onyeukwu, a Plant Taxonomist, in the Department of Plant Science and Technology, University of Nigeria Nsukka, Nigeria. 35 healthy Albino (Wister strain) rats of 3 months of age were obtained from the animal house of University of Nigeria Nsukka, Enugu State for this experiment and were grouped into seven.

**Study Design:** Rats were grouped into seven. Experimental animals were fed with normal feeds (marsh grower). Induction of diabetes was done with alloxan monohydrate. On 16th day of experiment, all the animals were sacrificed and blood collection was done via cardiac puncture. The blood samples of both diabetic and sub-diabetic rats collected were analyzed on the same day of collection and serum was separated by centrifugation at 3000rpm for 5 min for the assay of the total cholesterol, triglycerides, LDL cholesterol, HDL cholesterol, and VLDL cholesterol concentration in the blood samples, using the Cobas 111 instrument.

**Study Location and Duration:** This research work was carried out at the Federal Polytechnic Idah, Kogi State, in the Department of Science and Laboratory Technology from December 2018 to December 2019.

**Sample Size:** 35 healthy Albino (Wister strain) rats of 3 months of age were used in the present study. Out of 5mL of plantain stem juice collected, exactly 0.604mL of the juice was administered to the experimental animals at the end of the study.

**Dosage Determination:** 5mL of the stem juice was placed in a porcelain dish. This was then transferred to an oven and dried at 105°C till constant weight. This was carried out in triplicate. Their average dry weight was calculated. The residue obtained on evaporating 5mL of stem juice to dryness was 0.09g. From ethno medicine, 30mL is taken by an average 70kg man which is equivalent to 0.43mL/kg. The doses of 0.43mL/kg/bw as well as 0.21mL/kg/bw were

administered to the sub-diabetic and diabetic groups; while 0.43mL/kg/bw was given to stem juice control group. The rats were weighed and the appropriate dose calculated and administered.

#### **Selection of Animal and Animal Care;**

35 healthy Albino (Wister strain) rats were acclimatized for a period of 7 days to our laboratory conditions prior to the experiment. Rats were housed in colony cage (5 rats per cage) at room temperature with 12 hours' light and 12 hours' dark cycles at the Animal House of the Science Laboratory Technology, Federal Polytechnic Idah. Rats had free access to standard foods and water. Handling, management and use of the animals for the experiment followed the "Ethical and Scientific Considerations Regarding Animal Testing and research.

#### **Induction of Diabetes Mellitus and Feeding of Rats;**

Rats were on fasting before the induction of diabetes with alloxan oral feeding. Single oral feeding of freshly prepared solution of alloxan at the dose of 150mg/100mL of normal saline/kg body weight/rat was performed using micro-pipette. This single dose of alloxan produced type II diabetes (having fasting blood sugar level more than 125mg/dL) after 48 hours of alloxan oral feeding and this diabetic state was maintained throughout the experimental schedule. Rats were given standard foods; water and plantain stem juice were administered orally.

#### **Testing of Fasting Blood Glucose Level;**

At the time of grouping of the animals, fasting blood glucose (FBG) level was measured. At the interval of two hours, FBG was further recorded from all the animals of all groups throughout the experimental duration. Blood was collected from the tip of tail vein and blood glucose level (BGL) for fasting blood glucose (FBG) and glucose tolerance test (GTT). Studies were assayed using single touch glucometer (Accu-chek Sensor). Depending on their glucose level, the animals were divided randomly into two groups, sub-diabetic rats with FBG of 80mg/dL-124mg/dL and severely diabetic with FBG above 125mg/dL, but both show abnormal glucose tolerance.

#### **Experiments Procedure;**

Thirty-five rats were divided into seven groups as follows:

**Group I** (Normal Control group): Rats of this group received standard foods and water only.

**Group II** (Stem Juice Control group): Rats of this group received standard foods, water and plantain stem juice were administered orally.

**Group III** (Diabetic Control group): Rats of this group received standard foods, water and diabetes was induced in rats of this group by single oral feeding of alloxan dose of 150mg/100mL of normal saline/kg body weight/rat.

**Group IV** (Diabetic Rats): The diabetic rats of this group were forcefully fed with plantain stem juice at the dose of 250mg/kg per body weight/rat/day for 14 days.

**Group V** (Diabetic Rats): The diabetic rats of this group were forcefully fed with plantain stem juice at the dose of 500mg/kg per body weight/rat/day for 14 days.

**Group VI** (Sub-diabetic Rats): The sub-diabetic rats of this group were forcefully fed with plantain stem juice at the dose of 250mg/kg per body weight/rat/day for 14 days.

**Group VII** (Sub-diabetic Rats): The sub-diabetic rats of this group were forcefully fed with plantain stem juice at the dose of 500mg/kg per body weight/rat/day for 14 days.

Rats of group IV, V, VI and VII received standard foods, water and diabetes was induced in rats of this group by oral feeding of alloxan dose of 150mg/100mL of normal saline/kg body weight/rat. Administration of plantain stem juice in group II, IV, V, VI and VII was performed at early morning and at fasting state. From the starting day of plantain stem juice supplementation to diabetic rats, fasting blood sugar level of rats in all groups was measured by single touch glucometer at the interval of two hours.

#### **Blood Collection for Biochemical Analysis;**

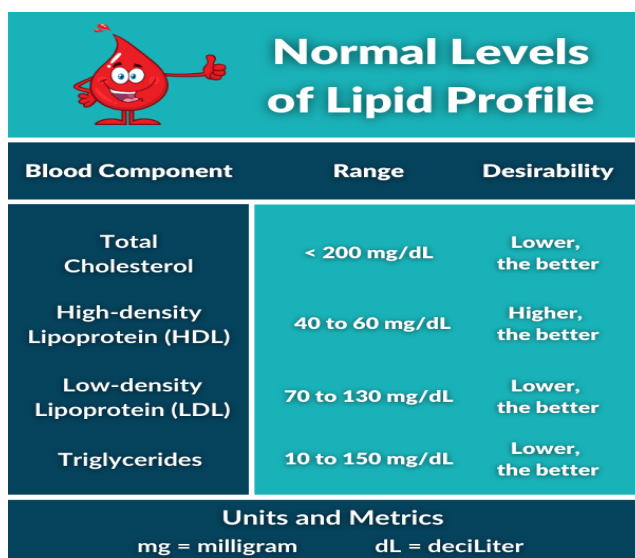
On 16th day of experiment, all the animals were sacrificed by decapitation after recording the final body weight. The rat was deeply anaesthetized. To ensure prolonged anesthesia, a paper towel soaked in volatile anesthetic (Chloroform) was placed on rat's nose during the procedure. The rat was placed on its back, and then a finger was placed at the level of lowest ribs without applying any pressure, the heart is roughly 1cm above this point, slightly right. Now holding the syringe at 45-degree angle, the needle was inserted between the two ribs and without moving the syringe, the syringe plunger was pulled to fill the syringe with blood. The syringe drew 3mL of blood from 70-150g rats. The rat was immediately euthanized. The blood samples collected were analysis on the same day of collection and serum was separated by centrifugation at 3000rpm for 5 min for the assay of the total cholesterol, triglycerides, LDL cholesterol, HDL cholesterol, and VLDL cholesterol concentration in the blood samples, using the Cobas 111 instrument.

#### **Status of the measuring process:**

At any stage of the measuring process, the status on the screen was checked. The system provides storage space for the results of one working day. For backup purposes, the results were exported to an external storage device.

## **IV. RESULTS AND DISCUSSION**

**Results:** Semi-automatic Clinical Chemistry Analyzer (Cobas III instrument) was used to determine the lipid profile.



Blood Component	Range	Desirability
Total Cholesterol	< 200 mg/dL	Lower, the better
High-density Lipoprotein (HDL)	40 to 60 mg/dL	Higher, the better
Low-density Lipoprotein (LDL)	70 to 130 mg/dL	Lower, the better
Triglycerides	10 to 150 mg/dL	Lower, the better

**Units and Metrics**  
mg = milligram      dL = deciLiter

Figure 1. Normal levels of lipid profile (sourced: researchgate.net)

Table 1: The results of effect of *Musa paradisiaca* in the serum total cholesterol, triglycerides, LDL cholesterol, HDL cholesterol, and VLDL cholesterol levels of the Alloxan induced diabetic and sub-diabetic rats.

Experimental Rats	Treatment with Juice	TC	TG	HDL	LDL	VLDL
Stem juice control	Feeds + 500mg/kg/bw/rat/day	93±3	87±3	49±5	36±4	17±3
Normal control	Feeds only	90±3	100±4	52±3	28±4	20±4
Diabetic control	Feeds only	131±3	185±6	35±6	35±4	37±2
Sub-diabetic rats	Feeds + 250mg/kg/bw/rat/day	101±2	117±6	43±3	31±4	21±3
Sub-diabetic rats	Feeds + 500mg/kg/bw/rat/day	82±2	69±4	45±3	28±5	14±4
Diabetic rats	Feeds + 250mg/kg/bw/rat/day	107±3	124±3	38±3	32±4	25±3
Diabetic rats	Feeds + 500mg/kg/bw/rat/day	88±3	76±4	41±4	31±4	15±3

Values are expressed as mean ±SD in milligram per deciliter (mg/dL),

Keys: Total Cholesterol (TC), Triglycerides (TG)

High Density Lipoprotein cholesterol (HDL)

Low Density Lipoprotein cholesterol (LDL)

Very Low Density Lipoprotein cholesterol (VLDL)

**Discussion:** In table above, the serum lipid profile in diabetic control rats differed significantly from the healthy and treated subjects. The result obtained shows that serum Total cholesterol, Triglycerides, LDL cholesterol, and VLDL cholesterol levels of the diabetic control rats are significantly higher than that of the stem juice control, normal control, diabetic rats (treated with both doses) and sub-diabetic rats (treated with both doses). This is an indication that diabetes mellitus is associated with elevated levels of Total cholesterol, LDL Cholesterol, Triglyceride and VLDL Cholesterol. Our results showing a significant positive effects of plantain stem juice on the lipids profile of the subjects suggest that it has high hypolipidemic potential. The result further reveals an increase in the levels of HDL Cholesterol when compared with diabetic control rats which in turn favors the treated subjects.

The serum TC, TGs, LDL-C and VLDL-C levels were significantly higher when fed with 250mg/kg/bw/rat/day plantain stem juice, but lower when fed with 500mg/kg/bw/rat/day plantain stem juice and serum HDL-C levels were significantly less when fed with 250mg/kg/bw/rat/day plantain stem juice, but higher when fed with 500mg/kg/bw/rat/day plantain stem juice which is a desirable effect. This is an indication that higher dose of plantain stem juice brings about significantly positive effects on the lipids profile.

Medically, high cholesterol and triglyceride levels are referred to as lipid disorder, which increases the risk of atherosclerosis and also heart disease, stroke and high blood pressure, hence consumption of plantain stem juice has been shown to normalizes the concentration of the following lipid parameters; triglyceride level, total cholesterol, HDL cholesterol, LDL cholesterol and VLDL cholesterol [19], [20].

## V. CONCLUSION AND FUTURE SCOPE

The reduction of these parameters (Total cholesterol, Triglycerides, LDL cholesterol, and VLDL cholesterol) led to a concomitant improvement in their HDL-cholesterol concentration. The intake of the plantain stem juice also normalized the condition of heart by reducing the concentrations of cholesterol and triglyceride. Of note is the overall hyperlipidemic influence of plantain stem juice which are within the normal range. In the light of this, healthy diet modifications through the use of plantain stem juice extract can be adopted in meals to prevent and manage lipid metabolism especially in individuals with hyperlipidemic condition in order to forestall its long-term complications.

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