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Evaluation of Antidiabetic Property of Ethanol Extract of *Musa Paradisiaca* in Streptozotocin (STZ) Induced Diabetic Rats

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ABSTRACT :

This work investigated the antidiabetic effect of the ethanol extract of *Musa paradisiaca* on the male wister rats induced with diabetes mellitus using streptozotocin sixty male wister were used which were divided into six groups labeled from A to F respectively of 10 male rats wister rats each and all groups were fed with water and normal feeds ad libitum. Group A was normal control. Group B was induced with streptozotocin but not treated. Group C was induced with streptozotocin but treated with standard drugs (Gluformin). Group D, E and F were induced with streptozotocin but treated with 100mg, 200mg, 400mg of *Musa paradisiaca* seed respectively. The weekly fasting sugar of group A, showed a normal mean blood sugar level up to week 4 when compared with the group A and group B control levels respectively. The concentration-dependent groups (D, E, F), a lot reduced in the statistical differences of the mean blood sugar respectively in D and E. ethanol extracts at 400mg(group F)grossly reduced mean blood sugar to 195.57±47.59 mg/dl($p<0.05$).The liver function showed the mean normal control levels were normal all through the parameters, while parameters of group range group B to group F showed varied results of the certain range, on group F show that concentration depends on seeds at high concentrations show a relationship with group A($p<0.05$).It was interfered that the ethanol extracts of *Musa paradisiaca* at high-concentration can manage menace of diabetes mellitus.

Key Words: Antidiabetic, Ethanol Extract, Musa Paradisiaca, Streptozotocin, Induced.

1. INTRODUCTION

Diabetes mellitus is a global metabolic disease that affects essential biochemical pathways in the body resulting to complications (Gavins 1998). Excess hepatic glycogen accumulation is seen in 80% of diabetic patients due to impaired glycogen synthesis and this could be a leading cause of liver disease in diabetics. Patients showing solely excessive glycogen deposition may exhibit hepatomegaly (Rhys, 2006) and liver enzyme abnormalities which are improved with sustained glucose control (Vasundev, 2006). Though synthetic drugs have been useful in the management of this disease, their use is limited by the side effects associated with them as well as the enormous cost they pose on the economies of developing nations (Heidari, 2008). Moreover, these therapies only partially compensate for metabolic derangements seen in diabetics and do not necessarily correct the fundamental biochemical lesions. Therefore, the need for alternative therapies cannot be overemphasized. *Musa paradisiaca* is cultivated in many tropical countries of the world, and it is known to be rich in iron, fiber, vitamins, minerals, and serotonin (Eleazu, 2010).

This research was therefore setup to study the effect of *Musa paradisiaca* on blood glucose, body weights, relative liver function; serum total and conjugated bilirubin, aspartate amino transaminase (AST), and alanine amino transaminase (ALT) in streptozotocin induced diabetic male wister rats.

Diabetes mellitus disease

Diabetes mellitus is a chronic metabolic disease that occurs either when the pancreas does not produce enough insulin or when the body cannot effectively use the insulin it produces. Insulin is a hormone that regulates blood sugar. Hyperglycaemia, or raised blood sugar, is a common effect of uncontrolled diabetes and over time leads to serious damage to many of the body's systems, especially the nerves and blood vessels. (Sarwar N,2010)

In 2014, 8.5% of adults aged 18 years and older had diabetes. In 2019, diabetes was the direct cause of 1.5 million deaths and 48% of all deaths due to diabetes occurred before the age of 70 years. (USRDS, 2014)

Type 2 diabetes:

Type 2 diabetes (formerly called non-insulin-dependent, or adult-onset) results from the body's ineffective use of insulin. More than 95% of people with diabetes have type 2 diabetes.

Symptoms may be similar to those of type 1 diabetes but are often less marked. As a result, the disease may be diagnosed several years after onset, after complications have already arisen.

Type 1 diabetes:

Type 1 diabetes (previously known as insulin-dependent, juvenile or childhood-onset) is characterized by deficient insulin production and requires daily administration of insulin.

Symptoms include excessive excretion of urine (polyuria), thirst (polydipsia), constant hunger, weight loss, vision changes, and fatigue. These symptoms may occur suddenly.

Gestational diabetes

Gestational diabetes is hyperglycaemia with blood glucose values above normal but below those diagnostic of diabetes. Gestational diabetes occurs during pregnancy. Gestational diabetes is diagnosed through prenatal screening, rather than through reported symptoms.

Impaired glucose tolerance (IGT) and impaired fasting glycaemia (IFG) are intermediate conditions in the transition between normality and diabetes. People with IGT or IFG are at high risk of progressing to type 2 diabetes, although this is not inevitable (GBD, 2021).

Gestational diabetes complications is Preeclampsia (high blood pressure, protein in urine, leg/foot swelling), the risk of gestational diabetes in future pregnancies, and diabetes in the mother later in life (Markolf , 2001).

1.2. Statement of the problem

Diabetes mellitus is a global metabolic disease that affects essential biochemical pathways in the body resulting to complications. Though synthetic drugs have been useful in the management of this disease, their use is limited by the side effects associated with them as well as the enormous cost they pose on the economies of developing nations, which brought the need for alternative therapies

1.2.1. Pathophysiology of Type 1 Diabetes.

T1DM is caused by the immune system's elicitation of pro-inflammatory reactions in response to beta-cell antigens. Chronic immunological responses result from poor management of immunological reactions after antigen presentation cells (APCs) transmit beta-cell antigens to the immune system, resulting in beta-cell death. The release of antigens and the start of immune responses against additional beta-cells are induced by beta-cell death caused by viruses or physiological processes. Normally, these antigens are taken up by dendritic cells (DCs) and presented to T cells. Only autoreactive T cells that have escaped thymic negative selection can cause an auto-immune response. DC-activated autoreactive T cells induce autoreactive cytotoxic T and B cells. Finally, the effector mechanisms that destroy beta cells necessitate the collaboration of DCs, macrophages, T, B, and natural killer (NK) cells (Anders, 2005).

Complication of Type 1 Diabetes Mellitus

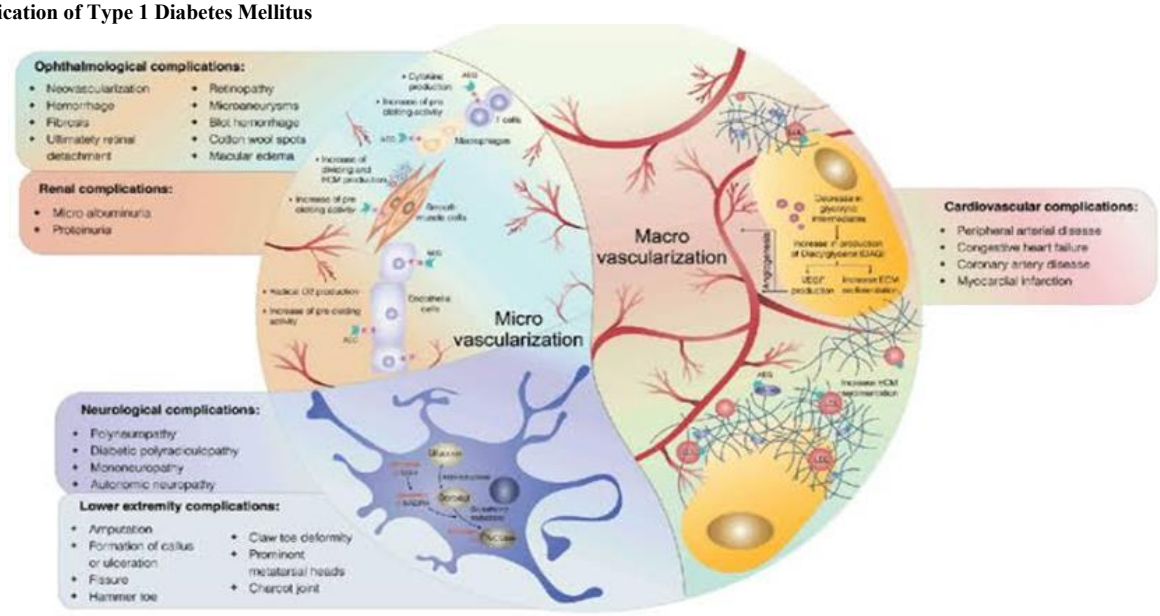

Figure 1: Diabetes Type 1 Chronic complications based on their pathogenesis: Macro vascular and Micro vascular

Microvascular and macrovascular late complications of T1DM damage the heart, limbs, neurological system, eyes, and kidneys, respectively. The right side of the circle in the diagram above represents macrovascular issues, while the left half represents microvascular complications. The role of big arteries, the extracellular matrix (ECM), and cells in the pathophysiology of macrovascular problems is depicted in the right side of the picture. A neuron cell in the lower left quadrant of the circle depicts intracellular causes of neurological and lower extremities problems.

LITERATURE REVIEW

Streptozotocin

Streptozotocin (STZ; N-nitro derivative of glucosamine) is a broad-spectrum antibacterial and cytotoxic drug that is particularly harmful to the pancreatic, insulin-producing -cells in mammals (Figure 1). (Jorda, 2015). It's a DNA alkylating agent that's frequently employed as both an antibacterial and anticancer agent (Eleazu, 2013). STZ is a pancreatic beta-cell-specific cytotoxin, it is commonly utilized in animal models to produce experimental diabetes (Kim, 2006).

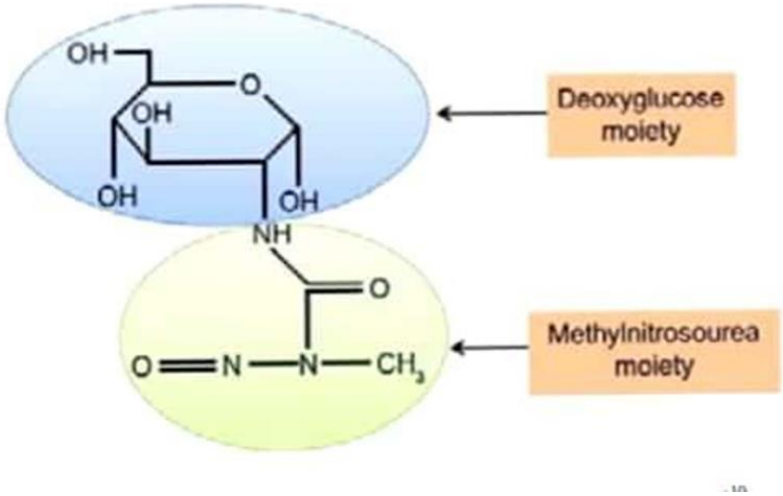

Figure 2: Chemical Structure of Streptozotocin. Source: (Jorda, 2015)

Streptozotocin is a long-acting diabetes inducer. It's made by a strain of the soil microbe Streptomyces achromogenes (a gram-positive bacterium) having antibacterial characteristics across the board (Dolan, 2016). Streptozotocin has antibiotic, -cell (beta)-cytotoxic, oncolytic, and oncogenic qualities, as indicated by its antibiotic, -cell (beta)-cytotoxic, oncolytic, and oncogenic actions (Rakieten , 2018). This antibiotic is an antineoplastic agent that is primarily used to treat pancreatic (islet cell) cancers. It's a drug that's used to treat malignant insulinoma.

Structural Features of STZ

Streptozotocin (2-deoxy-2-[3-methyl-3-nitrosourea] 1-D-glucopyranose) exists in two anomeric structures, and (Figure1a), which can be separated using tip top execution liquid chromatography (HPLC) (Eleazu, 2013). It appears as a glasslike powder that is light yellow or grayish in assortment. Streptozotocin, with the substance condition C8H15N3O7, has a sub-nuclear heap of 265 g/mol (Herr, 2017). The cytotoxic moiety of STZ in harming - cells is a N-methyl-N-nitrosourea bundle, which is superseded at C2 with a N-methyl-N-nitrosourea pack, which is like that of 2-deoxy-D-glucose. Streptozotocin (Figure 1b) is a glucosamine nitrosourea engineered with a methyl pack toward one side and a glucose molecule on the other (Eleazu, 2013).

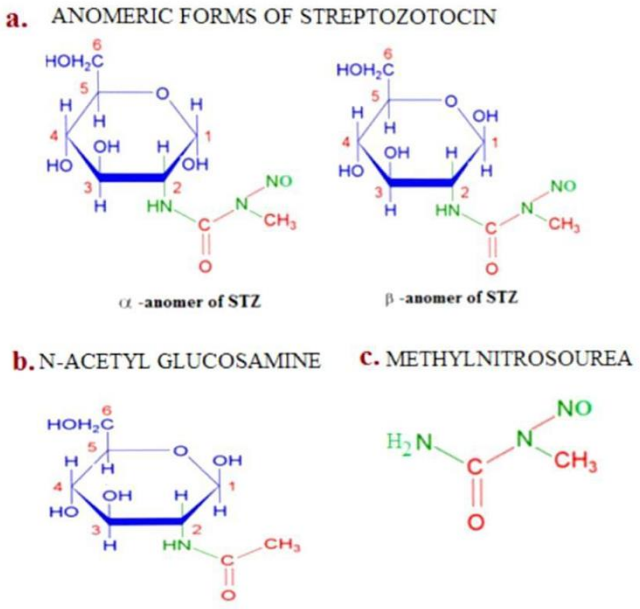

Figure 3: Structural Features of Streptozotocin. Source: (Eleazu, 2013)

a) α and β Anomeric forms of STZ; b) structural analog of STZ- N-acetyl glucosamine and c) cytotoxic moiety of STZ- N-methyl-N-nitrosourea.

2.2. Route of Administration and Dose Schedule of STZ

STZ has been used to induce diabetes in rats using a variety of dosing regimes and methods of administration. STZ is most typically administered intraperitoneally (IP) or intravenously (IV) (Deeds, 2011), while additional routes such as subcutaneous, intracardiac, and intramuscular administration

have been employed in rodents. Although IP provides a quick and convenient form of administration, particularly for studies involving several doses of the drug, unintentional distribution into the colon or subcutaneous region may result in increased moribundity or a reduction in diabetogenic action. Furthermore, additional investigations have found that IV STZ administration provides a more stable and repeatable diabetic model than IP therapy (Deeds, 2011).

MATERIALS AND METHODS

3.1 MATERIALS

3.1.1 Plant materials

The *Musa paradisiaca* variety, commonly known in Anambra State of Nigeria as Unele was obtained from Onitsha Ose market in August, 2020. It was identified by Prof G.C Ukpaka a taxonomist.

3.1.2 Reagents/chemicals

The streptozotocin (STZ) utilized was sourced from the United Kingdom's Sigma and Aldrich Chemical Company. Biosystems, Barcelona, Spain, provided the bilirubin, amylase, and lipase assay kits used. Randox provided the AST, ALT, and ALP kits used on August 2020.

3.1.3 Processing of the plant material.

The samples were properly peeled, soaked in water for about 10 min, washed, and dried at room temperature for 2 weeks and processed to powdered using Butterfly grinding machine. Exactly 2kg of the powdered *Musa paradisiaca* was soaked in 4Liters of 70% ethanol. The mixture was stirred at 2hrs interval for 24hrs to ensure complete extraction. After 24hrs, the mixture was sieved using muslin cloth and then filtered with whatmann no 1 filter paper.

The filtrate was concentrated using waterbath at 50°C. The extract was weighing 36.7g after concentration.

3.1.4 Animal experiments

Selection of animals'

Sixty male albino male rats of the Wister strain (120–150g) obtained from the animal house of the Dr Ezeigwe .O.C. in Awka, Anambra State, Nigeria, were used for the study. The animals were kept in metabolic cages in the animal house of Dr Ezeigwe .O.C. in Awka, Anambra State. Prior to the start of the trial, they were acclimatized to their diets for two weeks and kept in a consistent 12-hour light-dark cycle at room temperature.

3.1.5 Experimental procedure

LD50

The method as described by Lorke, 1983 was used. A total of 13 male rats (wister strain) Weighing between 120 to 150 g were used because of the different doses to be measured.

The study was carried out in two phases

Phase one involves grouping the male rats (wister strain) into 3 groups, which has 3 male rats (wister strain) on each group and administering low dose of 10, 100, 1000mg/kg of the ethanol extracts

Table 3.1: Grouping male rats (wister strain) into 3 groups with low dose of 10, 100, 1000mg/kg of the ethanol extracts

Group	No of Rats	Dose(mg/kg)	Mortality	Observation
Group A	3	10 mg/kg	-	None
Group B	3	100 mg/kg	-	None
Group C	3	1000 mg/kg	-	None

3.1.6 Induction of diabetes

Sixty male wister rats were used, which were divided into six groups labeled from A to F respectively of 10 male rats wister rats each, before acclimatizing them for 2 weeks and after the acclimatization, they were fasted for 16hrs before the induction of diabetes mellitus, using 40mg/kg of freshly prepared solution of streptozotocin. Diabetes was induced intra-peritoneal in the male rats (wister strain).Group A was normal control, not induced with STZ. Group B was induced with streptozotocin but not treated. Group C was induced with streptozotocin but treated with standard drugs (Gluformin). Group D, E and F were induced with streptozotocin but treated with 100mg, 200mg, and 400mg of *Musa paradisiaca* seed respectively.

The glucose levels were checked after 48 hours whether the rats were diabetic. Fasting glucose levels of 200mg/dl or more affirms that the rats were diabetic. Blood was collected from the tail vein, and blood glucose concentration was analyzed in the STZ -treated male rats (wister strain) prior to the commencement of the dietary feeding using a blood glucose meter (Double G glucometer, USA) and subsequently, every 4 days and the weight was checked at weekly interval (every Wednesday), throughout the duration of the experiment. The STZ-treated male wister rats with fasting blood glucose levels >200 mg/dl, after 2 days of induction of STZ and with evidence of glycosuria, were considered to be diabetic and used for the study.

The study lasted for 28 days

The STZ-treated male rats (wister strain) with stable diabetic condition were then divided into 5 groups (groups 2 to 6) comprising of ten rats per group while the non-diabetic group formed the first group (Group 1):

Group 1. Normal (non-diabetic control) male rats (wister strain) fed standard rat pellets and water ad libitum

Group 2. Diabetic (negative control) male rats (wister strain) fed standard rat pellets and water ad libitum (not treated).

Group 3. Diabetic (positive control) male rats (wister strain) fed on both standard rat pellets and water ad libitum treated with standard drug (Gluformin).

Group 4 - 6. Diabetic male rats (wister strain) fed on both standard rat pellets and water ad libithum treated with *Musa paradisiaca* extract 100mg, 200mg and 400mg respectively.

After 28 days, the male rats (wister strain) were sacrificed, and their blood samples were taken in non-anticoagulant tubes for serum analysis of liver and kidney function parameters The body weights of the male rats (wister strain) were recorded on weekly basis using an electronic weighing balance and the percentage change in weight was calculated as:

Percentage change in weight =

$$\frac{\text{Final weight - Initial weight}}{\text{Final weight}} \times \frac{100}{1}$$

Similarly, the percentage change in fasting blood glucose was calculated as:

Percentage change in fasting blood glucose (FBG) =

$$\frac{\text{Final FBG - Initial FBG}}{\text{Final FBG}} \times \frac{100}{1}$$

3.2 METHODS

3.2.1 Liver Function Test Manual Method

Determination of Alanine Aminotransferase (ALT)

The ALT was assayed using the method of Reitman and Frankel (1957) as outlined in Randox Kit.

PRINCIPLE: α-oxoglutarate + L-Alanine GPT ⟶ L-Glutmate + Pyruvate

Alanine Aminotransferase is measured by monitoring the concentration of pyruvate hydrazone formed with 2, 4-dinitrophenylhydrazine

PROCEDURE: ALT substrate 0.5ml was added to Test, Test Blank, Standard, and Standard Blank. This was incubated for 5mins at 37^{O}C. Thereafter, 0.1ml of serum was added to Test, 0.1ml of pyruvate standard added to Standard and 0.1ml of Distilled water added to test blank and standard blank. They were mixed and incubated at 37^{O}C for 30minutes. After the incubation, 5.0mls of 2,4 dinitrophenylhydrazine was added to all the tubes, mixed and incubated for 20min at room temperature (25 ^{O}C). This was followed by the addition of 5.0mls of 0.4N NaOH to all the tubes and read at 505nmλ after zeroing the spectrophotometer with the blank. The results were then read off using the calibration curve provided.

3.2.3. Determination of Aspartate Aminotransferase (AST)

The AST was determined using the method of Reitman and Frankel (1957) outlined in Randox Kit.

PRINCIPLE: α-oxoglutarate +L aspertate GOT ⟶ L-glutamate + oxaloacetate

AST was assayed by monitoring the concentration of oxaloacetate hydrazone formed with 2, 4-dinitrophenylhydrazine.

PROCEDURE: AST substrate 0.5ml was added to Test, Test Blank, Standard, and Standard Blank. This was incubated for 5mins at 37^{O}C. Thereafter, 0.1ml of serum was added to Test, 0.1ml of pyruvate standard added to Standard and 0.1ml of Distilled water added to test blank and standard blank. They were mixed and incubated at 37^{O}C for 30minutes. After the incubation, 5.0mls of 2.4 dinitrophenylhydrazine was added to all the tubes, mixed and incubated for 20min at room temperature (25 ^{O}C). This was followed by the addition of 5.0mls of 0.4N NaOH to all the tubes and read at 505nmλ after zeroing the spectrophotometer with the blank. The results were then read off using the calibration curve provided.

3.2.4. Determination of Alkaline Phosphatase (ALP)

Alkaline phosphatase (ALP) was determined using Randox kit as recommended by Deutsche Gesellschaft fur Klinische Chemmie (GSCC)

PRINCIPLE: P-nitrophenylphosphate + H_2O ⟶ ALP Phosphate + P-nitrophenol (a coloured chromogen)

PROCEDURE: To Test, blank and standard, was added 1.0ml of Alkaline buffer and phenyl phosphate substrate. They were incubated for 3min at 37^{O}C. Thereafter 0.1ml of serum was added to test, 0.1ml of phenol standard was added to standard and 0.1ml of distilled water was added to blank they were equally incubated for another 15mins at 37^{O}C. following the incubation, 1.0ml of 0.5NNaOH, 1.0ml of 0.5NNaHCO_3, 0.1ml of 4-amino antipyrine, 0.1ml of potassium ferricyanide were each added to all the tubes, mixed and read immediately after zeroing the spectrophotometer with blank at 510nmλ wavelength

3.2.5. Determination of Bilirubin

The concentrations of conjugated and unconjugated bilirubin were determined using the method of Jendrassik and Grof (1938) as outlined in Randox Kit.

PRINCIPLE: Colorimetric method: Direct (conjugated) bilirubin reacts with diazotized sulphanilic acid in alkaline medium to form a blue coloured complex. Total bilirubin is determined in the presence of caffeine, which releases albumin bound bilirubin, by the reaction with diazotized sulphanilic acid.

Procedure for Total Bilirubin (T BIL):

The sample blank and sample tubes were set for the analysis. Sulphanilic acid 200 µl was put into the sample blank and sample tubes. Then 50 µl of Sodium nitrite was added into the sample tube. Then 1000 µl of caffeine was added to both sample blank and sample tube. Also 200 µl of the sample was added to both sample blank and sample tubes. The tubes were mixed and allowed to stand for 10 minutes at 20 – 25ºC. Then 1000 µl of tartrate was added to both sample blank and sample tubes. The tubes were mixed and were incubated for 5- 30 minutes at 25ºC and then, the absorbance of the sample blank was read at wavelength of 578nm.

Procedure for Direct Bilirubin (D BIL)

The sample blank and sample tubes were set for the analysis. Sulphanilic acid 200 µl was put into the sample blank and sample tubes. Then 50 µl of Sodium nitrite was added into the sample tube. Then 2000 µl of sodium chloride was added to both sample blank and sample tube. Also 200 µl of the sample was added to both sample blank and sample tubes. The tubes were mixed and allowed to stand for 10 minutes at 20 – 25ºC.

The absorbance of the sample was read at wavelength of 546nm against the sample blank.

3.3Statistical Analysis

Data was subjected to analysis using the Statistical Pack-age for Social Sciences (SPSS), version 17.0. Results were presented as the means ± standard deviations. One-way analysis of variance (ANOVA) was used for comparison of the means. Differences between means were considered to be significant when $P < 0.05$.

4. Results

This result presented on the table below is the result of the phytochemical analysis done on *Musa paradisiaca*

Table I:

Phytochemicals	Mean ± SEM
Alkanoids	4.60±0.73g/100g
Flavoids	1.20±0.25g/100g
Tannins	3.20±0.57g/100g
Terperioids	2.05±0.34g/100g
Saponins	1.75±0.45g/100g
Glycosides	1.68±0.36g/100g
Phenols	1.86±0.73g/100g
Phytatus	0.93±0.33g/100g

The table below shows that the administration of STZ at a dosage of 40 mg/kg body weight was very effective in inducing diabetes mellitus at a result of 200mg/dl and above in the male rats (wister strain) and at the end of the experiment the male rats (wister strain) had a significant decrease of results at different groups of treatment using *Musa paradisiaca* ethanol extract

Table II:

Weeks	Group A	Group B	Group C	Group D	Group E	Group F
Week 1	75.50±54.82	462.46±43.25	437.94±44.52	455.32±46.06	378.00±46.06	404.88±43.25
Week 2	77.35±39.82	472.10±44.52	290.88±44.52	353.36±47.59	277.43±47.59	193.71±47.59
Week 3	86.60±39.82	472.72±47.59	106.69±44.52	235.29±47.59	293.00±47.59	142.43±47.59
Week 4	86.25±39.82	512.66±49.50	130.55±44.52	256.36±47.59	331.50±47.59	195.57±47.59
% Change	12.46%ic	9.79%ic	-235.46%dc	-77.61%dc	-14.03%dc	-107.033%dc

Results reported in Mean±SD

*Statistically significant at 0.05 compared with control

Key:

Group A: Normal control (Not diabetic and not treated)

Group B: Induced diabetes and untreated

Group C: Induced diabetes and treated with standard drug

Group D: Induced diabetes and treated with 100mg/kg body weight of *Musa paradisiaca* extract

Group E: Induced diabetes and treated with 200mg/kg body weight of *Musa paradisiaca* extract

Group F: Induced diabetes and treated with 400mg/kg body weight of *Musa paradisiaca* extract

The variation of Mass Samples studied of the male wister rats with Time (Weeks) is summarized and presented on table below

Table III:

Weeks	Group A	Group B	Group C	Group D	Group E	Group F
Week 1	135.00±5.07	132.00±6.06	132.63±5.67	120.43±6.06	124.00±6.06	127.44±5.34
Week 2	148.80±5.07	125.86±6.06*	145.75±5.67*	135.43±6.06*	133.43±6.06*	142.57±6.06
Week 3	154.60±5.07	127.29±6.06*	156.25±5.67*	147.00±6.54*	118.29±6.06*	151.71±6.06
Week 4	170.40±5.07	137.29±6.06*	168.25±5.67*	150.13±5.67*	125.43±6.06*	163.71±6.06
% Change	20.78%ic	3.85%ic	21.17%ic	19.78%ic	1.14%ic	22.16%ic

Results reported in Mean±SD

*Statistically significant at 0.05 compared with control

The results of the liver function parameters of the male wister rats is summarized and presented on the table below.

Table IV:

Parameter	Group A	Group B	Group C	Group D	Group E	Group F
Direct Bilirubin (µmol/l)	2.40±0.03	2.13±0.02*	2.22±0.02*	2.14±0.02*	2.13±0.02*	2.08±0.01*
Total Bilirubin (µmol/l)	16.00±1.33	15.43±0.54	16.00±0.93	15.33±1.03	15.00±0.58*	14.71±0.49*
Alkaline Phosphatase (IU/L)	46.70±1.49	42.29±0.76*	44.50±0.93*	41.33±1.03*	43.43±1.51*	44.43±0.98*
Aspartate Aminotransferase (IU/L)	7.20±1.03	6.43±0.98	6.25±1.04*	6.00±1.10*	5.00±0.00*	5.71±0.49*
Alanine Transaminase (IU/L)	9.10±0.57	7.57±0.54*	7.50±0.54*	5.83±0.75*	7.14±0.90*	6.43±0.54*
Urea (mmol/l)	6.30±0.08	5.21±0.09*	7.14±0.05*	6.17±0.10*	6.31±0.09	6.76±0.08*
Creatinine (µmol/l)	119.80±0.63	86.57±1.51*	128.88±0.99*	91.50±1.23*	86.14±1.77*	86.57±0.54*
Sodium (mEq/l)	131.40±0.97	123.43±0.98*	143.13±2.03*	119.50±1.23*	124.86±0.96*	133.57±1.10*
Potassium (mEq/l)	3.48±0.09	3.14±0.08*	5.15±0.05*	3.65±0.12*	4.17±0.10*	3.71±0.09*
Chloride (mEq/l)	89.30±1.06	81.43±1.40*	110.88±1.13*	90.67±0.82*	102.57±0.54*	100.57±0.98*
Bicarbonate (mEq/l)	24.30±0.48	23.43±0.54	23.75±1.04	23.67±0.52	24.00±1.00	23.92±0.49

Results reported in Mean±SD

*Statistically significant at 0.05

5. DISCUSSION AND CONCLUSION

5.1 Discussion

Diabetes mellitus is a disease characterized by impaired insulin action or secretion, which leads to chronic hyperglycemia and long-term vascular consequences (Gavins 1998). Diabetes mellitus (DM) is an endocrine gland disease characterized by improper glucose metabolism, which is connected to low blood insulin levels or insulin sensitivity in target organs. Diabetes has been linked to oxidative stress, which causes tissue damage and other metabolic diseases such as glucose insensitivity in needy tissues, microvascular and macrovascular complications. Furthermore, the presence of a secondary metabolite is associated to the use of medicinal plants in the management or treatment of type-2 diabetes Mellitus linked to hyperglycemia. In diabetes, the fasting blood glucose level is an important determining factor.

The antihyperglycemic effects of *Musa paradisiaca* are suggested by the stabilization of blood glucose to the extent seen in this study, similarly found in previous study work by Ekpo (2011).

The STZ-induced diabetic rats showed higher blood glucose level than control group as shown similarly in previous study (Akbarzadeh, 2007). According to Holemans (1997), STZ prevents DNA synthesis in β-pancreatic cells by inhibiting many enzymes involved in DNA synthesis. Besides

that, it also results in the degeneration and destruction of DNA in β-pancreatic cells. As a consequence, the β-pancreatic cells are unable to produce insulin therefore caused the increase of blood glucose level. However, the considerable reduction of glucose level in the blood samples of diabetic male rats (wister strain) treated with *Musa paradisiaca* extract by the last week of the experiment further supports *Musa paradisiaca* antidiabetic potential in helping β-pancreatic cells to produce insulin.

Bilirubin is excreted by the liver,High levels of bilirubin could mean that either your red blood cells are breaking down at an unusual rate or that your liver isn't breaking down waste properly and clearing the bilirubin from your blood. However, high levels can also be due to medications, exercise, or certain foods. Bilirubin is also a product of breakdown of red blood cells, and an elevated reading may be related to disorders of red blood cells and not liver disease. Results which are not in the normal range do not necessarily mean there is a medical condition needing treatment. A benign liver disease called Gilbert's syndrome may cause minor elevations of bilirubin and can be ignored. (Webmd, 2021).

In this dissertation report the bilirubin of those treated with *Musa paradisiaca* extract shows a normal level of bilirubin when compared with those of negative and positive control and any disruption of normal liver function impacts its rate of conjugation and excretion, making bilirubin a useful indicator of liver function and bile excretion status, which is in agreement with previous study work of Lin, (2010)

Changes in the activities of aminotransferases (AST and ALT) and phosphatases are suggestive of tissue damage caused by toxicants or disease conditions, hence measuring their activities are important in clinical and toxicological settings. The toxicity of STZ to tissues that express the GLUT 2 transporter, such as hepatocytes and renal tubular cells, results in a drop in the amount of diagnostic enzymes (AST, ALT, and ALP) in the blood of streptozotocin diabetic rat models. Streptozotocin influence on the levels of diagnostic enzymes in the liver is still unknown.

They found a nonsignificant drop in the activities of AST and ALT in streptozotocin diabetic rat models' livers, but a significant rise in the activity of ALP. The lower hepatic AST, ALT, and ALP activities of diabetic male rats (wister strain) seen in this study support previous work by El-Demerdash (2005), who found decreased hepatic AST, ALT, and ALP activities in diabetic rat models.

5.2 Conclusion

In conclusion, an increase in the body weight was observed in the male wister rats. This study which is the effects of ethanol extract of Musa paradisiaca in diabetic male wister rats, suggest that *Musa paradisiaca* extract can be useful in the treatment of diabetes-related liver problems.

5.3 Recommendation

This comprehensive information presented in this paper will enrich the knowledge of the public on the health benefits of the plant and stimulate further research on the plant.

Further research to isolate key active ingredients in *Musa paradisiaca* is suggested. There is a need to conduct clinical trials on the anti-diabetic activities of ethanol extract *Musa paradisiaca.*

5.4 Contribution to knowledge

The purity of fund and lack of standard equipment with within our zone made it impossible to undergo GasChromatography (GCM) and High Performance Liquid Chromatography (HPLC) analysis of *Musa paradisiaca*

The contribution based his own facility before us *Musa paradisiaca* is an anti-diabetic agents with property to delay the onset of diabetes in susceptible individuals

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APPENDIX

GRAPHICAL REPRESENTATION OF LIVER FUNCTION TEST

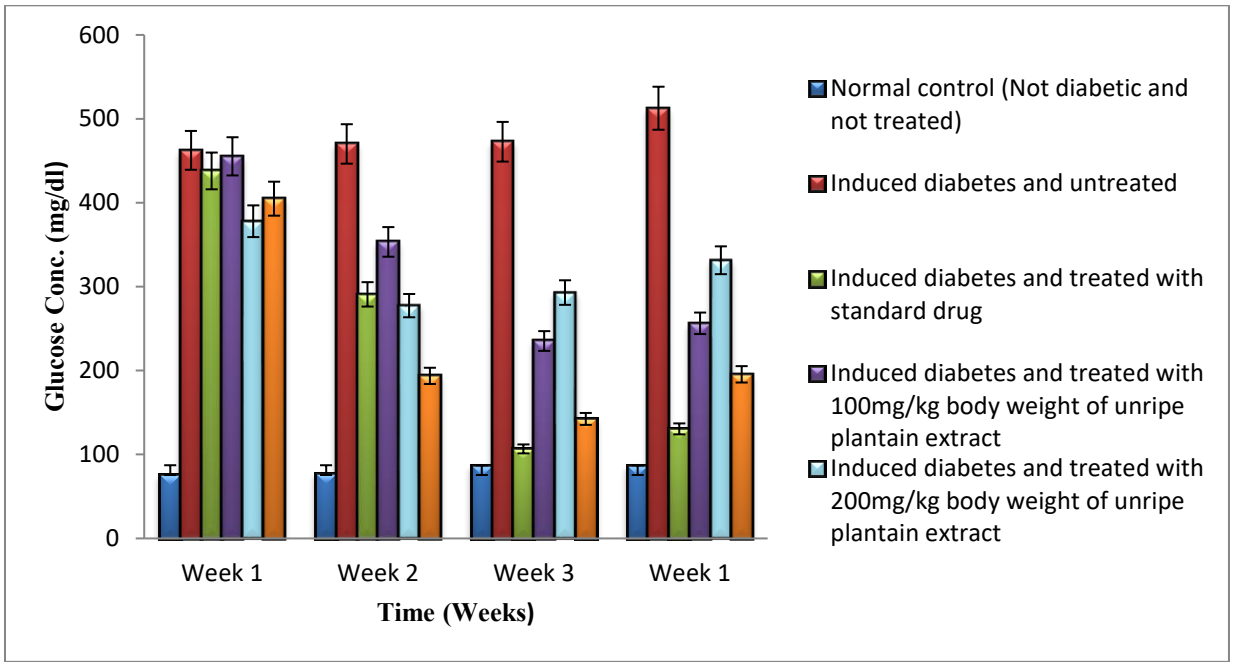

Figure I: Fasting blood glucose of male Wister rats (FBG) (mg/dL)

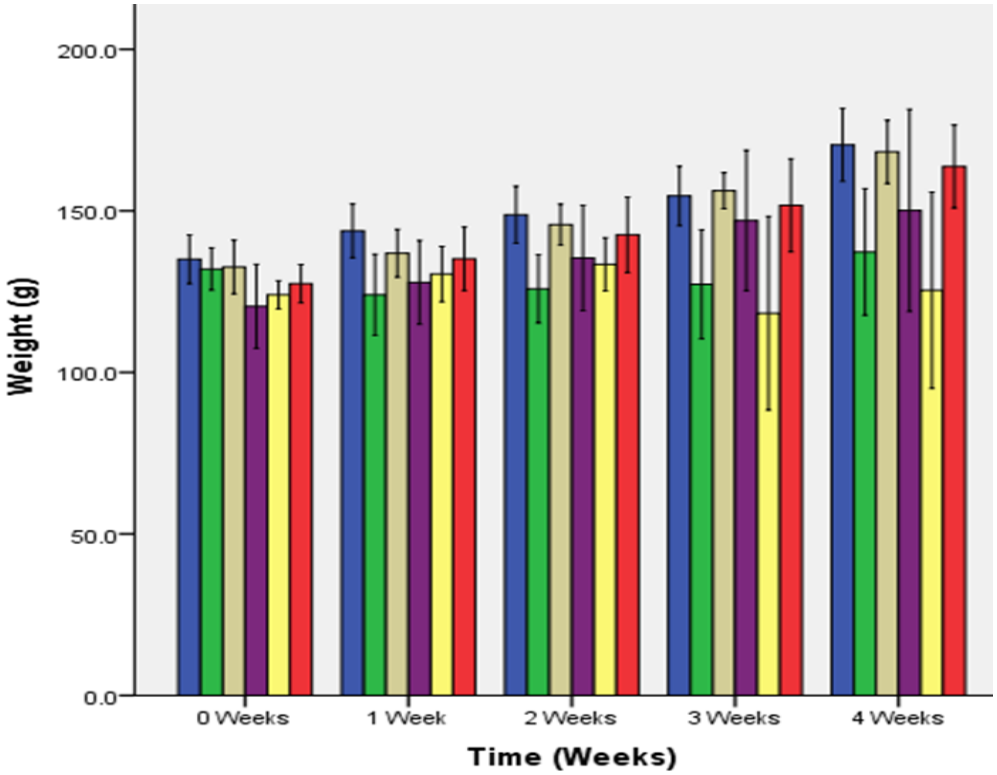

Figure II: Variation of Mass of sample studied with Time (Weeks)

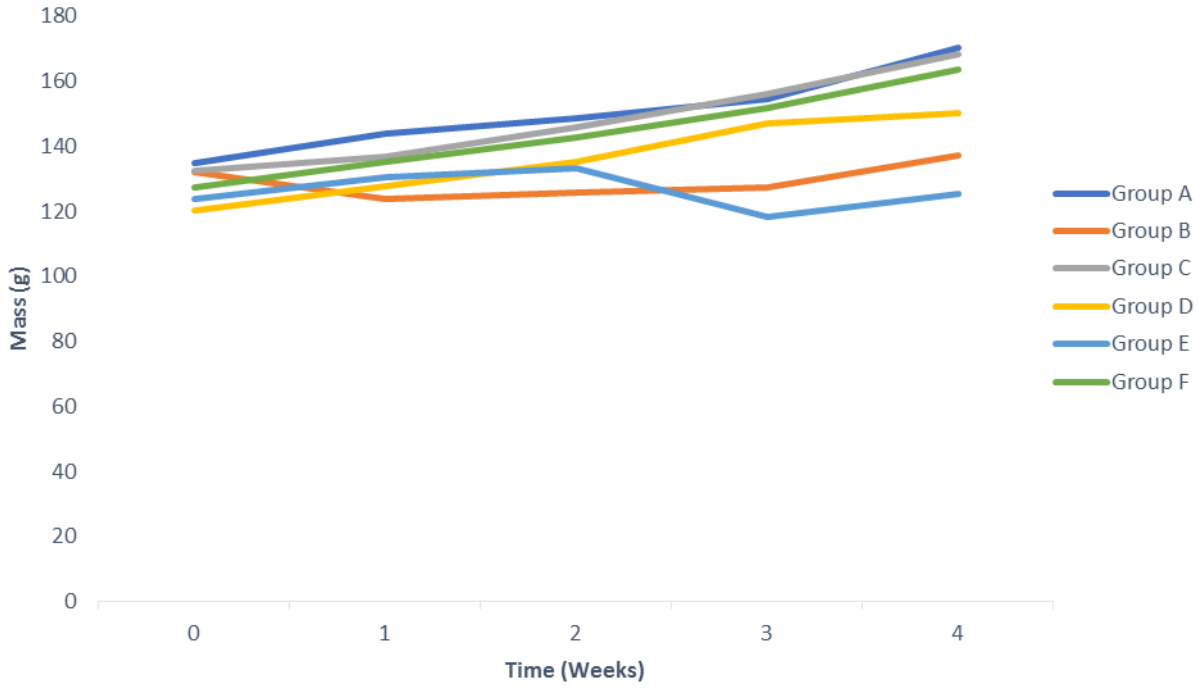

Figure III: Variation of Mass

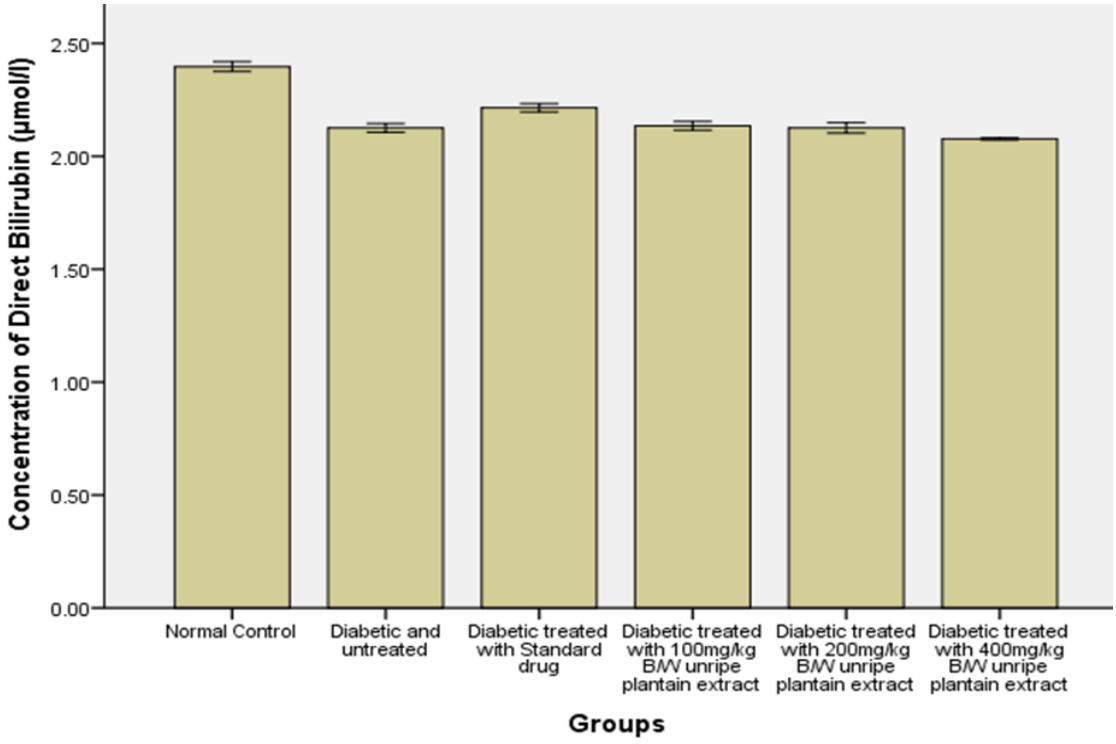

Figure IV: Concentration of Direct Bilirubin

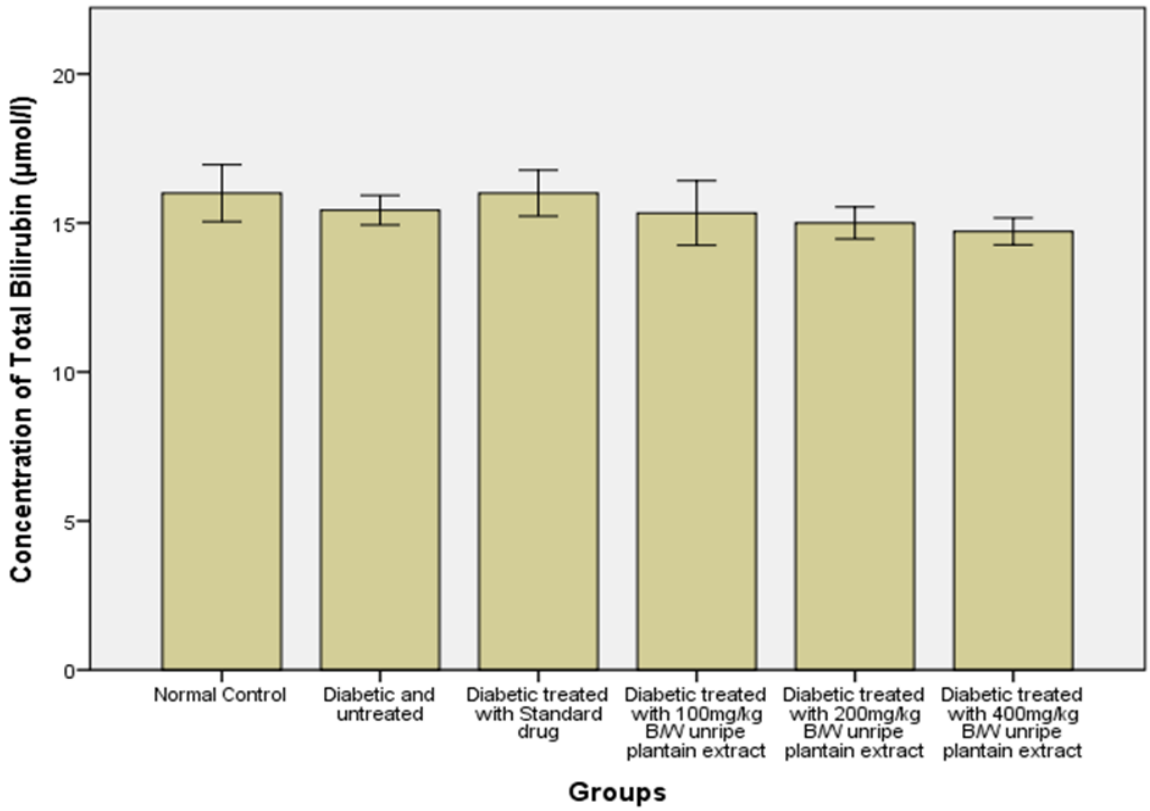

Figure V: Concentration of Total Bilirubin

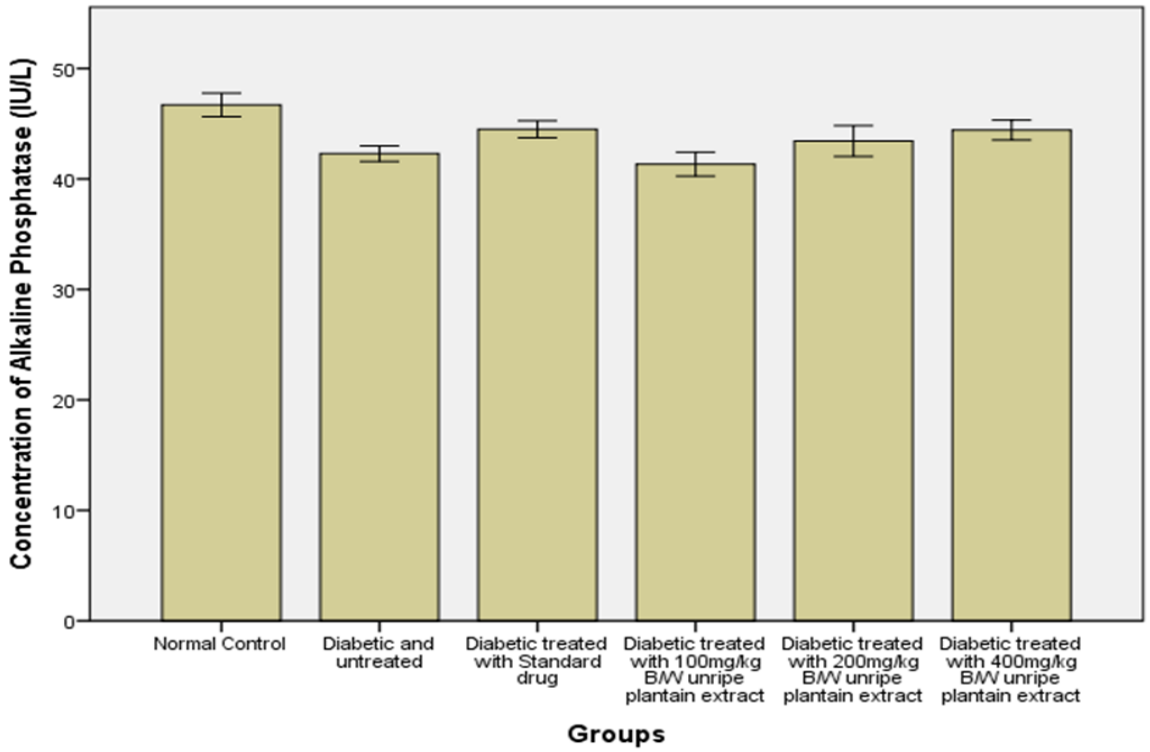

Figure VI: Concentration of Alkaline Phosphatase (IU/L)

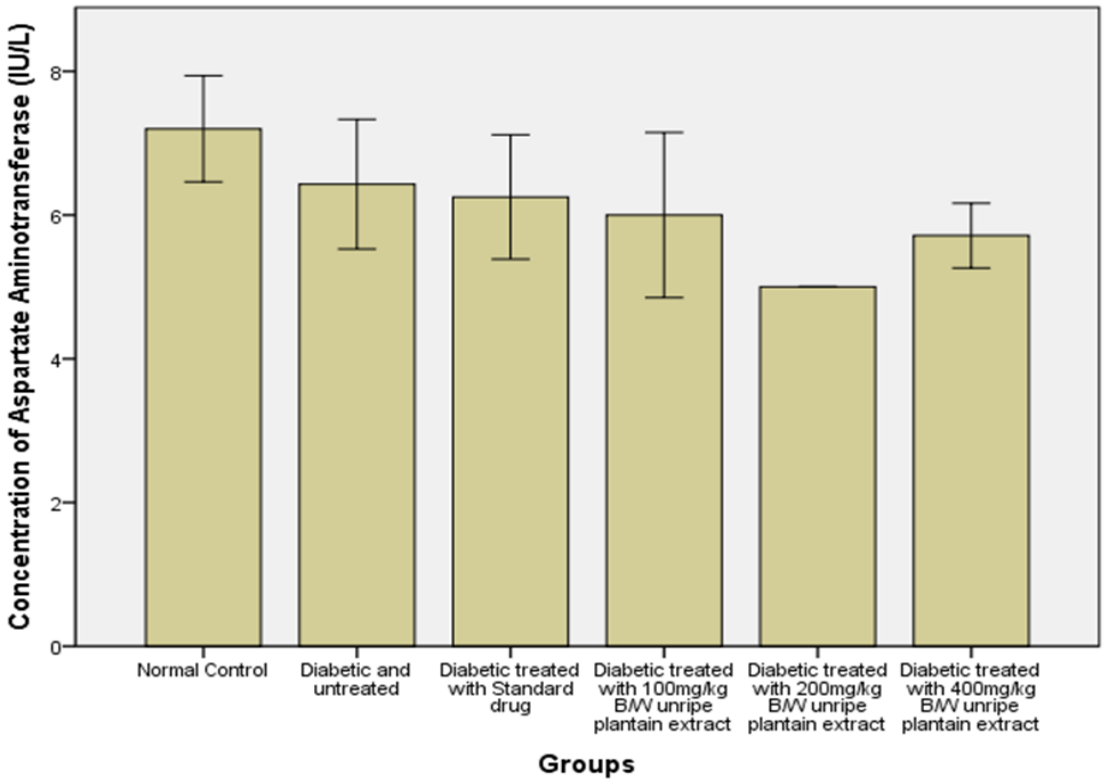

Figure VII: Concentration of Aspatrtate Aminotransferase (IU/L)

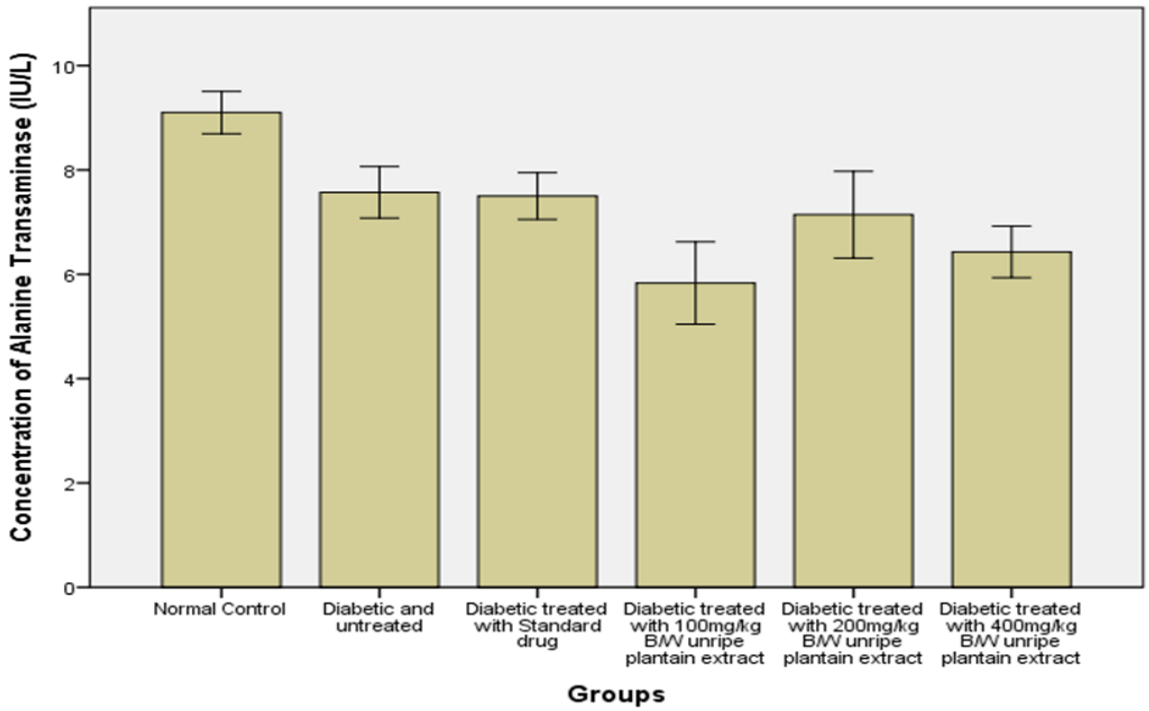

Figure VIII: Concentration of Alanine Transaminase (IU/L)