

## Effects of *Aframomum Sceptrum* and *Parinari Congensis* Seed Extracts in Alloxan Induced-Diabetic Wistar Albino Rats

<sup>1\*</sup>Dokubo A., <sup>2</sup>Uwakwe, A.A. & <sup>2</sup>Amadi B.A.

<sup>1</sup>Department of Biochemistry,  
Faculty of Science,  
Rivers State University of Science and Technology,  
PM B 5080, Port Harcourt,  
Nigeria.

<sup>2</sup>Department of Biochemistry,  
Faculty of Science,  
University of Port Harcourt,  
PMB 5323, Port Harcourt,  
Nigeria.

\*Corresponding Author: awodus@yahoo.com

### ABSTRACT

#### Introduction

Combination of medicinal preparations (polytherapy) derived from different plant products are frequently employed to provide the synergistic efficacy required for the management of diabetes. *Aframomum sceptrum* and *Parinari congensis* are seeds that are locally used as spices in Nigeria to enhance the flavor and aroma of soups as well as several alcoholic drinks. Ethnopharmacological survey revealed that these seeds are commonly found ingredients in traditional herbal formulation in treatment of various ailments. This study therefore, investigates the combined effects of aqueous and ethanol seed extracts of *Aframomum sceptrum* (AS) and *Parinari congensis* (PC) in alloxan induced diabetic rats.

#### Methods

Initial phytochemical analysis of the extracts was conducted using gas chromatography (GC). The seed extracts were prepared in 20% tween 80. Forty Wistar albino rats weighing between (150-200) g were used for this study. The acute toxicity study was conducted according to the OECD guidelines of 2001. 100mg/kg B.W of alloxan was used to induce diabetes in the rats. 400mg/kg B.W of aqueous and ethanol seed extracts of AS+PC were administered for a period of 7, 14 and 21 days orally. Fasting blood glucose, Amylase and insulin levels were determined by standard test methods and commercial bioassay kits. Histopathological examinations of rat pancreases were also conducted.

#### Results

Phytochemical analyses of the seed extracts revealed various phytochemicals at varied concentrations which include Narigerin, Anthocyanin, Quercitrin, Lunamarine, Catechin, Sapogenin, Phytate, Rutin, Kaempferol, Spartein, Ribalinidine and Epicatechin. In vivo acute toxicity studies showed no sign of toxicity and death at relatively high doses of 4000mg/kg B.W of aqueous and ethanol extracts of combined seeds administered. Thus, 1/10<sup>th</sup> of this dose (400mg/kg B.W) was used as a fixed dose for this study. Intraperitoneal injection of 100mg/kg B.W of alloxan caused significant increase in glucose level, significant ( $p < 0.05$ ) increase in amylase activity and significant ( $p < 0.05$ ) decrease in insulin levels when compared to the control. Body weight of rats also showed significant ( $p < 0.05$ ) decrease when compared to the control. Result obtained after 7, 14 and 21 days of 400mg/kg B.W of extract administration showed significant ( $p < 0.05$ ) reduction in fasting blood sugar (FBS) and amylase and significant ( $p < 0.05$ ) increase in insulin levels. The % reduction for FBS in

*ETASPC group is not significantly ( $p>0.05$ ) different from RD group. There was no significant ( $p>0.05$ ) change in the body weights of the extracts treated group compared to the control group.*

### **Conclusion**

*Administration of 400mg/kg B.W of AQASPC and ETASPC exhibited cytoprotective effect on pancreatic  $\beta$ - cells and prevented progression to diabetes. The presence of potent bioactive phytochemicals and minerals in the combined seeds extracts of *Aframomum sceptrum* and *Parinari congensis* could have played a role of synergy in alleviating progression to diabetes. Thus the seeds could serve as a new source of raw materials for anti-diabetic drugs in controlling blood glucose concentration.*

**Keywords:** *Diabetes, combined, Glucose, extracts, insulin spices, hypoglycemia, alloxan*

## **1 Introduction**

Diabetes is a major metabolic disorder that is characterized by chronic hyperglycemia. In this condition glucose becomes freely available in the blood and cannot enter into the cell of the body for production of energy in form of ATP, via glycolysis (Ramanathan *et al.*, 2010). The uptake of glucose is tightly regulated by insulin, a hormone, produced by the beta cells of Islets of Langerhans in pancreas. Insulin stimulates the translocation of glucose transporter (GLUT4) from intracellular space to the plasma membrane to facilitate glucose storage or its utilization by cells (Cushman, 2002). Impairment in insulin secretion or insensitivity of insulin to insulin receptors family can trigger very serious metabolic complications which include accelerated hepatic production of glucose via gluconeogenesis, the hallmark sign of hyperglycemia in all forms of diabetes. Hyperglycemia has been implicated in the pathogenesis of many diabetic related diseases which include foot ulcers, nephropathy, coronary heart disease, painful muscle wasting and weakness and atherosclerosis (Soumya and Srilatha, 2011).

Diabetes often imposes tremendous agony and financial burden on people who suffer the diseases. The World Health Organization (WHO) recognizes diabetes as one of the prominent global health challenges that is likely to be the leading cause of morbidity and mortality in the nearest future (Dagogo-Jack, 2002, Sarah *et al.*, 2004). Chemo-therapies that offer effective control of hyperglycemia exist. However, they are usually expensive and associated with adverse side effects (Emeka and Oludare, 2011). In most developing countries majority of the population rely on remedies that are obtained from medicinal plants that are readily available. There are several species of medicinal plants that have been combined (polytherapy) or used singly in the management of diabetes (Okigbo and Mmeka, 2006). A large number of them have already been reported for anti-diabetic, antioxidant and hypoglycemic effects (Ojewole, 2006, Anwar, 2007, Oladoye and Akintola, 2014). However, these effects still remain to be investigated in other plant products that are readily available with the view of developing plant-based therapies that are relatively safe and affordable in the management of this wide spread disease.

*Aframomum sceptrum* (Oliv. & T. Hanb.) K. Schum belongs to the Zingiberaceae family while *Parinari congensis* F. Didr belongs to the Chrysobalanaceae family (Dokubo *et al.*, 2013, Christenhusz and Brying, 2016). These seeds are locally used as spices in Nigeria to enhance the flavor and aroma of soups as well as several alcoholic drinks (Ndukwu and Ben-Nwadibia, 2005, Ogunka-Nnoka and Mepba, 2008, Erukainure *et al.*, 2011). Ethnopharmacological survey revealed that these seeds are commonly used in traditional herbal formulation used in management of malaria, post natal womb discomforts and infections (Feitosa *et al.*, 2012). Some species have been investigated for hypoglycemic potentials (Ighodaro *et al.*, 2012). This study therefore, investigates the hypoglycaemic

potentials of aqueous and ethanol seed extracts of *Aframomum sceptrum* and *Parinari congensis* in alloxan induced hyperglycemic rats.

## **2 Materials and Methods**

### **2.1 Collection and Identification of Plant Materials**

The seeds of *Aframomum sceptrum* and *Parinari congensis* were obtained from Mile 3 Market, Diobu. Port Harcourt. They were identified at the taxonomy unit of the Department of Plant science and Biotechnology, University of Port Harcourt, Rivers State, Nigeria.

### **2.2 Reagents and Chemicals**

Alloxan monohydrate was procured from Sigma Company, St. Louis, USA. 500mg Metformin was obtained from Letco Medical, Decatur, Alabama. All other reagents and Chemical were of analytical grade supplied by the Department of Biochemistry, University of Port-Harcourt Nigeria and procured from reputable firms.

### **2.3 Preparation of the Extracts of Plant Materials**

The seeds of *Aframomum sceptrum* and *Parinari congensis* were sorted and ground to fine powder using a mechanical grinder. 100g each of the powdered form was combined and macerated in 1000ml of water and ethanol with intermittent shaking to facilitate extraction at room temperature for 72hours. The extracts were filtered using a Buchner funnel and Whatman no. 1 filter paper. The resulting filtrates were evaporated to dryness using a rotary evaporator and later oven dried at a temperature of 50°C and later reconstituted separately in 20% tween 80. The volume of extracts were administered according to the body weight of animals as described by (Erhirhe *et al.*, 2014).

### **2.4 Extraction of Sample for Phytochemicals**

The seeds of *Aframomum sceptrum* and *Parinari congensis* were crushed into a powdered form. 1g of the crushed sample was weighed and transferred into a test tube containing 15 ml of ethanol and 10 ml of 50% w/v potassium hydroxide. The content of the test tube was allowed to stand in a water bath at a temperature of 60°C for 60 minutes after which it was carefully transferred into a separating funnel and rinsed with 10ml of cold water, 10ml of hot water, 20ml of ethanol and 3ml of hexane. The extract in the test tube was washed three times with 10ml of 10% v/v ethanol solution and dried with anhydrous sodium sulphate and the solvent evaporated. A sample of the extract was then made soluble in 1000µl of pyridine of which 200µl was transferred into a vial on the Gas Chromatography machine for phytochemical analysis.

### **2.5 Quantification of Phytochemical using GC**

Phytochemical investigation of the seed extracts was conducted using a GC (Buck Scientific-GC M910, USA) equipped with flame ionization Samples detector. A RESTEK 15 meter MXT-1 column (15m× 250µm ×0.15µm) was used. A RESTEK 15 meter MXT-1 column (15m x 250µm x 0.15µm) was used. The injector temperature was 280°C with split less injection of 2 µl of sample and a linear velocity of 30cms-1, Helium 5.0 Pas was the carrier gas with a flow rate of 40ml/min. The oven operated initially at 200°C, it was heated to 330°C at a rate of 3°C/min and was kept at the temperature for 5min. Separation is governed by the more volatile nature of each component present in the sample and its interaction with the column stationary phase. Every separated component is brought to the detector system and transformed by the detector to equivalent electronic signal which is collected and recorded as data. Phytochemicals were determined by the ratio between the area and mass of internal standard and the area of the identified phytochemicals.

## 2.6 Experimental Animals

Wistar albino rats weighing between 150-200 g were used for this study. They were obtained from the animal house of University of Port Harcourt and were allowed to acclimatize under laboratory conditions prior to experiment for seven (7) days. Food and water were given *ad libitum* prior to the conduct of experiment. The experiment was performed according to the University's ethical guidelines for use of laboratory animals.

## 2.7 Acute Toxicity

Acute toxicity test was conducted according to the OECD guide lines No. 425. 2001. Normal healthy rats were divided into three groups containing five (5) rats. Group A served as control and was given food and water, group B was administered with relatively high dose of 4000mg/kg body weight of aqueous extract of *Aframomum sceptrum* and *Parinari congensis* (AQASPC) seeds and group C was administered with 4000mg/kg body weight of ethanol extract of *Aframomum sceptrum* and *Parinari congensis* (ETASPC) seeds orally. The rats were then observed continuously for 14 days for behavioral, neurological, autonomic responses and death.

## 2.8 Induction of Diabetes in Rats

Diabetes was induced in the rats by injecting 100mg/kg body weight of alloxan monohydrate in 0.9% NaCl solution to rats that were fasted overnight intraperitoneally (i.p) using insulin syringes. The rats were kept for 24 hour on 10% glucose solution to prevent initial hypoglycemia associated with alloxan. After 48 hours of i.p injection, blood glucose level was determined using Accucheck Active glucometer. Rats with blood glucose levels equal to 200mg/dl or > 200mg/dl were considered diabetic and used for this study (Bamidele *et al.*, 2014). The rats were further divided into four (4) groups containing five rats each. Group II received 100 mg/kg body weight of alloxan only, group III received 100 mg/kg of metformin only, and group IV received 400mg/kg body weight of aqueous seed extract of combined *Aframomum sceptrum* and *Parinari congensis* (AQASAP) while group IV received 400mg/kg body weight of ethanol seed extract of *Aframomum sceptrum* and *Parinari congensis* (ETASPC). Group I served as normal control and received 1ml of 20% tween 80 as shown in Table 1.

**Table 1: Groups and Treatment Protocol for Animals**

| S/N | Groups  | Treatment   |
|-----|---|---|
| 1   | Normal Control (NC)   | 1ml of 20% tween 80   |
| 2   | Diabetic Control (DC)   | 100mg/kg B.W of alloxan only                                      |
| 3   | Reference Drug (RD)   | 100mg/kg B.W of Metformin   |
| 4   | Aqueous Extract of <i>A. sceptrum</i> +<br><i>P. congensis</i> in 20% tween 80.<br>(ratio 1:1)      | 400mg/kg body weight of (AQASPC)+<br>100mg/kg body weight alloxan |
| 5   | Ethanol Extract of <i>A. sceptrum</i> + <i>P.</i><br><i>congensis</i> in 20% tween 80<br>(ratio1:1) | 400mg/kg body weight of (AQASPC)+<br>100mg/kg body weight alloxan |

## 2.9 Collection of Blood Samples

After the last dose, the rats were fasted overnight and sacrificed under chloroform anaesthesia. Blood samples were collected via cardiac puncture and transferred to appropriate sample bottle for biochemical analysis after 7, 14, and 21 days of treatment.

## 2.10 Determination of Biochemical Parameters

Blood glucose concentration was determined using Accucheck Active glucose strips and glucometer. The plasma insulin level was measured by a sandwich ELISA rat kit (Bio Ray Research and Diagnostic, USA), while amylase was assayed using commercial amylase kit (Tulip diagnostics, India).

## 2.11 Percentage Reduction of Fasting Blood Glucose (FBG)

Percentage reduction in FBG concentration of the diabetic rats within the 21- day treatment period was calculated according to the formula;

$$\% \text{ RFBGL} = \frac{\text{FBGL Day0} - \text{FBGL Day21}}{\text{FBGL Day0}} \times 100$$

## 2.12 Histopathology

The pancreas were excised from each group after 21 days of treatment and preserved in 10% formalin solution. They were processed and embedded in paraffin wax. Sections 4-6 microns were made and stained with hematoxylin / eosin and photomicrographs were made.

## 2.13 Statistical Analysis of Data

Data obtained from this study were expressed as mean  $\pm$  SEM followed by one-way analysis of the variance (ANOVA) and turkey post hoc test for the establishment of significance differences set at (p<0.05).

## 3.0 RESULTS

### 3.1 Results Obtained from Phytochemical Composition of the Seed Extracts

The result obtained for the phytochemical analyses of combined *A. sceptrum* and *P. congensis* Seeds is presented in Table 2. The table showed the presence of Narigerin, Anthocyanin, Quercitrin, Lunamarine, Catechin, Sapogenin, Phytate, Rutin, Kaempferol, Spartein, Ribalinidine and Epicatechin at various concentrations with Kaempferol showing the highest concentration of 61.0467 $\mu$ g/ml.

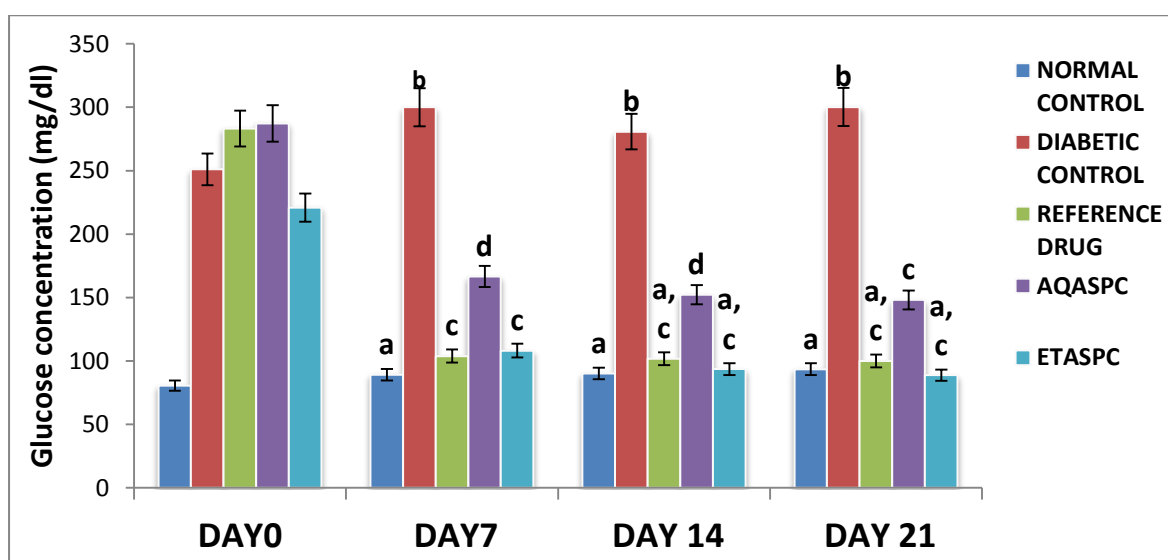
**Table 2: Phytochemical analyses of Combined *A. sceptrum* and *P. congensis* Seed Extracts**

| Phytochemical Component | Retention Time | Concentration ( $\mu$ g/ml) |
|-------------------------|----------------|-----------------------------|
| Naringerin              | 1.603          | 11.0761                     |
| Anthocyanin             | 4.100          | 16.0312                     |
| Quercitrin              | 9.146          | 43.1804                     |
| Lunamarine              | 12.016         | 31.7856                     |
| Catechin                | 14.310         | 29.5487                     |
| Sapogenin               | 20.116         | 33.3412                     |
| Phytate                 | 25.573         | 28.674                      |
| Rutin                   | 29.456         | 35.0932                     |
| Kaempferol              | 32.263         | 61.0467                     |

|                     |        |         |
|---------------------|--------|---------|
| <b>Sparteine</b>    | 35.140 | 14.3705 |
| <b>Ribalinidine</b> | 40.080 | 7.1185  |
| <b>Epicatechin</b>  | 45.223 | 38.1678 |

### 3.2 Effects of Combined *A. sceptrum* and *P. congensison* Fasting Blood Glucose Levels of Rats

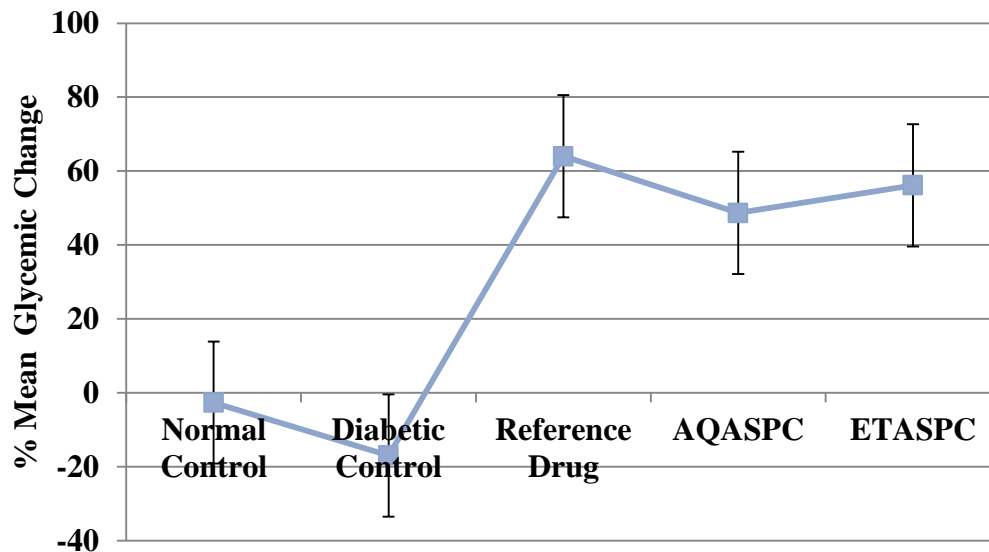
The result obtained for the effect of combined *A. sceptrum* and *P. congensison* glucose levels of the rats is shown in Figure 1. From the figure, there was an increase in glucose concentration of alloxan treated groups compared to control at Day 0. Fasting blood glucose concentration at day 7, 14 and 21, significantly ( $p < 0.05$ ) increased in diabetic control group compared to the normal control group which is an indication of hyperglycemia. Groups treated with the Reference drug, AQASPC and ETASPC showed significant reduction ( $p < 0.05$ ) in fasting blood glucose level compared to the diabetic control group. The result obtained for the ETASPC extract treated group showed decrease not significantly different ( $p > 0.05$ ) from reference and normal control.



**Figure 2: Effects of Aqueous and Ethanol Extracts of Combined *A. sceptrum* and *P. congensison* seeds on Fasting Blood Glucose Levels.** Values are expressed as Mean  $\pm$  S.E.M (n=5). Means with different superscript (a-d) are significantly different (Turkey HSD,  $p < 0.05$ ).

### 3.3 Effect of Combined *A. sceptrum* and *P. congensison* Mean % Glucose Reduction in Rats

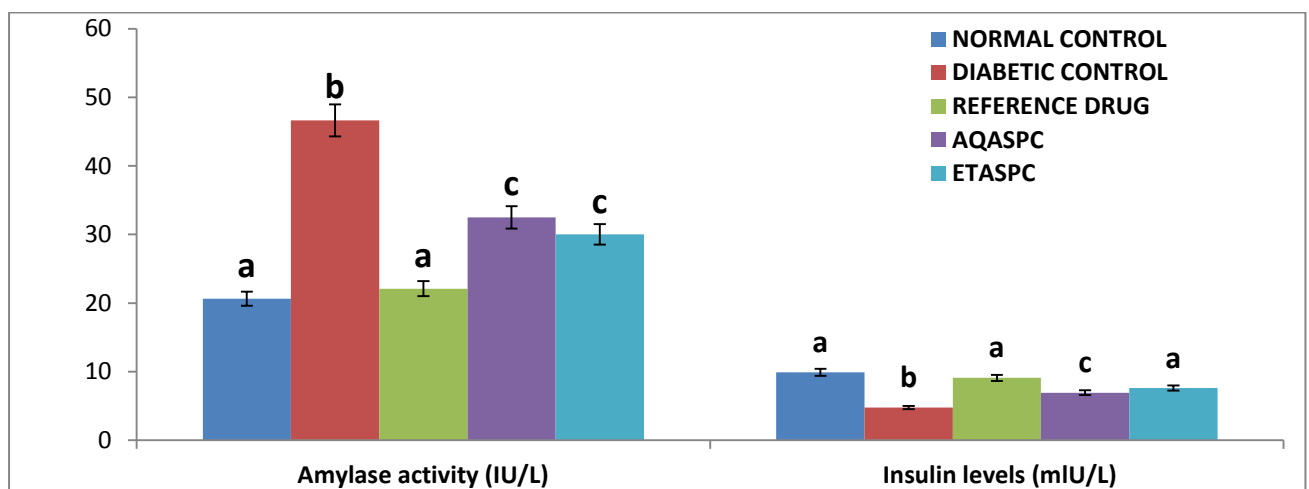
Effect of combined *A. sceptrum* and *P. congensison* percentage reduction of blood glucose is shown in Figure 3. The reference drug, AQASPC and ETASPC extract showed significant ( $p < 0.05$ ) reduction compared to the diabetic group. However, the result obtained for the mean % glucose reduction for ETASPC was not significantly ( $p < 0.05$ ) different from the groups treated with the Reference drug. This shows that the extract had similar ability to establish normal level of blood glucose like the reference drug and delay progression to diabetes.



**Figure 3: Effects of Aqueous and Ethanol Extracts of Combined *A. sceptrum* and *P. Congensis* Seed extracts on % Mean Glycemic Change.**

### 3.4 Effects of Combined Extracts of *A. sceptrum* and *P. congensis* Seeds on Amylase and Insulin levels

The result obtained for effect of combined *A. sceptrum* and *P. Congensis* on amylase enzyme and insulin levels are presented in Figure 4. From the figure, there was significant ( $p < 0.05$ ) increase in amylase level and significant ( $p < 0.05$ ) decrease in insulin level in the diabetic group compared to normal control group. This is an indication of inflammation and impairment in insulin secretion. Treatment with the reference drug and AQASPC and ETASPC extract showed significant decrease ( $p < 0.05$ ) in amylase activity and significant ( $p < 0.05$ ) increase in insulin compared to diabetic group. However result obtained for group comparison of the extract treated groups and reference showed no significant ( $p > 0.05$ ) change.

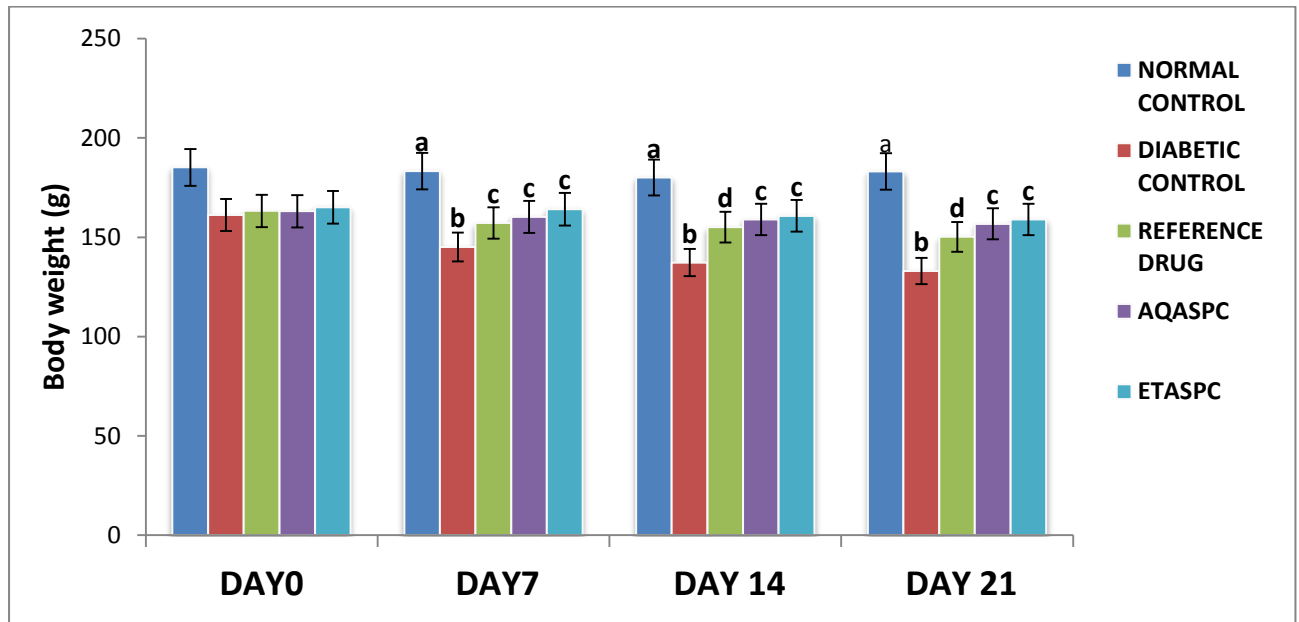


**Figure 4: Effect of Aqueous and Ethanol Extracts of Combined *A. sceptrum* and *P. congensis* Seeds on Amylase and Insulin Levels.**

Values are expressed as mean  $\pm$  S.E.M (n=5). Means with different superscript (a-c) are significantly different (Turkey HSD,  $p < 0.05$ ).

### 3.5 Effects of Combined *A. sceptrum* and *P. congensis* Seeds Extracts on Body Weight of Rats

The result obtained for the body weight of the rats is presented in Figure 5. The body weights of all alloxan induced diabetic rats significantly ( $p < 0.05$ ) decreased compared to control. However, AQASPC and ETASPC treated group showed no significant ( $p > 0.05$ ) decrease when compared to each other while there was significant ( $p < 0.05$ ) increase when compared to the reference group at day 14 and 21 respectively.



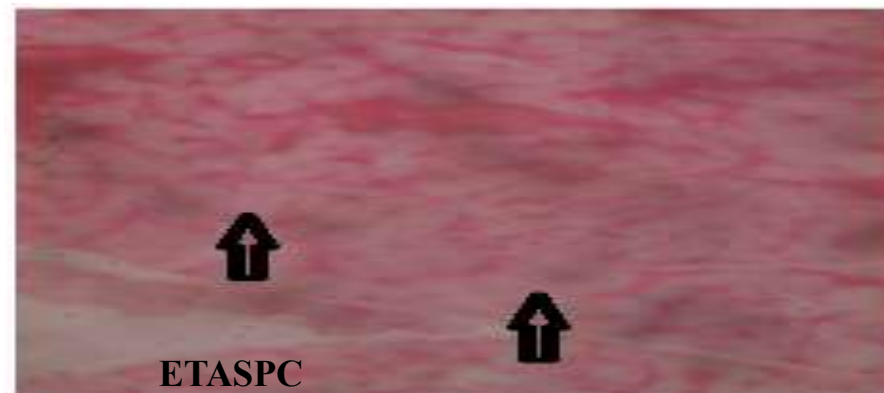
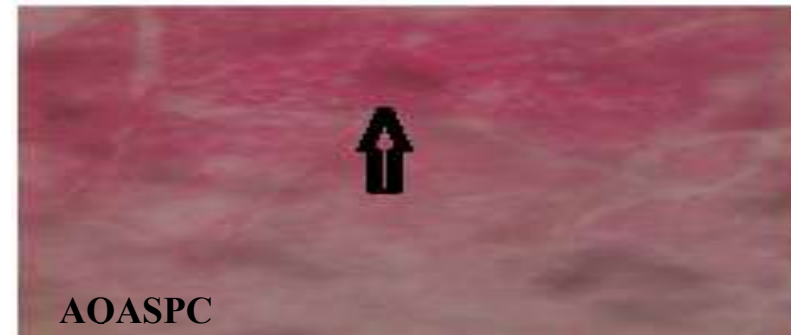
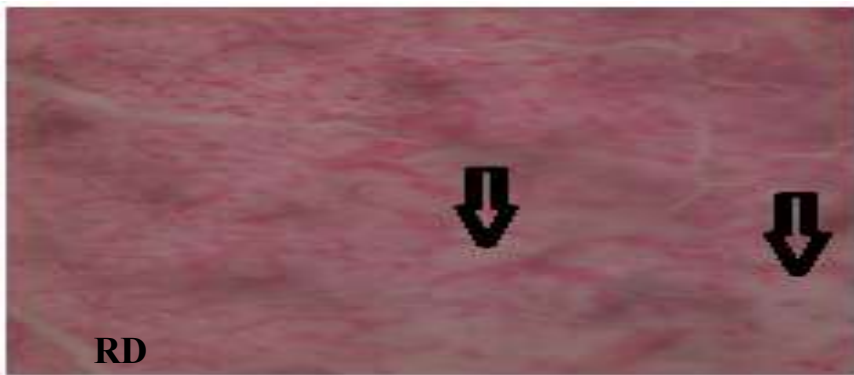
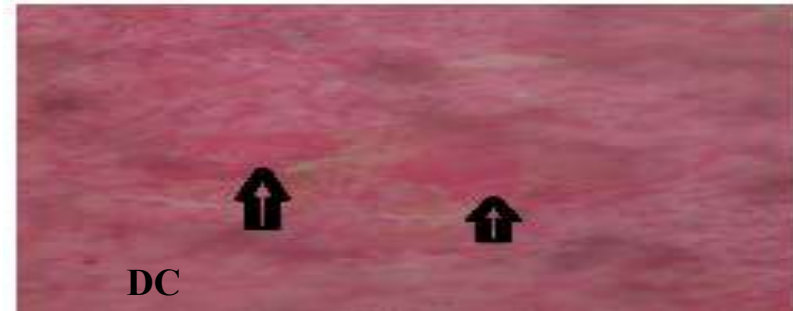
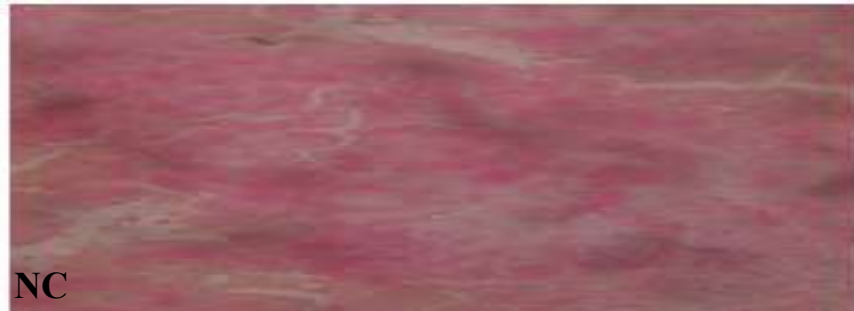
**Figure 5: Effects of Aqueous and Ethanol Extracts of Combined *A. sceptrum* and *P. congensis* Seeds on Body Weight of Rats.**

Values are expressed as Mean  $\pm$  S.E.M (n=5). Means with different superscript (a-c) are significantly different (Turkey HSD,  $p < 0.05$ ).

### 3.6 Histopathological Examination of Rats Pancreas

Histopathological observation of pancreas of rats showed Normal morphology in Normal control group and Reference drug treated group. The acini portions and Langerhans islets were well organized and with normal morphology. In diabetic control rats, the pancreatic tissue showed distorted pancreatic duct and degenerated  $\beta$ - cells. The extracts treated groups showed few swollen and distorted  $\beta$ - cells





**Figure 6: Effects of Combined *A. sceptrum* and *P. congensis* Seeds Extracts on the histological of rat pancreas by hematoxylin and eosin (H&E) staining (X400).** NC: Pancreas of normal control rats showing acini and duct with normal histology. DC: Pancreas of diabetic control showing distorted pancreatic duct and degenerated  $\beta$ - cells. RD: Pancreas of reference drug treated group showing normal appearance of Langerhans islets. AQASPC: Pancreas of AQASPC treated showing pancreatic vacuoles previously occupied by glycogen with few swollen  $\beta$ - cells. ETASPC: Pancreas of ETASPC treated group showing mild distorted  $\beta$ - cells.

#### 4.0 Discussion

Plants and their products possess different phytochemicals also known as bioactive active principles with diverse pharmacological and physiological functions which include hypolipidemic, antioxidant, and hypoglycemic, antimicrobial and anticancer activity (Ujowundu *et al.*, 2015). Ethno botanical survey and the knowledge about these pharmacological active principles of medicinal plants have led to various investigations and search for new and readily available drugs Medicinal preparations derived from different plant products are currently explored singly or in combination to provide the synergistic efficacy required for the treatment of various diseases such as diabetes, cancer, “malaria”, “cough” and post natal womb discomfort (Odegbemi, 2006, Emeka *et al.*, 2011, Sari *et al.*, 2015, Ojiako *et al.*, 2016). Researchers are constantly combing the earth for various phytochemicals as lead compounds for the design and synthesis of novel drugs with no side effects. (Idu and Onyinibe, 2007). From this study, phytochemical analyses of the seed extracts of *Aframomun sceptrum* and *Parinari congensis* revealed varied concentrations of phytochemical components which include Narigerin, Anthocyanin, Quercitrin, Lunamarine, Catechin, Sapogenin, Phytate, Rutin, Kaempferol, Spartein, Ribalinidine and Epicatechin. Understanding of the chemical interactions between these components and other organisms including humans could provide therapeutic agents that can address specific health related problems contributing to healthier life span.

Acute toxicity is better defined as LD<sub>50</sub>, a dose that kills 50% of animals. It involves short term evaluation or consequences of single dose response of the test substance. It is also done to establish a safety profile of the test substance in formulation of drugs before it can be used on humans (David and Enegeide, 2014). The result of *in vivo* acute toxicity study showed that there was no sign of toxicity and death recorded at relatively high doses of 4000mg/kg body weight of extracts administered after fourteen (14) days. This is an indication that the LD<sub>50</sub> is greater than 4000mg/kg body weight and considered to be safe. Thus one tenth of this high dose (400mg/kg) was selected and used as a fixed dose for this study.

Diabetes mellitus commonly known as diabetes is a chronic metabolic disorder that is frequently characterized by chronic hyperglycemia. In this condition, glucose becomes liberally available and cannot enter into cells of the body for rapid production of ATP (Ozougwu *et al.*, 2013). It occurs due to deficiency in insulin secretion from pancreatic beta cells or insensitivity of insulin actions by insulin receptors family (Raveendran and Rajamohan, 2012). Complications and metabolic derangements associated with the disease often impose tremendous agony and financial burden on people who suffer the disease. Diabetes doubles the risk of cardiovascular disease, cause diabetic retinopathy, nephropathy neuropathy painful muscle wasting and weakness (Arul *et al.*, 2016). Induction of diabetes in experimental animals has given elaborate information of the biochemical derangements associated with diabetes (Arul *et al.*, 2016). Alloxan is a toxic glucose analogue that is used widely to induce diabetes in experimental animals. It is well known for its selective destruction of insulin producing pancreatic beta cells by free radical generating mechanism formed in redox reaction (Ankurand Shahjad, 2012, Ramadan *et al.*, 2017). It causes

reduction of insulin secretion by damaging pancreatic  $\beta$  -cells in rats. The deficiency of insulin triggers the influx of varieties of enzymes, metabolic derangements, biochemical transformation and alteration of membranes and organs in the body (Ozougwu *et al.*, 2013). In this study, intraperitoneal administration of 100mg/kg body weight of alloxan caused significant increase in glucose levels (hyperglycemia). Amylase activity showed significant increase while insulin levels decreased significantly. The significant increase in amylase activity may be an indication of a pathological condition resulting from inflammation of the exocrine pancreas which can cause elevation of the pancreatic enzymes like amylase (Peter and Martin, 2006) Reduction or deficiency in insulin secretion makes glucose to be liberally available in blood and can result to hyperglycemia. Administration of 400mg/kg body of aqueous and ethanol extracts of combined *Aframomum sceptrum* and *Parinari congensis* seeds significantly reduced the glucose and amylase levels while significant increase was observed in insulin levels. This is an indication of hypoglycemic and extra pancreatic effects preventing progression to diabetes. Hepatic production of glucose is the hallmark sign of hyperglycemia in all forms of diabetes (Agostino, 1992). Inhibitory hepatic production and insulin mediated uptake of glucose by cells could be a possible mechanism for these observed effects. This result is similar to those reported in previous works (Emeka and Oludare, 2011, Ezejiofor *et al.*, 2013, George and Uwakwe, 2014). Increase in insulin levels may also contribute in alleviating progression to diabetes.

Diabetes is often characterized by rapid and significant weight loss (WHO, 2002). The decrease in body weight observed in the diabetic control group may be imposed by alloxan. Toxic fallout of alloxan may regulate bitter taste perception and reduce the ability of animals to eat food. Subsequently, rapid catabolism of fats and protein occur which may result to reduction in body weight. Protein content in muscular tissue may be decreased via proteolysis while that of fat occur by lipolysis (Bhatia and Keran 2013, Ramadan *et al.*, 2017). The insignificant body weight change observed in the extract treated group compared to the reference drug may be an indication that the extract had no adverse effect on the body weight and show insulin mediated uptake of glucose, amino acids and fat into insulin sensitive cells like muscle and fat cells since insulin is the body's fat storage hormone that governs appetite, satiety and blood glucose levels (Soumya and Srilatha, 2011)

Administration of 400mg/kg body weight of aqueous and ethanol seed extracts of *Aframomum sceptrum* and *Parinari congensis* exhibited cytoprotective effect on pancreatic  $\beta$ - cells and increased insulin secretion which ameliorates progression to diabetes and its complications. However results obtained for the ethanol extract exhibited hypoglycemic effects comparable to the reference drug metformin. Inhibition of hepatic production of glucose, insulin mediated uptake of glucose by cells, tissue control of lipolysis and proteolysis could contribute to possible mechanism for the observed hypoglycemic effects. Different bioactive components derived from plant products have been reported to exhibit hypoglycemic control through various mechanisms such as modulating the activity or gene expression of enzymes related to antioxidant glucose, stimulating insulin secretion, inhibition of intestinal  $\alpha$ -glucosidase, pancreatic lipase, and amylase activities, facilitated uptake of glucose, regeneration/proliferation of  $\beta$ -cells (Emeka *et al.*, 2011, Ojiako *et al.*, 2015). Furthermore, the presence of these bioactive components with multifunctional properties in the combined seed extracts of *Aframomun sceptrum* and *Parinari congensis* could have played a role of synergy in ameliorating progression to diabetes.

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