# Characterisation and Anti-diabetic Activity of Phenylquinoline, and Narceine Isolated from *Ficus polita* Leaf

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***Authors' contributions***

*This work was carried out in collaboration between all authors. Authors AN, MSS and AJA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors AMW, AAI, AI, IUM, AIY, KIM and AMK managed the analyses of the study and literature searches. All authors read and approved the final manuscript.*

***Article Information***

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| *Original Research Article* |

## ABSTRACT

The present study was conducted to evaluate anti-diabetic potentials of column chromatography fractions (F1-F6) of chloroform leaf extract of *Ficus polita* and to detect the probable bioactive compounds present in the most active fraction using spectroscopic techniques. Antidiabetic potential of the fractions (F1-F6) were tested at a dose of 50 mg/kg on wistar rats. Fraction 3 and metformin treated diabetic groups showed significant decreases in fasting blood glucose (FBS) level, ameliorate hepatic and renal damages by decreasing the levels of serum total bilirubin, direct bilirubin AST, ALT, creatinine, urea, potassium and chloride, but increasing the levels of serum total

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protein, albumin, sodium, and bicarbonate compared to untreated diabetic rats. Fraction 3 also stimulates insulin secretion by β cells. After alloxan administration, the levels of hepatic and renal tissues antioxidant markers such as GSH, SOD and catalase were decreased whereas the level of hepatic and renal tissues MDA was elevated. The levels of these antioxidant markers were brought to normalcy by fraction 3 (F3). Histological studies of the pancreas supported the biochemical findings, and treatment with fraction 3 (F3) was found to be effective in restoring alloxan-induced pancreatic toxicity in rats. FTIR and GCMS and analyses were conducted for the detection of bioactive compound(s) in fraction 3 (F3) and the result revealed the presence of "8-methoxy-4-phenylquinoline and narceine The study concludes that; the anti-diabetic property of the leaf of *Ficus polita* is mediated by the bioactive compounds " 8-methoxy-4-phenylquinoline, and narceine." through their antioxidant properties and stimulation of damaged pancreas to produce more insulin.

## 1. INTRODUCTION

Diabetes mellitus is an endocrine disease characterised by chronic hyperglycemia with disturbances of carbohydrate, fat, and protein metabolism resulting from defects in insulin secretion, insulin action or both, and is typically associated with failure of pancreatic β cells [1]. There are two major types of diabetes mellitus; type 1 and type 2. In type 1 diabetes, or insulin dependent diabetes mellitus, the body has little or no insulin secretory capacity and depends on exogenous insulin to prevent metabolic disorders and death. In type 2 diabetes, a non-insulin dependent diabetes mellitus, the body retains some endogenous insulin secretory capability; however, its insulin level is low relative to its blood glucose level and/or there is a measure of insulin resistance [1,2].

Medicinal plants have been used extensively as a source for numerous active constituents for treating human diseases and they, as well, have high therapeutic value [3]. *Ficus polita*, also called Fig tree, is one of the *Ficus species* belonging to the family *Moraceae*. They are often distinguished by their characteristic root growing from the branches and a common homestead tree in Nigeria grown to provide shade around houses [4].

Locally, it is called "Durumi" in Hausa. Traditionally the fruit and young leaf are chewed for dyspepsia. The bark and roots infusions are used in treatment of infectious diseases, diarrhoea, abdominal pain, like many of the species of Moraceae family [5].

Previous researches suggest that the genus *Ficus* is a rich source of a wide range of phytochemicals with health benefits, and of these, antidiabetic activity is perhaps the most notable [6]. Olaokun et al. [1] reported an *in vitro* alpha glucosidase and alpha amylase inhibitory of ten *Ficus species*, *Ficus polita* inclusive. The present study was aimed at evaluating the antidiabetic activities of the chromatographic fractions of chloroform leaf extract of *F. polita* on Wistar Rats.

## 2. MATERIALS AND METHODS

### 2.1 Materials

#### 2.1.1 Study animals

*Wistar* albino rats of both sexes, weighing 100-150 g, were obtained from Department of Physiology, Bayero University Kano, Nigeria. They were kept, at room temperature, in wire-mesh cages, to acclimatise for 1 week. They were fed with animal feeds (Vitalised Feeds, Jos, Nigeria) and tap water *ad libitum*.

#### 2.1.2 Plant material

The leaves of *F. polita* were obtained from Kofar Marusa New Lay-out, Katsina, Nigeria. The plant was identified and voucher specimen (BUKHAN 0104) was deposited at the Herbarium Unit of the Department of Plant Biology, Bayero University Kano, Nigeria. The leaves were air dried under shade for two weeks and ground into powder using a mortar and pestle.

### 2.2 Methods

#### 2.2.1 Preparation of alloxan

One point five (1.5 g) of alloxan hydrate was dissolved in 10 ml of distilled water to give a concentration 150 mg/ml.

### 2.2.2 Induction of diabetes mellitus with alloxan

Diabetes mellitus was induced with a single intraperitoneal injection of alloxan hydrate at a dose of 150 mg/kg, after the rats were allowed to fast for 12 hours. The volume of the solution containing 150 mg/kg given to each experimental rat was determined by the following relationship.

Volume administered (ml) = {Dose (mg/kg) × weight of rat (kg)/ Concentration of alloxan (mg/ml)}

After 48 hours' window period, diabetic state was confirmed by the measurement of fasting blood glucose level using Accu – Chek Glucometer and strips, with blood collected by tail vein puncture. Rats with fasting glucose concentration ≥200 mg/dl were considered diabetic, and were used for the study [7].

### 2.2.3 Screening of the fractions for hypoglycaemic activities

Forty-five (45) rats were used and grouped into nine groups of five rats each. Fractions were administered to animals for a period of two weeks.

**Group I:** Normal control

**Group II:** diabetic control

**Group III:** standard drug (Metformin, 100 mg/kg body weight)

**Group IV:** diabetic, administered with 50 mg/kg body weight of fraction 1 (F1)

**Group V:** diabetic, administered with 50 mg/kg body weight of fraction 2 (F2)

**Group VI:** diabetic, administered with 50 mg/kg body weight of fraction 3 (F3)

**Group VII:** diabetic, administered with 50 mg/kg body weight of fraction 4 (F4)

**Group VIII:** diabetic, administered with 50 mg/kg body weight of fraction 5 (F5)

**Group IX:** diabetic, administered with 50 mg/kg body weight of fraction 6 (F6).

Fasting blood glucose concentrations of rats was measured at an interval of three (3) days for a period of two (2) weeks. The animals were then euthanized, and blood samples were collected for analyses of liver function parameters, kidney function parameters, insulin, alpha amylase, and alpha glucosidase. Liver and kidney tissue samples were taken and homogenized for antioxidant assay, while pancreas was fixed in 10% formalin solution, for 24 hours, for histopathological studies.

### 2.2.4 Statistical analysis

Results were expressed as mean ± standard error of mean. Statistical differences between groups were analysed by one-way analysis of variance (ANOVA) followed by Tukey's comparison test using Graph Pad Instat 3 Software version 3.05. Differences of $p < 0.05$ were considered to be significant.

## 3. RESULTS

### 3.1 Effect of Column Chromatography Fractions (F1-F6) on Fasting Blood Glucose Concentrations of Diabetic Rats

Fig. 1 shows the fasting blood glucose concentrations of diabetic rats administered with column chromatography fractions (F1-F6) taken at interval of three (3) days over two (2) weeks of administration. After 48 hours of alloxan injection (at day 3), the blood glucose concentrations of diabetic control group (group 2) and the treatment groups (group 3, 4, 5, 6, 7, 8, and 9) increases significantly ($p < 0.05$) compared to normal control group (group 1). A significant ($p < 0.05$) decrease in fasting blood glucose concentrations of diabetic rats administered with standard drug (metformin), fractions 1, 2, 3, 4, 5, and 6 was observed. Of all the fractions, fraction 3 showed the highest hypoglycaemic activity.

### 3.2 Effect of Column Chromatography Fractions (F1-F6) on Feed Intake, Water Intake, and Body Weight of Diabetic Rats

Throughout the 15 days of the experiment, there was increase in feed intake and water intake in diabetic control rats compared normal control rats (Figs. 2 and 3). After induction (at day 3), there was increase in feed intake and water intake in standard drug control group, F1, F2, and F3 administered rats, but the feed and water intake decrease at day 6, and continue to decrease at day 9, day 12, up to day 15 (Figs. 2

and 3). Throughout the 15 days of the experiment, there was decrease in weight in diabetic control rats compared to normal control rats (Fig. 4). After induction (at day 3), there was decrease in weight in standard control group, F1, F2, and F3 administered rats, but the weight increases at day 6, and continue to increase at day 9, day 12, up to day 15 (Fig. 4).
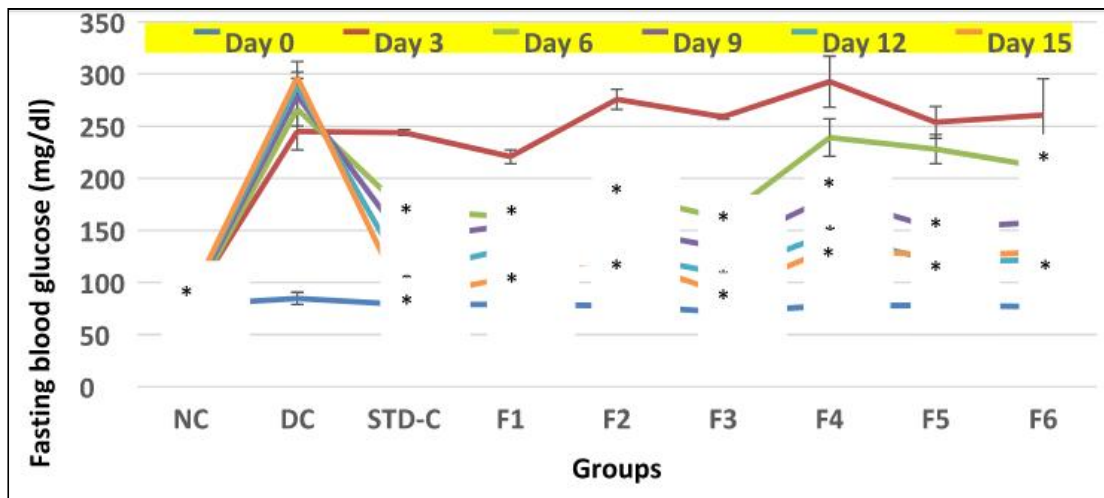


**Fig. 1. Fasting blood glucose level of rats administered with column chromatography fractions for two weeks (from day 0 to day 15)**
*Key: Day 0 = Before alloxan, NC= Normal control, DC= Diabetic control, STD-C= Standard drug control,*
*F1 = fraction 1, F2 = fraction 2, F3 = fraction 3, F4 = fraction 4, F5 = fraction 5, F6 = fraction 6.*
*Data are mean ± Standard error of mean, n = 5. Comparisons are DC vs NC, treatment groups,*
*\* = significant different (p<0.05).*
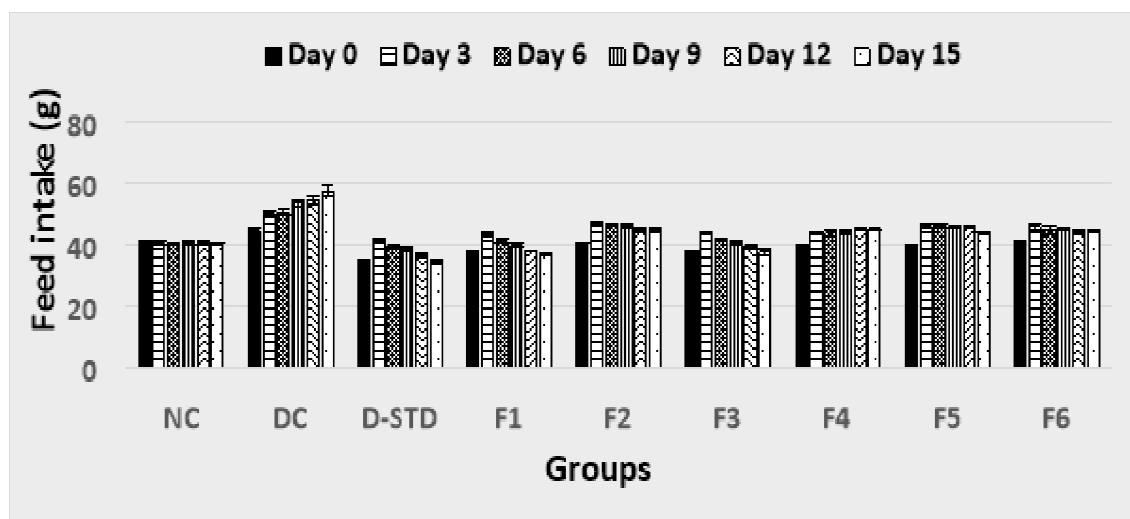


**Fig. 2. Feed intake of alloxan induced diabetic rats (at interval of 3 days) administered with column chromatography fractions (F1 to F6) for two weeks**
*Key: NC= Normal control, DC= Diabetic control, STD-C= Standard drug control, F1 = fraction 1,*
*F2 = fraction 2, F3 = fraction 3, F4 = fraction 4, F5 = fraction 5, F6 = fraction 6.*
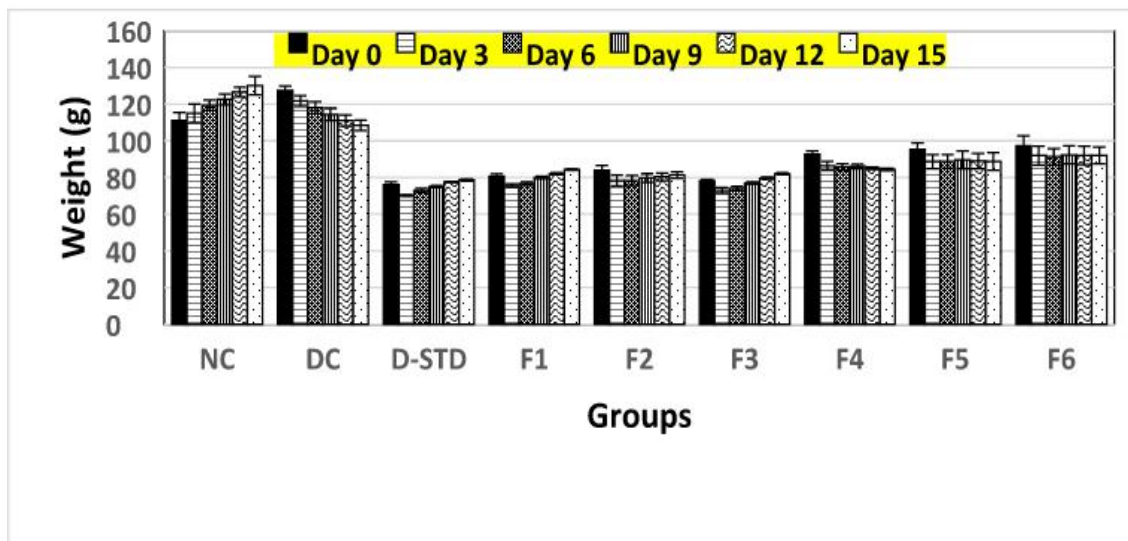*Data are mean ± Standard error of mean, n = 5*
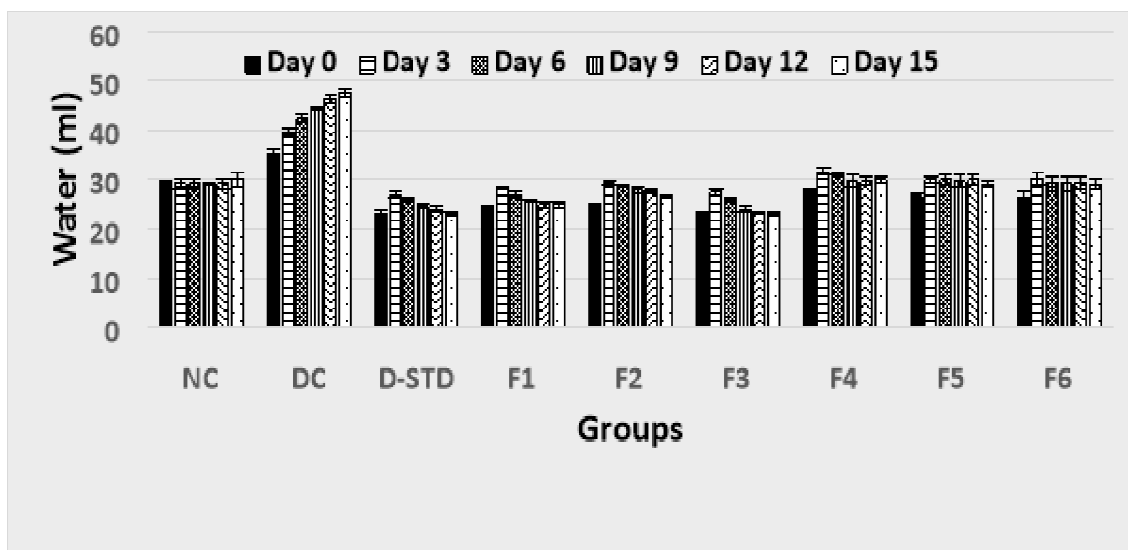
**Fig. 3. Water intake of alloxan induced diabetic rats (at interval of 3 days) administered with column chromatography fractions (F1 to F6) for two weeks**
*Key: NC= Normal control, DC= Diabetic control, STD-C= Standard drug control, F1 = fraction 1, F2 = fraction 2, F3 = fraction 3, F4 = fraction 4, F5 = fraction 5, F6 = fraction 6. Data are mean ± Standard error of mean, n = 5*

### 3.3 Effect of Fraction 3 on Liver Function Indices

There was significant ($p < 0.05$) decrease in serum total protein and serum albumin, but significant ($p < 0.05$) increase in the levels of serum TB, DB, AST and ALT, in DC rats compared to NC rats (Table 1). Administration of F3 leads to significant ($p < 0.05$) increase in the levels of serum total protein and serum albumin, but significant ($p < 0.05$) decrease in the levels of TB, DB, AST and ALT (Table 1).



**Fig. 4. Weight of alloxan induced diabetic rats (at interval of 3 days) administered with column chromatography fractions (F1 to F6) for two weeks**
*Key: NC= Normal control, DC= Diabetic control, STD-C= Standard drug control, F1 = fraction 1, F2 = fraction 2, F3 = fraction 3, F4 = fraction 4, F5 = fraction 5, F6 = fraction 6. Data are mean ± Standard error of mean, n = 5*

**Table 1. Liver function parameters of rats administered with column chromatography fraction (F3) for two weeks**

| Treatment (mg/kg) | TP (g/dl) | ALB (g/dl) | TB (mg/dl) | DB (mg/dl) | AST (U/l) | ALT (U/l) |
|---|---|---|---|---|---|---|
| NC | 5.27±0.06* | 3.52±0.10* | 0.74±0.06* | 0.21±0.03* | 21.88±1.19* | 18.64±0.97* |
| DC | 2.74±0.04 | 2.37±0.05 | 2.40±0.09 | 1.36±0.03 | 95.47±1.81 | 49.49±1.67 |
| STD-C | 4.63±0.03* | 3.26±0.04* | 1.46±0.05* | 0.67±0.02* | 38.48±3.15* | 26.23±0.94* |
| F3 | 4.41±0.03* | 3.14±0.03* | 1.44±0.05* | 0.89±0.02* | 68.10±2.05* | 37.98±1.39* |

Key: TP= Total Protein; ALB= Albumin; TB= Total Bilirubin; DB= Direct Bilirubin; AST= Aspartate amino Transferase, ALT= Alanine amino Transferase, NC= Normal control, DC= Diabetic control, STD-C= Standard drug control, F3 = fraction 3. Data are mean ± SEM, n = 5. Comparisons are DC vs NC, STD-C, and F3, * = significant different (p<0.05)

**Table 2. Kidney function parameters of rats administered with column chromatography fraction (F3) for two weeks**

| Treatment (mg/kg) | Creatinine (mmol/L) | Urea (mmol/L) | Bicarbonate (mmol/L) | Sodium (mEq/L) | Potassium (mEq/L) | Chloride (mEq/L) |
|---|---|---|---|---|---|---|
| NC | 0.07±0.01* | 6.08±0.75* | 24.36±1.86* | 134.29±1.75* | 3.04±0.02* | 94.79±1.73* |
| DC | 0.23±0.03 | 17.84±0.89 | 12.05±1.35 | 146.75±2.29 | 4.12±0.02 | 134.16±1.89 |
| STD-C | 0.11±0.02* | 9.29±1.43* | 24.29±1.77* | 137.02±2.28* | 3.59±0.09* | 105.86±1.01* |
| F3 | 0.12±0.01* | 9.79±1.20* | 19.32±1.73* | 136.27±1.76* | 3.62±0.11* | 105.26±1.62* |

Key: NC= Normal control, DC= Diabetic control, STD-C= Standard drug control, F3 = fraction 3. Data are mean ± SEM, n = 5. Comparisons are DC vs NC, STD-C, and F3. * = significant different (p<0.05)

## 3.4 Effect of Fraction 3 on Kidney Function Indices

There was significant (p<0.05) increase in the levels of serum creatinine, urea, potassium and chloride, but significant (p<0.05) decrease in the level of serum sodium and bicarbonate, in DC rats compared to NC rats (Table 2). Administration of F3 leads to significant (p<0.05) decrease in the levels of serum creatinine, urea, potassium and chloride, but significant (p<0.05) increase in the level of serum sodium and bicarbonate (Table 2).

## 3.5 Effect of Fraction 3 on Liver and Kidney Tissues Oxidative Stress Markers

There was significant (p<0.05) decrease in liver tissue GSH, SOD, CAT, but significant (p<0.05) increase in liver tissue MDA, in DC rats compared to NC rats (Table 3). Administration of F3 leads to significant (p<0.05) increase in the GSH, SOD, CAT, but significant (p<0.05) decrease in the MDA (Table 3). There was significant (p<0.05) decrease in kidney tissue GSH, SOD, CAT, but significant (p<0.05) increase in kidney tissue MDA, in DC rats compared to NC rats (Table 4). Administration of F3 leads to significant (p<0.05) increase in the GSH, SOD, CAT, but significant (p<0.05) decrease in the MDA (Table 4).

## 3.6 Effect of Fraction 3 on Serum Alpha Amylase, Alpha Glucosidase and Insulin

There was significant (p<0.05) increase in serum α-amylase and serum α-glucosidase activities, but significant (p<0.05) decrease in serum insulin level, in DC rats compared to NC rats (Table 5). Administration of F3 leads to significant (p<0.05) decrease in the activities of α-amylase and α-glucosidase, but significant (p<0.05) increase in the level of serum insulin (Table 5).

## 3.7 Histopathological Examination of Pancreatic Tissues of Diabetic Rats Administered with Fraction 3

Histopathological examination of pancreatic tissues of diabetic rats administered with fraction 3 were shown in Plate 1(A-D). Plate 1A showed photomicrograph of normal control rat with normal pancreatic tissue architecture, showing unremarkable tissue lesions. Plate 1B showed pancreatic tissue section of diabetic control rat showing no pancreatic islets. Plate 1C showed pancreatic tissue section administered with standard drug showing well – formed pancreatic islets. Plate 1D showed section of pancreatic tissue administered with fraction 3 showing well – formed pancreatic islets.

**Table 3. Liver tissue oxidative stress markers of diabetic rats treated with column chromatography fraction (F3) for two weeks**

| Treatment (mg/kg) | MDA (µmol/mg Protein) | GSH (µg/ml) | SOD (U/mg/Protein) | CAT (U/mg Protein) |
|---|---|---|---|---|
| NC | 48.22 ± 2.45* | 60.04 ± 3.81* | 9.30 ± 0.27* | 12.08 ± 0.33* |
| DC | 88.55 ± 2.75 | 21.39 ± 0.64 | 6.69 ± 0.07 | 6.31 ± 0.25 |
| STD-C | 64.39 ± 1.47* | 32.76 ± 1.42* | 7.70 ± 0.04* | 8.70 ± 0.61* |
| F3 | 68.17 ± 2.22* | 29.20 ± 0.50 | 7.47 ± 0.07* | 9.10 ± 0.70* |

*Key: MDA= Malondialdehyde, GSH= Reduced glutathione, SOD= Superoxide dismutase, CAT= Catalase, NC= Normal control, DC= Diabetic control, STD-C= Standard drug control, F3 = fraction 3. Data are mean ± SEM, n = 5. Comparisons are DC vs NC, STD-C, and F3, \* = significant different ($p<0.05$)*

**Table 4. Kidney tissue oxidative stress markers of diabetic rats treated with column chromatography fraction (F3) for two weeks**

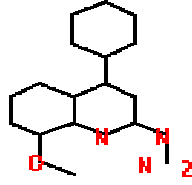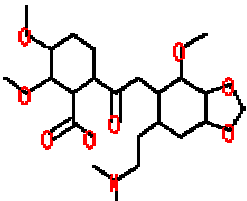| Treatment (mg/kg) | MDA (µmol/mg Protein) | GSH (µg/ml) | SOD (U/mg/Protein) | CAT (U/mg Protein) |
|---|---|---|---|---|
| NC | 51.43 ± 0.91* | 47.49 ± 1.78* | 9.77 ± 0.25* | 11.48 ± 0.29* |
| DC | 76.06 ± 2.01 | 26.39 ± 1.08 | 5.53 ± 0.21 | 5.67 ± 0.22 |
| STD-C | 56.93 ± 1.00* | 39.99 ± 1.43* | 6.55 ± 0.18* | 10.12 ± 0.15* |
| F3 | 58.70 ± 1.19* | 32.41 ± 1.13* | 6.55 ± 0.20* | 10.03 ± 0.21* |

*Key: MDA= Malondialdehyde, GSH= Reduced glutathione, SOD= Superoxide dismutase, CAT= Catalase, NC= Normal control, DC= Diabetic control, STD-C= Standard drug control, F3 = fraction 3. Data are mean ± SEM, n = 5. Comparisons are DC vs NC, STD-C, and F3, \* = significant different ($p<0.05$)*

**Table 5. Serum α-Amylase, α-glucosidase, and insulin activities of diabetic rats treated with column chromatography fraction (F3) for two weeks**

| Treatment (mg/kg) | α-Amylase (IU/L) | α-Glucosidase (IU/L) | Insulin (µIU/L) |
|---|---|---|---|
| NC | 27.71 ± 1.74* | 20.77 ± 1.44* | 9.15 ± 0.05* |
| DC | 56.37 ± 2.17 | 28.04 ± 1.30 | 5.10 ± 0.06 |
| STD-C | 35.31 ± 1.78* | 21.53 ± 0.97* | 8.16 ± 0.04* |
| F3 | 38.43 ± 1.81* | 22.10 ± 1.55* | 7.50 ± 0.15* |

*Key: NC= Normal control, DC= Diabetic control, STD-C= Standard drug control, F3 = fraction 3. Data are mean ± SEM, n = 5. Comparisons are DC vs NC, STD-C, and F3, \* = significant different ($p<0.05$)*

**Table 6. GC-MS analysis of the most potent fraction**

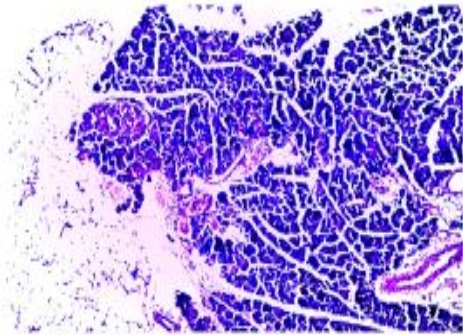| Peak | R. time | MW | M. formula | Name | Structure |
|---|---|---|---|---|---|
| 1 | 7.796 | 265 | $C_{16}H_{15}N_3O$ | 8-Methoxy-4-phenylquinoline-2-hydrazine |  |
| 2 | 8.569 | 445 | $C_{23}H_{27}NO_8$ | Narceine |  |

Plate A (Normal control): Pancreas section shows unremarkable pancreatic tissue
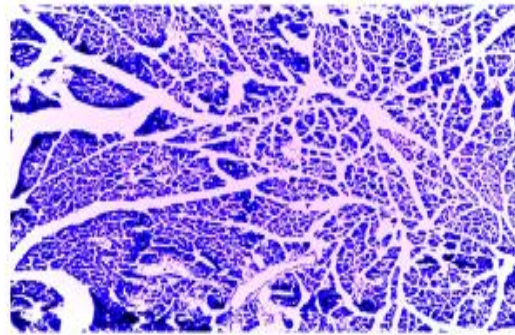
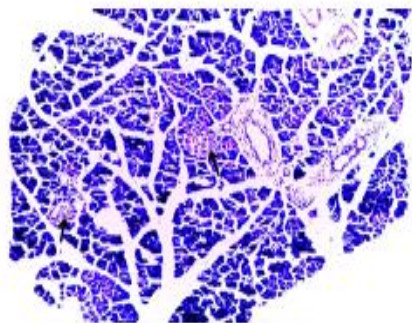Plate B (Diabetic control): Section of pancreatic tissue shows no pancreatic islets.

Plate C (Standard drug control): Section of pancreatic tissue shows well – formed pancreatic islets.
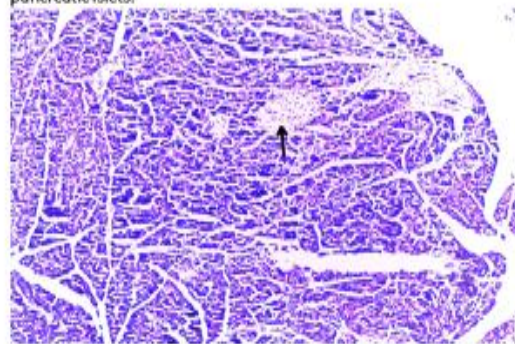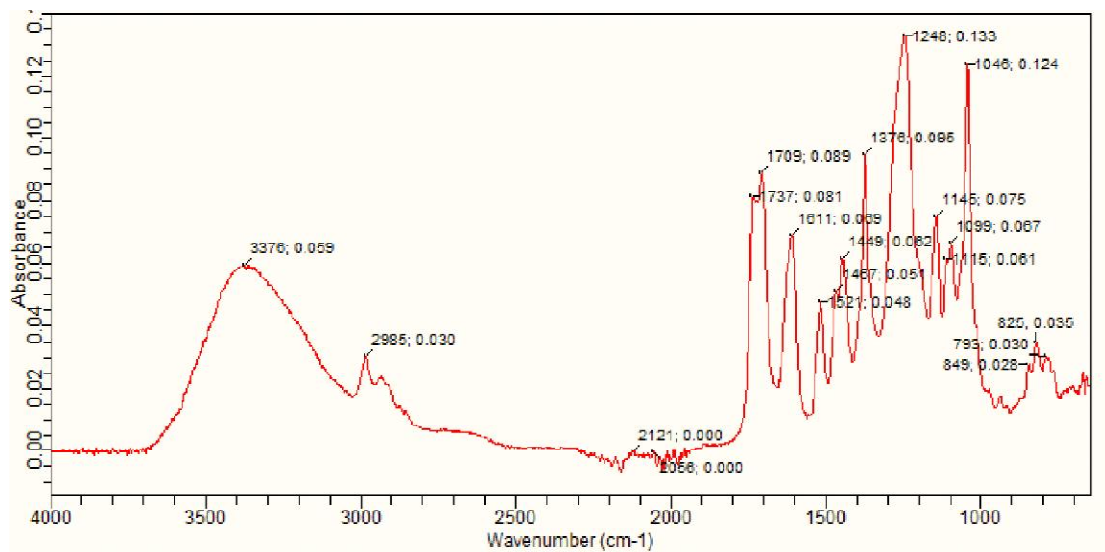
Plate D (F3): Section of pancreatic tissue shows well – formed pancreatic islets.

**Plate 1. Histopathological examination of pancreatic tissues of diabetic rats administered with fraction 3 of *F. polita* (H and E Magnification ×100)**



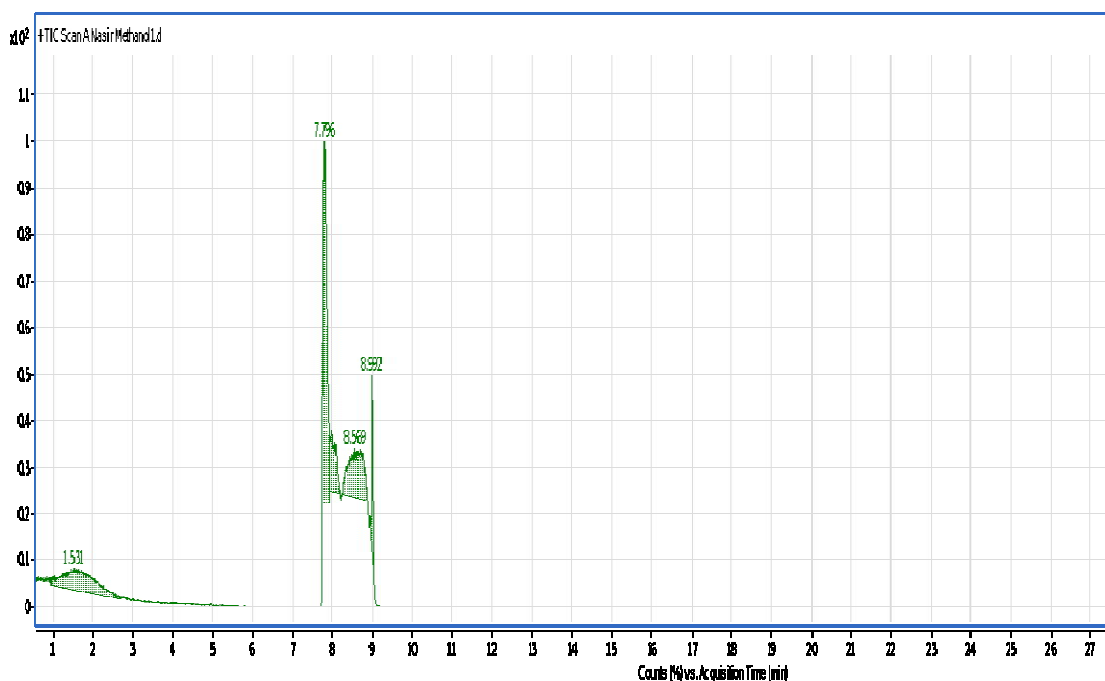**Fig. 5. FTIR spectra of the most potent fraction (Fraction 3)**

**Fig. 6. Mass spectra of the most potent fraction (Fraction 3)**

### 3.8 Characterisation of the Bioactive Compound (fraction3) using Fourier Transform Infrared (FTIR) and Gas Chromatography - Mass Spectroscopy (GCMS) Techniques

The FTIR spectra of the most potent fraction (fraction 3) is presented in Fig. 5. The IR spectra exhibit characteristic absorption band at wavelength 3376 cm-$^1$ which shows that the compound possesses -OH stretching and a C=O stretching is present at 1709 cm-$^1$. A characteristic absorption band at 1611 cm-$^1$ shows the presence of C=C, stretching at 1376cm-$^1$ indicating the presence of $CH_3$ functional group.

The mass spectrum of the most potent fraction is shown in Fig. 6. GC-MS analysis of fraction F3 reveals the presence of various compounds. The most notable probable bioactive compounds 8-Methoxy-4-phenylquinoline-2-hydrazine and Narceine.

### 4. DISCUSSION

At various stages of the current study, alloxan induced diabetic rat model was developed by the administration of 150 mg/kg body weight of alloxan monohydrate, and this might be as a result of the destruction of the pancreas. Alloxan is a toxic glucose analogue [8], which has been reported to cause selective destruction and reduction of the β-cells of islets of Langerhans mediated by the formation of reactive oxygen species, resulting in partial or complete loss of insulin synthesis and leading to development of hyperglycaemia [9]. Administration of column chromatography fractions of the chloroform leaf extract of *F. polita* significantly reduced the weight loss, the amount of feed intake, and the water intake, in the diabetic treated groups compared to the diabetic control group. The relatively improved body-weight gain in the fractions treated groups as compared to the diabetic control group suggests its antidiabetic efficacy. The ability of the extract to reverse the body weight loss could be due to its potential to reduce hyperglycemia by increasing peripheral glucose uptake, or by inhibition of catabolism of proteins and fats [10]. This is an indication that the extract aided in amelioration of weight loss associated with diabetes.

Renal diseases are severe complications of diabetes. Serum creatinine and urea are common biomarkers for prediction of renal dysfunction, due to the fact that they are elevated significantly in diabetic conditions [11]. Increased blood urea production in diabetes may be attributed to enhanced catabolism of both liver

and plasma proteins [12]. In this study, high levels of these biomarkers were observed in the diabetic control group as compared to the normal control group. This finding corroborate previous investigators [13]. The significantly high levels of serum creatinine and urea are signs of reduced capacity of the kidney to sieve these waste products from the blood and excrete them in urine. However, treatment with chloroform leaf extract (fraction 3) of *F. polita* for two weeks was able to significantly (p<0.05) reduce the serum concentration of urea and creatinine in diabetic rats. It was observed that fraction 3 was able to significantly reduce the serum levels of creatinine and urea in a manner comparable to the standard drug metformin in the STD-C group. Data from this study suggest that fraction 3 of might have improved the capacity of the kidneys to eliminate these waste products from the blood.

Indicators for evaluation of ROS are MDA, GSH, and endogenous enzymes such as superoxide dismutase (SOD), and catalase (CAT). In the present study, MDA level was elevated, in the liver and kidney of diabetic control group with depressed level of GSH, SOD and catalase, in the liver and kidney of diabetic control group. The increase in MDA formation, in the liver and kidney of diabetic induced rats could be due to raised levels of oxygen free radicals. This is due to the fact that oxygen free radicals exert their cytotoxic effect by peroxidation of membrane phospholipids, and this leads to change in permeability and loss of membrane integrity [14]. While decreased levels of GSH, SOD and CAT observed in diabetic control rats could be explained by the accumulation of superoxide anion and hydrogen peroxide, which would have been effectively scavenged by these enzymes [15]. This result demonstrates that the complications observed may be due to depression of the antioxidant defence system in the rats. These oxidative damages could be retarded by endogenous defence systems (antioxidant) such as reduced glutathione (GSH), superoxide dismutase (SOD) and catalase (CAT) which work in synergy to detoxify free radicals [16]. Hence, administration of the chloroform leaf extract (fraction 3) *F. polita* significantly decreased the tissue level of MDA and increased the tissue levels GSH, SOD, and catalase when compared to the diabetic control group and. This also suggests that chloroform leaf extract (fraction 3) of *F. polita* might have carried out its antidiabetic effect by enhancing the depressed antioxidant defence system in the rats. The decrease in MDA levels could be attributed to the

antioxidant activity of the plant extract. The increased level of GSH and increased activities of SOD and CAT suggest a compensatory response to oxidative stress as it decreases the endogenous hydrogen peroxide produced, thus, diminishing toxic effects due to this radical or other free radicals derived from secondary reactions [17].

In the *in vivo* study, there was significant increase in serum α-amylase and serum α-glucosidase activities in diabetic control group compared to normal control group rats. However, the decrease in serum level of these enzymes observed in chloroform leaf extract (fraction 3) of *F. polita* administered group compared to diabetic control group corroborates the observed restoration of pancreatic β cell function by the fraction as well as uptake of glucose by the peripheral tissues, thus decreasing the rate of digestion of carbohydrates as well as postprandial blood glucose, probably by reducing the expression of these carbohydrates digesting enzymes.

Insulin, a peptide hormone that exerts a wide spectrum of anabolic effects, is exclusively synthesised and secreted by pancreatic β – cells [18]. The regulation of whole body fuel homeostasis primarily involves insulin action in skeletal muscle, adipose tissue, and liver where insulin enhances uptake and storage of carbohydrate, fat, and amino acids, while concurrently antagonising the catabolism of these fuel reserves [19]. There was significant decrease in serum insulin level in diabetic control group compared to normal control group. Nevertheless, the significant increase observed in serum insulin level of diabetic rats administered with the chloroform leaf extract (fraction 3) of *F. polita* compared to diabetic control group might be linked to high antioxidant activity of this fraction thereby promoting the regeneration of pancreatic β-cells damaged by alloxan. Hence, stimulating the pancreas to produce more insulin.

The IR spectrum of most active fraction 3 shows absorbance at wavelength 3376 cm$^{-1}$ which shows that the compound possesses –N-H stretching and a C=O stretching is present at 1709 cm$^{-1}$. A characteristic absorption band at 1611 cm$^{-1}$ shows the presence of C=C, stretching at 1376cm$^{-1}$ indicating the presence of CH$_3$ functional group in the compound. The presence of a C-O (strong and broad) at 1240 cm$^{-1}$ confirms the ester [20].

The use of mass spectra is convincing evidence for identification of molecules. In case of unknown compound, the molecular ion, fragmentation pattern and evidence from other forms of spectrometry can lead to identification of new compound(s). The observed mass spectrum of fraction 3 gives reveals two major biological compounds; 8-Methoxy-4-phenylquinoline-2-hydrazine and Narceine with molecular weight of 265 and 445 respectively. 8-Methoxy-4-phenylquinoline-2-hydrazine and Narceine belongs to quinolone derivative. Quinoline alkaloids are important N-based heterocyclic aromatic compounds with a broad range of bioactivities. They have attracted significant attention from researchers over the past 200 years.

Quinolone alkaloids (1-methyl-2-(6Z)-6-undecenyl-quinolone) were reported to possess strong antibacterial activities in *in vitro* tests with *Mycobacterium fortuitum, M. smegmatis,* and *M. phlei* with MIC of 12.5–200 µM [21]. Moreover, furoquinoline alkaloids also show cardiovascular protective activity. Robustine and confusameline inhibited human phosphodiesterase 5, which regulates the intracellular levels of cGMP and influences vascular smooth muscle tone [22]. Three quinolone alkaloids, evocarpine, 1-methyl-2-[(4Z,7Z)-4,7-tridecadienyl]-4(1H)-quinolone, and 1-methyl-2-[(6Z,9Z)-6,9-pentadecadienyl]-4(1H)-quinolone from isolated from *E. rutaecarpa* blocked the angiotensin II receptor and inhibited angiotensin II binding to rat liver receptor [23]. The Antiviral activity of quinolone derivatives was also reported. Uranidine, a quinolone alkaloid and well-known yellow pigment, inhibits the RNA-directed DNA synthesis of the reverse transcriptases (RTs) of human immunodeficiency virus HIV-1 and HIV-2, with the 3-hydroxy-4-oxo system likely being a key structural element for the inhibitory activity [24].

Anti-hyperglycemic activities of quinolone derivatives where also reported. A derivative isolated from the culture broth of *Helicomyces sp.* is a novel gluconeogenesis inhibitor [25]. Despite high hypoglycemic activity in vitro, it exhibited weak activity in vivo. Furthermore, orally administered Circumdatin E suppressed glucagon-induced hyperglycemia in mice. The peripheral blood glucose levels of db/db mice, an animal model of spontaneous type 2 diabetes, were significantly decreased in a dose-dependent manner by the administration of Circumdatin E. Thus, this compound could be used as a novel lead to develop new

hypoglycemic agents [26]. The observed hypoglycemic activity of the fraction could be modulated in the same way as seen from the low level of alpha glucosidase and alpha amylase.

## 5. CONCLUSION

The research concludes that chloroform leaf extract of *F. polita* possesses antidiabetic activity in addition to its ability to ameliorate oxidative stress – induced organ dysfunction. The antidiabetic property is mediated through its antioxidant properties by improving the level of antioxidant enzymes and minimising hyperglycaemia, thereby stimulating the production of more insulin from remnant and recovered pancraeatic β cells. The antidiabetic property could also be by suppressing or inhibiting the activities of digestive enzymes (alpha amylase and alpha glucosidase).

## ETHICAL APPROVAL

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

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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