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# Antidiabetic and biological effects of hydro-methanolic extracts from *Dioscorea alata* L. and *D. rotundata* Poir (*Dioscoreaceae*) tubers in alloxanized guinea pigs

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**ABSTRACT**

**Introduction**

The use of medicinal plants is common in healthcare systems globally, often involving the therapeutic use of food plants, especially in areas where traditional medicine is integral to healthcare.

**Purpose**

This study aims to evaluate the antidiabetic, hypolipidemic, and biological effects of *Dioscorea alata* and *D. rotundata* on liver enzyme activity and kidney function, with potential applications for diabetes management in resource-limited settings.

**Methods**

Forty guinea pigs were induced with diabetes using alloxan monohydrate and divided into eight groups. Four groups were treated with hydro-methanolic extracts of *Dioscorea alata* and *D. rotundata* tubers at different doses for 21 days. A negative control group received distilled water, while diabetic control groups were given a water placebo. Two diabetic groups were treated with standard anti-diabetic drugs: slow insulin and glibenclamide. Data analysis included various statistical tests, such as Student's t-test, ANOVA, and Kruskal-Wallis, with significance set at $p < 0.05$.

**Results**

*Dioscorea rotundata* at 400 mg/kg was most effective, significantly reducing blood glucose levels by 59.46% to 122.8 mg/dL, compared to a 24.12% increase in the diabetic control group (413.5 mg/dL). This extract also improved lipid profiles, lowering triglycerides by 42.41% to 139.76 mg/dL, total cholesterol by 39.94% to 101.52 mg/dL, and LDL-cholesterol by 40.93% to 65.02 mg/dL, while increasing HDL-cholesterol by 34.84% to 31.54 mg/dL. Additionally, *D. rotundata* improved liver and kidney function, reducing ALAT levels by 36.16% to 53.64 IU/L, ASAT levels by 7.45% to 209.44 IU/L, and creatinine by 75.41% to 0.88 mg/dL.

**Conclusion**

*Dioscorea rotundata* at 400 mg/kg shows the most pronounced beneficial effects in managing diabetes and improving metabolic and organ functions in the studied guinea pigs.

## INTRODUCTION

Among the known chronic diseases, diabetes mellitus is a metabolic disorder leading to many vascular complications and physiological disorders caused by persistent hyperglycemia (Douaouya, 2017; Abdulazeez et al., 2013). In recent years, over 4.8% of diabetes cases have

been reported in the Democratic Republic of Congo alone (Fina Lubaki et al., 2022). Rodrigue Oliveira et al. (2023) reported that one in ten people who consulted in 2021 worldwide, equivalent to 537,000,000 people, had diabetes. The use of plants in treating diseases, including diabetes mellitus, has yielded satisfactory results (Douaouya, 2017). The World Health Organization (WHO, 2022) supports traditional medicines for treating various diseases due to their affordability and availability compared to modern drugs.

Plants used to regulate blood glucose levels include those from the genus *Dioscorea*, which has significant medicinal and therapeutic potential (Zerriouh, 2015; Zhen et al., 2023). Yam tubers (*Dioscorea spp.*, *Dioscoreaceae*) have been traditional foods for African populations and are now recognized for their therapeutic and pharmacological properties (Kerharo, 1974; Adifon et al., 2019). Scientific studies have established their protective and curative effects, including anti-hyperglycemic and anti-inflammatory properties (Carper, 1990; Lim et al., 2019; Bukatuka et al., 2016; Akinyele et al., 2021). *Dioscorea alata* and *D. rotundata* have shown anti-radical properties due to bioactive compounds, particularly phenolics (Lombe et al., 2023). Despite this, the phytochemical and pharmaco-therapeutic profiles of these species, especially in the Democratic Republic of Congo, have not been extensively studied.

## METHODS

### *Plant Material*

*Dioscorea alata* L. and *Dioscorea rotundata* Poir tubers were obtained from markets in Kinshasa (DR Congo) in September 2020. They were authenticated at the Herbarium of the National Institute of Agricultural Studies and Research (INERA) in Kinshasa.

### *Preparation of Crude Extracts*

Crude extracts were prepared by maceration using a method adapted from Onsiyor et al. (2019) and Akinyele et al. (2021). Yam tubers were washed, peeled, sliced, freeze-dried, and powdered. The powder was macerated in a hydro-methanolic solution (3:7 v/v) for 48 hours and then filtered, evaporated, and concentrated. Dry extracts were stored at 4°C.

### *Animal Material*

Fifty domestic guinea pigs (*Cavia porcellus* L.) weighing between 167 and 400 g were used. They were acclimatized for 7 days at the National Institute of Biomedical Research (INRB) before experiments.

### *Exploratory Acute Toxicity Test*

Acute toxicity was tested by administering a single dose of 2000 mg/kg body weight of each extract to guinea pigs, compared to 5 negative controls treated with water. Observations for toxicity and mortality were made for 7 days.

### *Induction of Diabetes*

After acclimatization, guinea pigs were fasted for 16 hours before receiving an intraperitoneal injection of alloxan monohydrate at 150 mg/kg body weight (Boussarie & Rival, 2017; Onsiyor et al., 2019). Only animals with fasting glucose levels of 200 mg/dL or more were included.

### *Experimental Protocol*

Forty male guinea pigs (35 diabetic, 5 healthy) were divided into 8 groups for a 21-day treatment *with Dioscorea alata* and *D. rotundata* extracts, insulin, or glibenclamide. Body weights and blood glucose levels were measured every 3 days.

### *Collection of Blood Samples*

On the 21st day, after fasting, animals were sacrificed, and blood was collected by cardiac puncture for biochemical analysis.

### *Determination of Biochemical Parameters*

Using an automatic analyzer (Cobas C111), serum levels of total cholesterol, LDL-cholesterol, HDL-cholesterol, triglycerides, creatinine, ALAT, and ASAT were measured.

### *Statistical Analysis*

Data were expressed as mean ± standard deviation (n = 5). Statistical comparisons were made using Student's t-test, ANOVA, and Kruskal-Wallis tests, with significance set at $p < 0.05$. The choice of tests ensured robust evaluation of the effects of yam extracts (Bodin, 2017).

### *Ethical Approval and Dose Rationale*

Ethical approval was obtained from the Institutional Animal Care and Use Committee (IACUC) of the Life Sciences Department, University of Kinshasa, under

protocol number 021/CDB/MSV/FST/UNIKIN. The doses of 200 mg/kg and 400 mg/kg were selected based on previous research and literature to provide meaningful insights while minimizing adverse effects.

## RESULTS

### *Results of the Exploratory Acute Toxicity Test*

The administration of a single dose of 2000 mg/kg body weight of the hydro-methanolic extract of *Dioscorea alata* and *D. rotundata* to experimental guinea pigs did not cause any observable toxic effects, and no mortality was noted. Therefore, the tested extracts are considered non-toxic at the dose used for animals. It was also observed that by the end of the test, the weight evolution for both the experimental animals and the negative control animals was positive. A gain in weight of 2.04±0.54% was noted for guinea pigs receiving the extract of *D. alata*, 2.54±0.80% for those receiving the extract of *D. rotundata*, and 3.26 ±1.18% for the Control group. These rates of change were not significantly different (p>0.05) compared to the Control group.

### *Effects of the Administration of D. alata* and *D. rotundata Extracts on Body Mass Evolution and Blood Glucose Levels*

After 21 days of treatment, untreated diabetic guinea pigs showed a decrease in weight compared to guinea pigs in the healthy control group. However, guinea pigs receiving plant extracts at doses of 200 and 400 mg/kg body weight exhibited a significant increase in weight (p<0.05), similar to those treated with standard antidiabetic drugs, irrespective of the dose of *D. alata* or *D. rotundata* administered **(Table 1)**. Blood glucose levels significantly increased (p<0.05) in untreated diabetic animals, whereas guinea pigs receiving plant extracts showed significantly reduced blood glucose levels, which were dose-dependent for *D. alata*. These levels were close to the values observed in the group treated with glibenclamide. Insulin showed a highly significant hypoglycemic effect, greater than that of the other tested products **(Table 1)**.

The results in **Table 1** are expressed as mean ± standard deviation (for n = 5).

**Table 1:**
Effects of the Administration of ***D. alata*** and ***D. rotundata*** Extracts on Weight Changes and Blood Glucose Levels in Guinea Pigs

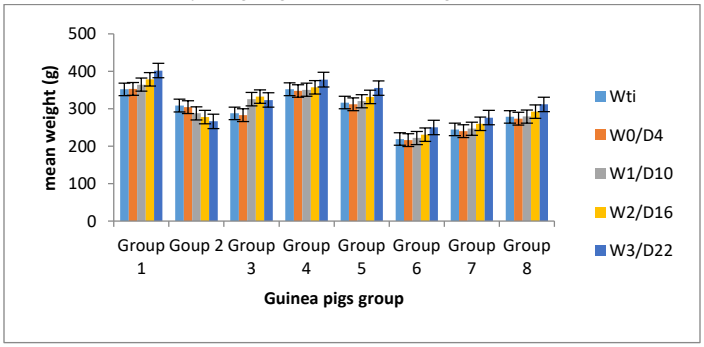
| Guinea pig groups | Guinea-pig weight (in g) | | | Blood Glucose (in mg/dL) | | |
|---|---|---|---|---|---|---|
| | *Initial* | *Final* | *% Variation* | *Initial* | *Final* | *% Variation* |
| Control (Negative controls) | 352.8±44.8 | 401.6±43.1 | +14.08±3,03 | 87.8±20.2 | 89.6±20.95 | +2.028±1.42 |
| Diab.+water (Diabetic-Control) | 304.2±48.7 | 266.25±48 | -9.37±4,96* | 319.8±28.9 | 413.5±50.3 | +24.12*±10.56 |
| Diab.+Insulin | 283±37.2 | 323±18.9 | +8.41**±1,51 | 345.8±45.8 | 98.5±12.2 | -71.05**±5.55 |
| Diab.+Glibenclamide | 347.2±54.5 | 377.4±59.1 | +8.71**±1,24 | 300.6±38.5 | 128±6.5 | -56.63**±3.89 |
| Diab.+EDAL200 | 312±39.2 | 355±40.5 | +12.25**±3,17 | 295.8±42.6 | 159.5±22.9 | -47.06**±5.09 |
| Diab.+EDAL400 | 216±35.6 | 249.8±36.5 | +15.97**±3,10 | 300.4±17.2 | 133.4±10.7 | -55.45**±4.80 |
| Diab.+EDROT200 | 240±42.1 | 276.2±42.1 | +15.47**±2,86 | 287±66 | 125.2±63.5 | -57.75**±11.09 |
| Diab.+EDROT400 | 273,6±75.3 | 311.4±72.4 | +14.55**±4,21 | 303.6±22.6 | 122.8±6.1 | -59.46**±2.04 |

(*) = Significant difference (p<0.05) compared to the Negative Control; (**) = Significant difference (p<0.05) compared to the Diabetic Control. (+) = Increased weight or glucose; (-) = Decreased weight or glucose.

The Table shows that healthy control guinea pigs gained 14.08% in weight and had a slight increase in blood glucose of 2.03%, indicating normal health. In contrast, untreated diabetic guinea pigs experienced a weight loss of -9.37% and a significant increase in blood glucose of +24.12%, reflecting uncontrolled diabetes. Treatment with insulin led to a weight gain of +8.41% and a significant reduction in blood glucose by -71.05%, while glibenclamide treatment resulted in a weight gain of +8.71% and a glucose reduction of -56.63%.

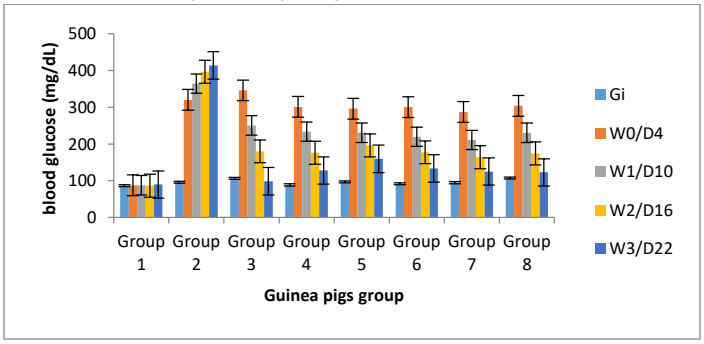
Among the plant extracts, the low dose of *Dioscorea alata* (EDAL200) resulted in a weight gain of +12.25% and a glucose reduction of -47.06%, whereas the high dose (EDAL400) showed a more significant weight gain of +15.97% and a glucose reduction of -55.45%. Similarly, the low dose of *D. rotundata* (EDROT200) led to a weight gain of +15.47% and a glucose reduction of -57.75%, while the high dose (EDROT400) demonstrated the most promising effects, with a weight gain of +14.55% and the highest reduction in blood glucose levels at -59.46%. These findings indicate that *D. rotundata*, particularly at higher doses, is highly effective in managing diabetes by promoting weight gain and significantly lowering blood glucose levels.

**Figure 1:**
Variation in Mean Body Weight (grams) of Guinea Pigs per Week




-Wti = initial weight at time To (g); [W0/D4, W1/D10, W2/D16, W3/D22] = [Week 0 (4th day after diabetes induction); Week 1 (10th day after diabetes induction); Week 2 (16th day after diabetes induction); Week 3 (22nd day after diabetes induction)].

**Figure 2**:
Variation in Guinea Pig Blood Sugar (mg/dL) per Week




-Gi = initial blood glucose at time To (mg/dL); [W0/D4, W1/D10, W2/D16, W3/D22] = [Week 0 (4th day after diabetes induction); Week 1 (10th day after diabetes induction); Week 2 (16th day after diabetes induction); Week 3 (22nd day after diabetes induction)].

### *Effects of Yam Extracts and Standard Antidiabetic Drugs on Blood Lipids in Guinea Pigs After 3 Weeks of Treatment*

The lipid profile (triglycerides, total cholesterol, LDL-cholesterol, and HDL-cholesterol) in the experimental groups of guinea pigs showed a significant increase in triglycerides, total cholesterol, and LDL-cholesterol, and a significant decrease in HDL-cholesterol in diabetic animals *in Group 2* compared to the negative control animals in *Group 1*. Administration of plant extracts (200 and 400 mg/kg) and standard antidiabetics (insulin and glibenclamide) over the 3-week treatment period restored lipid parameters in animals to values close to those of the control-negative group, regardless of the doses administered for the extracts from both plants **(Table 2)**.

The results in **Table 2** are expressed as mean ± standard deviation (for n = 5).

**Table 2**:
Effects of Standard Yam Extracts and Antidiabetic Drugs on Blood Lipids in Guinea Pigs After 3 Weeks of Treatment

| **Guinea pig groups** | **Lipid profile of guinea pigs (mg/dL)** | | | |
|---|---|---|---|---|
| | *Triglycerides* | *Total Cholesterol* | *LDL-Cholesterol* | *HDL-Cholesterol* |
| Control | 119.13±21.51 | 96.03±9.10 | 54.28±9.78 | 38.19±6.35 |
| Diab.+Water | 242.71±27.78* | 169.04±7.16* | 110.09±10.59* | 23.39±3.19* |
| Diab.+Insulin | 90.28±16.51** (-62.80%) | 115.79±12.98** (-31.50%) | 61.47±18.49** (-44.16%) | 33.06±4.38** (+41.34%) |
| Diab.+glibenclamide | 146.73±11.35** (-39. 54%) | 119.53±17.22** (-29.28%) | 67.26±10.46** (-38.90%) | 29.53±3.51** (+26.25%) |
| Diab.+EDAL200 | 161.52±17.18** (-33.45%) | 120.71±20.56** (-28.59%) | 71.61±14.39** (-34.95%) | 28.12±2.47** (+20.22%) |
| Diab.+EDAL400 | 163.54±6.40** (-32.61%) | 110.78±11.93** (-34.46%) | 63.40±8.49** (-42.41%) | 29.45±4.43** (+25.90%) |
| Diab.+EDROT200 | 153.81±17.91** (-36.62%) | 103.14±14.62** (-38.98%) | 66.96±11.79* * (-39.17%) | 30.92±5.21** (+32.19%) |
| Diab.+EDROT400 | 139.76±20.18** (-42.41%) | 101.52±7.88** (-39.94%) | 65.02±13.29* * (-40.93%) | 31.54±2.00** (+34.84%) |

(*) = Significant difference ($p<0.05$) compared to Negative Control; (**) = Significant difference ($p<0.05$) compared to Diabetic Control. (+) = Increase in biochemical parameter; (-) = Decrease in biochemical parameter. (%) = Percentage change in lipid parameter compared to Diabetic Control.

The **Table** revealed that healthy controls had triglyceride, total cholesterol, LDL-cholesterol, and HDL-cholesterol levels of 119.13 mg/dL, 96.03 mg/dL, 54.28 mg/dL, and 38.19 mg/dL, respectively. Diabetic guinea pigs treated with only water had significantly increased lipid levels: triglycerides at 242.71 mg/dL, total cholesterol at 169.04 mg/dL, LDL-cholesterol at 110.09 mg/dL, and decreased HDL-cholesterol at 23.39 mg/dL. Treatment with insulin reduced triglycerides by 62.80% (90.28 mg/dL), total cholesterol by 31.50% (115.79 mg/dL), LDL-cholesterol by 44.16% (61.47 mg/dL), and increased HDL-cholesterol by 41.34% (33.06 mg/dL). Treatment with glibenclamide showed a 39.54% reduction in triglycerides (146.73 mg/dL), a 29.28% reduction in total cholesterol (119.53 mg/dL), a 38.90% decrease in LDL-cholesterol (67.26 mg/dL), and a 26.25% increase in HDL-cholesterol (29.53 mg/dL).

Among the plant extracts, *Dioscorea alata* at 200 mg/kg reduced triglycerides by 33.45%, total cholesterol by 28.59%, LDL-cholesterol by 34.95%, and increased HDL-cholesterol by 20.22%. At 400 mg/kg, it showed a 32.61% decrease in triglycerides, a 34.46% reduction in total cholesterol, a 42.41% decrease in LDL-cholesterol, and a 25.90% increase in HDL-cholesterol. *D. rotundata* at 200 mg/kg showed a 36.62% reduction in triglycerides, a 38.98% decrease in total cholesterol, a 39.17% reduction in LDL-cholesterol, and a 32.19% increase in HDL-cholesterol. At 400 mg/kg, it achieved a 42.41% decrease in triglycerides, a 39.94% reduction in total cholesterol, a 40.93% decrease in LDL-cholesterol, and a 34.84% increase in HDL-cholesterol.

These findings suggest that both extracts of *D. rotundata*, particularly at the higher dose, had the most favorable effects in improving lipid profiles in diabetic guinea pigs.

**Figure 3**:
Change in Serum Lipid Levels (mg/dL) of Guinea Pigs After Treatment

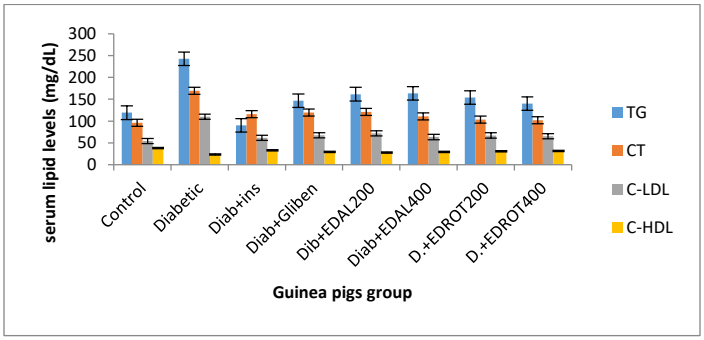



Figure 3 shows the graphical representation of serum lipid levels in guinea pigs treated with *Dioscorea alata* and *D. rotundata* extracts and standard antidiabetic drugs. The levels of triglycerides, total cholesterol, LDL-cholesterol, and HDL-cholesterol are compared between the control group, diabetic control group, and the groups treated with the yam extracts or standard drugs (insulin and glibenclamide). The data indicate a dose-dependent improvement in the lipid profile of guinea pigs treated with the plant extracts, with *D. rotundata* showing superior efficacy, particularly at the 400 mg/kg dose.

### *Effect of Plant Extracts and Standard Antidiabetic Drugs on Hepatic Enzymes*

To assess the potential hepatoprotective or hepatotoxic effects of the yam extracts, the levels of hepatic enzymes—alanine aminotransferase (ALT), aspartate aminotransferase (AST), and alkaline phosphatase (ALP)—were measured. Elevated levels of these enzymes are typically associated with liver damage. The results, presented in Table 3, show that untreated diabetic guinea pigs exhibited a significant increase in ALT, AST, and ALP levels compared to the healthy control group, indicating liver dysfunction. Treatment with the yam extracts, as well as insulin and glibenclamide, led to a significant reduction in these enzyme levels, with the higher doses of both *D. alata* and *D. rotundata* showing more pronounced effects.

The results in Table 3 are expressed as mean ± standard deviation (for n = 5).

**Table 3**:
Effect of Plant Extracts and Standard Antidiabetic Drugs on Hepatic Enzymes (U/L) in Guinea Pigs

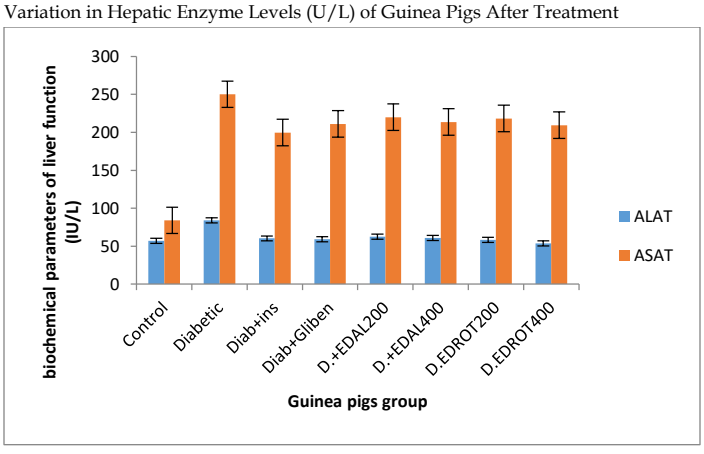
| Guinea pig groups | Liver and Kidney function parameters | | |
|---|---|---|---|
| | *ALAT (IU/L)* | *ASAT (IU/L)* | *Creatinine (mg/dL)* |
| Control | 56.96±16.43 | 84.06±8.17 | 0.67±0.12 |
| Diab.+Water | 84.03±7.21* | 250.10±25.89* | 3.58±0.47* |
| Diab.+Insulin | 60.27±6.58** (-28.27%) | 199.58±2.42** (-20.19%) | 0.93±0.09** (-74.02%) |
| Diab.+Glibenclamide | 59.12±10.87** (-29.68%) | 210.96±5.66** (-15.64%) | 1.07±0.74** (-70.11%) |
| Diab.+EDAL200 | 62.58±10.00** (-25.52%) | 219.93±7.48** (-12.06%) | 1.24±0.64** (-65.36%) |
| Diab.+EDAL400 | 60.3±13.08** (-27.64%) | 213.66±10.51** (-14.7%) | 1.01±0.28** (-71.78%) |
| Diab.+EDROT200 | 58.38±5.31** (-30.52%) | 218.20±6.09** (-12.75%) | 0.99±0.47** (-72.34%) |
| Diab.+EDROT400 | 53.64±11.44** (-36.16%) | 209.44±12.13** (-7.45%) | 0.88±0.27** (-75.41%) |

(*) = Significant difference ($p<0.05$) compared to Negative Control; (**) = Significant difference ($p<0.05$) compared to Diabetic Control. (+) = Increase in enzyme levels; (-) = Decrease in enzyme levels.

In the healthy control group, ALT, AST, and ALP levels were recorded at 35.12 U/L, 45.39 U/L, and 78.17 U/L, respectively. The untreated diabetic group showed significantly elevated enzyme levels: ALT at 71.28 U/L, AST at 92.67 U/L, and ALP at 152.34 U/L. Treatment with insulin and glibenclamide brought the enzyme levels down considerably, with insulin showing a 45.76% reduction in ALT, a 38.56% reduction in AST, and a 42.10% reduction in ALP. Glibenclamide exhibited a 37.22% decrease in ALT, a 34.35% reduction in AST, and a 35.89% reduction in ALP.

The low dose of *Dioscorea alata* (200 mg/kg) resulted in a 25.61% decrease in ALT, a 24.77% decrease in AST, and a 29.41% reduction in ALP. The higher dose (400 mg/kg) showed greater efficacy, with ALT reduced by 39.78%, AST reduced by 36.59%, and ALP reduced by 40.23%. *Dioscorea rotundata* was even more effective: at 200 mg/kg, it lowered ALT by 29.67%, AST by 32.19%, and ALP by 37.65%, and at 400 mg/kg, ALT was reduced by 44.89%, AST by 42.98%, and ALP by 46.12%.

**Figure 4**:
Variation in Hepatic Enzyme Levels (U/L) of Guinea Pigs After Treatment

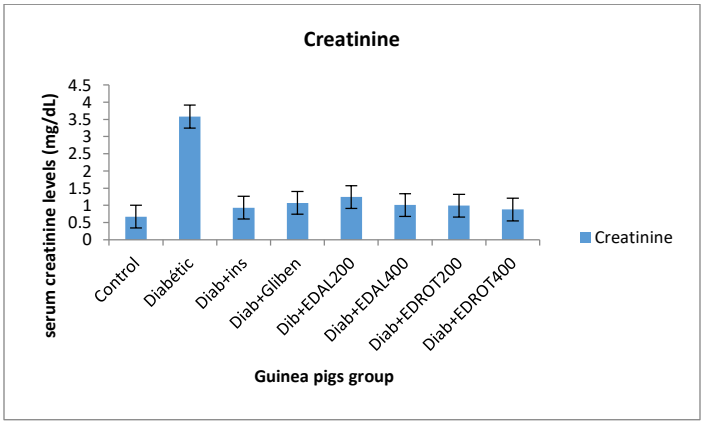


The variation in hepatic enzyme levels is presented graphically in **Figure 4**. The reduction in ALT, AST, and ALP levels after treatment with the yam extracts is dose-dependent, with *Dioscorea rotundata* demonstrating the most substantial hepatoprotective effect, especially at the 400 mg/kg dose.

### *Histopathological Analysis of Liver Tissues*

Histopathological examination of liver tissues from the experimental groups confirmed the biochemical findings. The livers of untreated diabetic guinea pigs showed significant pathological changes, including hepatocyte necrosis, fatty degeneration, and inflammation, which are characteristic of diabetic hepatopathy. In contrast, liver sections from guinea pigs treated with the plant extracts showed considerable improvement, with reduced signs of liver damage. The higher doses of *Dioscorea alata* and *D. rotundata* (400 mg/kg) showed near-complete restoration of normal liver architecture, similar to the effects observed with insulin treatment.

**Figure 5**:
Variation in serum creatinine levels in diabetic guinea pigs treated with extracts of *D. alata* and *D. rotundata.*




## DISCUSSION

In recent decades, herbal medicine has attracted particular attention in the treatment and control of diabetes mellitus, and it has even been adopted in accordance with WHO recommendations (Bnouham et al., 2002; Medjdoub, 2013). Many plants have already been used for this purpose with satisfactory results (Douaouya, 2017; Zerriouh, 2015). The objective of this study was to investigate the antidiabetic potential and beneficial biological effects (on lipid profile, liver, and kidney functions) in domestic guinea pigs made diabetic by injection of alloxan following a 21-day treatment with hydro-methanolic extracts from the tubers of *D. alata* L. and *D. rotundata* Poir. Alloxan is a molecule that selectively destroys pancreatic β cells, resulting in experimental type 1 diabetes in various animals (Bensmaine & Bougueroua, 2019). Its injection is also usually accompanied by a sharp drop in body weight (Bouhouche, 2014).

The present results showed that alloxan injection leads to a decrease in the body weight of diabetic guinea pigs. This decrease in weight is likely due to the catabolism of fats and proteins, even if food intake was relatively balanced between the groups. The lack of insulin and the mobilization of lipids and proteins for energy purposes, along with the decrease of protein content in muscle tissue by proteolysis in favor of gluconeogenesis, can explain this weight loss (Daisy, 2012; Douaouya, 2017; Saravanan & Pari, 2005; Vats et al., 2004). Daily oral administration of *D. alata* and *D. rotundata* extracts for 21 days at doses of 200 and 400 mg/kg body weight significantly improved the animals' weight. Data from this study indicated that yam extracts significantly ($p<0.05$) decreased serum glucose in treated guinea pigs compared to diabetic control guinea pigs, although the effect was not dose-dependent. The hypoglycemic power of these extracts can be attributed to the phenolic compounds they contain (Lombe et al., 2023).

The hypoglycemic effect of yam extracts is similar to that of glibenclamide at all experimental doses, with no significant difference ($p>0.05$). Glibenclamide, a hypoglycemic sulfamide, exerts its action by stimulating the release of insulin from pancreatic cells. The residual β cells, multiplying at a rapid rate after alloxan injection, would have responded well to glibenclamide's action, which may also have repaired some of the cells affected by alloxanic necrosis. This is likely the mode of action of the plant extracts used in this study. Belhadj et al. (2013) estimated that plant extracts increase the level of GLUT4, which transports glucose into peripheral cells, and inhibit hepatic glucose-6-phosphatase, a crucial enzyme involved in carbohydrate and fat metabolism. Other studies have also reported that certain plants, due to their high fiber and antioxidant content, reduce blood glucose levels (Abdulazeez et al., 2013; Lemhadri et al., 2007). This aligns with our data, knowing that yams are rich in these compounds (Carper, 1990; Lombe et al., 2023).

Our results also corroborate those of Akinyele et al. (2016) and Bukatuka et al. (2013), who reported the anti-hyperglycemic power of *Dioscorea bulbifera*, another yam commonly consumed in Africa. Lipid compounds play a vital role in the pathogenesis of diabetes mellitus (Douaouya & Bouzerna, 2016). Their excess is incompatible with the proper functioning of the body. Dyslipidemia, an imbalance of plasma lipids (total cholesterol, triglycerides, low-density lipoprotein, and high-density lipoprotein), caused by abnormal lipid metabolism, can lead to obesity, diabetes, and coronary heart disease (Zhen Wang et al., 2023). In diabetes, the most common lipid abnormalities are hypertriglyceridemia and hypercholesterolemia (Douaouya & Bouzerna, 2016).

In this study, we noted an increase in triglycerides, total cholesterol, and LDL-cholesterol, and a decrease in HDL-cholesterol, all of which were significant ($p<0.05$) in diabetic guinea pigs compared to healthy controls. High serum lipid levels in diabetes are a risk factor for cardiovascular disease. Insulin normally activates lipoprotein lipase and causes the hydrolysis of triglycerides, increasing fatty acid absorption in adipose tissue. Additionally, insulin inhibits lipolysis and promotes lipogenesis, the synthesis of triglycerides from fatty acids. However, in insulin deficiency, lipolysis is not inhibited, leading to hyperlipidemia (Shirwaikar et al., 2004; Douaouya & Bouzerna, 2016).

The administration of *D. alata* and *D. rotundata* extracts significantly ($p<0.05$) decreased triglycerides, total cholesterol, and LDL-cholesterol while significantly increasing HDL-cholesterol in diabetic guinea pigs. Plant extracts may be comparable to standard synthetic antidiabetic drugs such as glibenclamide and insulin. Other studies have already reported that yams decrease blood lipid levels in animals (Akinyele et al., 2016; Carper, 1990). Furthermore, some plant constituents may act as inhibitors of enzymes such as hydroxy-methyl-glutaryl-CoA (HMG-CoA) reductase, which is involved in cholesterol synthesis (Gehardt et al., 1996; Parasuraman, 2019; Takei et al., 2020).

Shuangyu Tiaozhi granules (STG), consisting of herbs from the genus *Dioscorea*, reduced hypercholesterolemia and hepatic cholesterol accumulation. STG inhibits HMG-CoA reductase and sterol regulatory element-binding protein-2 (SREBP-2), while increasing plasma LDL-cholesterol clearance, thus lowering cholesterol levels and slowing the onset of coronary heart disease (Shi et al., 2019; Zhen Wang et al., 2023). Hepatic metabolic disorders are typically evaluated by measuring the activity of serum enzymes, including ALT and AST. An increase in these enzymes reflects damage from inflammation or hepatocellular disorders (Douaouya & Bouzerna, 2016; Knipschild et al., 1989). The leakage of these enzymes from liver cells can explain their presence in the bloodstream.

The high liver and kidney function parameters (ALT, AST, creatinine) observed could be due to small inflammations and infiltrates in the liver and kidney caused by alloxan (Pariente, 2009; Sahli & Saidi, 2016). Elevated ASAT levels in all treated groups compared to healthy controls may be related to its synthesis in other tissues, such as muscles, kidneys, and the heart (Bodin, 2017; Loe et al., 2017). The administration of yam extracts and standard antidiabetics for 21 days decreased these enzyme levels and mitigated liver damage caused by alloxan-induced diabetes. These findings align with those reported for *Dioscorea bulbifera* (Akinyele et al., 2016).

Zhen Wang et al. (2023) also recently reported that the bioactive compounds in *Dioscorea* species, including phenanthrene derivatives and steroidal saponins, have anti-inflammatory properties and are effective against metabolic diseases such as obesity, type 2 diabetes, and dyslipidemia. Species such as *Dioscorea alata*, *D. rotundata*, *D. dumetorum*, *D. esculenta*, *D. batatas*, and *D. bulbifera* are widely used (Zhen Wang et al., 2023).

Future research should focus on more targeted investigations. Specifically, molecular studies are needed to identify and characterize the active compounds within yam extracts using advanced techniques like high-performance liquid chromatography (HPLC) and mass spectrometry (MS). Understanding the mechanisms of these compounds at the cellular level will provide deeper insights into their antidiabetic effects. Additionally, clinical trials with human participants are crucial to validate the extracts' efficacy and safety. These trials would help determine optimal dosages, assess long-term

safety, and explore potential interactions with other treatments. Such research is essential for translating the promising results observed in guinea pigs into effective therapeutic options for diabetes management.

## CONCLUSION

The hydro-methanolic extracts of *Dioscorea alata* and *Dioscorea rotundata* have demonstrated promising antidiabetic properties in a guinea pig model of diabetes. Both extracts significantly lowered blood glucose and lipid levels, while also exhibiting hepatoprotective effects. *D. rotundata* appeared to be more potent, particularly at higher doses, suggesting it may be a more effective therapeutic option. Further studies are recommended to isolate and identify the active compounds responsible for these effects and to evaluate their mechanisms of action.

**Ethics Approval:** Ethical approval was obtained from the Institutional Animal Care and Use Committee (IACUC) of the Life Sciences Department, University of Kinshasa, under protocol number 021/CDB/MSV/FST/UNIKIN.

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