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ARTICLE

Anti-hyperglycemic Potential of *Desplatsia dewevrei* (De Wild. & Th. Dur) Burret Methanol Seed Extract in Diabetic Wistar Rats

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Abstract

This study investigate the anti-hyperglycemic effect of *Desplatsia dewevrei* seed methanol extract in diabetic rats. A standard protocol was modified using forty (40) Wistar rats in five groups. The standard control (10 mg/kg Glibenclamide), the untreated control group (45 mg/kg streptozotocin) (STZ), and graded doses (30, 50 and 100 mg/kg) of *D. dewevrei* seed methanol extract were administered after inducing diabetes. The blood glucose level were observed in days 1, 7 and 14. The animals were sacrificed, blood and organ samples were isolated and analyzed for their biochemical and histopathological evaluations. The results obtained showed a significant decrease in the blood sugar level at graded doses specifically in 14 days after treatment (46, 47.67 and 68 mg/dl). The body and organ weight, kidney function and lipid profile test elicited no significant different across the doses, with normal physiological state when compared with the control groups ($p < 0.05, 0.01$). Graded doses of *D. dewevrei* seed methanol extract exhibited a protective effects on the organs (pancreas, liver, spleen, lungs, heart, kidney and ovary), which elicited no deformities or malfunctioning of the organs when compared with the control. In conclusion, *Desplatsia dewevrei* possessed therapeutic property, which adhere to the folklore report.

Keywords: Hyperglycemic, *Desplatsia dewevrei*, Diabetic, Wistar rats

1. Introduction

Diabetes is accompanied by an increase in blood sugar level; which causes different type of health cases such as hypertension, heart failures and others. Diabetes is a metabolic disorder which may be caused by partial deficiency of insulin secretion or its resistance [1]. Diabetes increases daily due to the nature of our food intake worldwide and hence it is predicted that the number of diabetic patient could reach up to 365 million at 2030 [2]. Diabetes is defined as a situation where by the body does not process food properly for use as energy. The food we eat is stored as glucose for our body to use as energy. A hormone called the insulin is produced by the pancreas to help glucose penetrates into the cells of our body [3]. Diabetes occurs when the body refuses to make enough insulin or cannot use its own insulin as much as it should causing sugar to build up in the blood. This is why diabetes is referred to as sugar (see Figs. 3–8).

Plants as natural sources play an important part in treating diabetes, they assist in delaying the development of some complications and they help in correcting abnormalities. *Desplatsia dewevrei* is among plants that have beneficial effects in treatment of some diseases [4]. These effects are such as malaria treatment, skin treatment, anti-inflammatory, cardio-vascular, renal, anti-diabetic effects and many other effects. This may be as a result of the

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active metabolites and components which are gotten from it. *Desplatsia dewevrei* was named after Professor Desplats, a Frenchman in the nineteenth Century [5]. This is a West African plant commonly known as "bush okra". An angiosperm from the order Malvales and family Malvaceae, which is estimated to have about 244 genera and 4225 species of plants such as Okra, Cotton, and Cacao, with known economic importance. It is mainly distributed along West African coast of Ivory Coast to Uganda where it is a source of food to animals [6]. This study was carried out to estimate the anti-hyperglycemic effect of *Desplatsia dewevrei* (methanol extracts) on diabetic Rats.

2. Materials and methods

2.1. Collection of plant materials

The fruits of *Desplatsia dewevrei* were harvested from a forest in Ugbogiobo village located in Ovia North-East Local Government Area of Edo State and was identified by Dr. Odaro Timothy of the Department of Plant Biology and Biotechnology, University of Benin, Benin City and assigned a voucher number UBHm0283.

2.2. Preparation of plant materials

The fruits of *Desplatsia dewevrei* was sliced evenly, rinsed under running water and air-dried for 3 weeks. It was further oven dried at 55 °C for an hour and where blended using a mechanical blender. The dried seeds samples was pulverized using the British milling machine. The weights of the powdered sample was obtained at 870 g for each. The samples were extracted into *D. dewevrei* extract using the maceration extraction technique using an absolute methanol with a constant stirring and shaking. The extract was concentrated to dryness using a rotary evaporator, and store in a freeze-drier at 4 °C for further use.

2.3. Experimental animals

Forty (40) rats of female sex weighed 180–200 g were gotten from the Department of Biochemistry animal house, University of Benin. They were randomly selected into 5 groups (n = 8). The animals were

Table 1. Effect of Desplasia dewevrei methanol seed extract on streptozotocin-induced diabetic rats.

Groups	Doses (mg/kg)	Blood glucose (mg/dl) Baseline	Blood glucose (mg/dl) 24 h	Blood glucose (mg/dl) day 7	Blood glucose (mg/dl) day 14
Streptozotocin	45	344.0 ± 3.46	354.7 ± 7.45[a]	361.3 ± 17.15[a]	375.7 ± 16.01[a]
Glibenclamide	10	242.0 ± 30.73	34.0 ± 5.51[c]	40.0 ± 2.31[c]	38.33 ± 5.36[c]
D. dewevrei	30	275.0 ± 23.69	80.67 ± 6.49[c]	53.33 ± 5.24[c]	46.00 ± 2.52[c]
D. dewevrei	50	246.0 ± 25.15	83.00 ± 8.96[c]	63.33 ± 9.28[c]	47.67 ± 6.69[c]
D. dewevrei	100	223.3 ± 20.33	74.67 ± 5.55[c]	69.00 ± 2.08[c]	68.00 ± 1.16[c]

Values were expressed as Mean ± SEAM, *p-value* > 0.5——— DW——Distilled water.

Table 2. Effect of Desplasia dewevrei methanol seed extract on the body weight of rats.

Groups	Doses (mg/kg)	Body weight (g) day 1	Body weight (g) day 7	Body weight (g) day 14
Streptozotocine	45	240.7 ± 8.95	207.7 ± 4.10	199.0 ± 5.13
Gliberclamide	10	187.0 ± 1.73	173.0 ± 3.06	181.0 ± 3.61
D. dewevrei	30	193.0 ± 9.54	180.7 ± 10.11	190.7 ± 10.71
D. dewevrei	50	164.7 ± 2.91	153.3 ± 3.84	166.7 ± 5.46
D. dewevrei	100	189.7 ± 9.35	173.3 ± 8.37	188.0 ± 9.61

Values were expressed as Mean ± SEAM, *p-value* > 0.5——— DW——Distilled water.

Table 3. Effect of Desplasia dewevrei methanol seed extract on the kidney function test of rats.

Groups	Doses (mg/kg)	Creatinine (mg/dl)	Urea (mg/dl)	Bicarbonate (HCO_3) (mg/dl)	Sodium (Na^+) (mg/dl)	Potassium (K^+) (mg/dl)	Chloride (Cl^-) (mg/dl)
Streptozotocin	45	0.25 ± 0.01a	43.86 ± 0.25a	25.16 ± 0.20a	106.0 ± 0.19a	16.88 ± 0.08a	58.97 ± 0.80[a]
Glibenclamide	10	0.26 ± 0.00a	43.48 ± 0.74a	24.60 ± 0.34a	106.5 ± 0.71a	16.67 ± 0.18a	59.95 ± 0.27[a]
D. dewevrei	30	0.26 ± 0.00a	44.07 ± 1.01a	24.77 ± 0.29a	104.3 ± 0.70a	16.45 ± 0.28a	56.50 ± 0.21[a]
D. dewevrei	50	0.28 ± 0.00[b]	44.73 ± 0.36a	25.40 ± 0.59a	106.6 ± 1.07a	15.97 ± 0.19a	58.97 ± 1.09[a]
D. dewevrei	100	0.27 ± 0.01[a]	45.19 ± 0.91a	25.14 ± 0.43a	107.5 ± 0.76a	16.17 ± 0.33a	60.05 ± 0.16[a]

Values were expressed as Mean ± SEAM, *p-value* > 0.5——— DW——Distilled water.

Table 4. Effect of Desplasia dewevrei methanol seed extract on the lipid profile test of rats rats.

Groups	Doses (mg/kg)	Cholesterol (mg/dl)	Triglyceride (mg/dl)	High Density Lipoprotein (mg/dl)	Low Density Lipoprotein (mg/dl)	Very Low Density Lipoprotein (mg/dl)
Streptozotocin.	45	81.74 ± 0.94[a]	209.7 ± 0.28[a]	52.60 ± 0.60[a]	12.81 ± 0.33[a]	41.95 ± 0.06[a]
Glibenclamide	10	81.32 ± 1.18[a]	209.7 ± 1.13[a]	51.52 ± 0.76[a]	12.15 ± 1.31[a]	41.95 ± 0.23[a]
D. dewevrei	30	75.12 ± 1.50[b]	202.7 ± 0.90[b]	54.35 ± 0.73[b]	9.77 ± 2.01[b]	40.54 ± 0.18[a]
D. dewevrei	50	81.25 ± 3.69[a]	209.6 ± 4.82[a]	51.29 ± 1.17[a]	11.96 ± 3.81[a]	41.92 ± 0.96[a]
D. dewevrei	100	83.54 ± 1.16[a]	213.0 ± 1.39[a]	50.61 ± 0.40[a]	9.67 ± 1.07[b]	42.60 ± 0.28[a]

Values were expressed as Mean ± SEAM, *p-value* > 0.5——— DW——Distilled water.

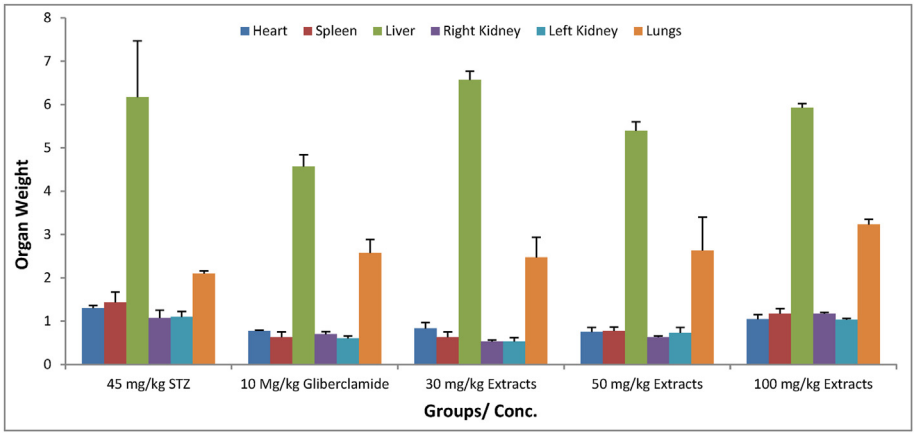

Fig. 1. Effect of Desplasia dewevrei methanol seed extract on the organ weight of rats.

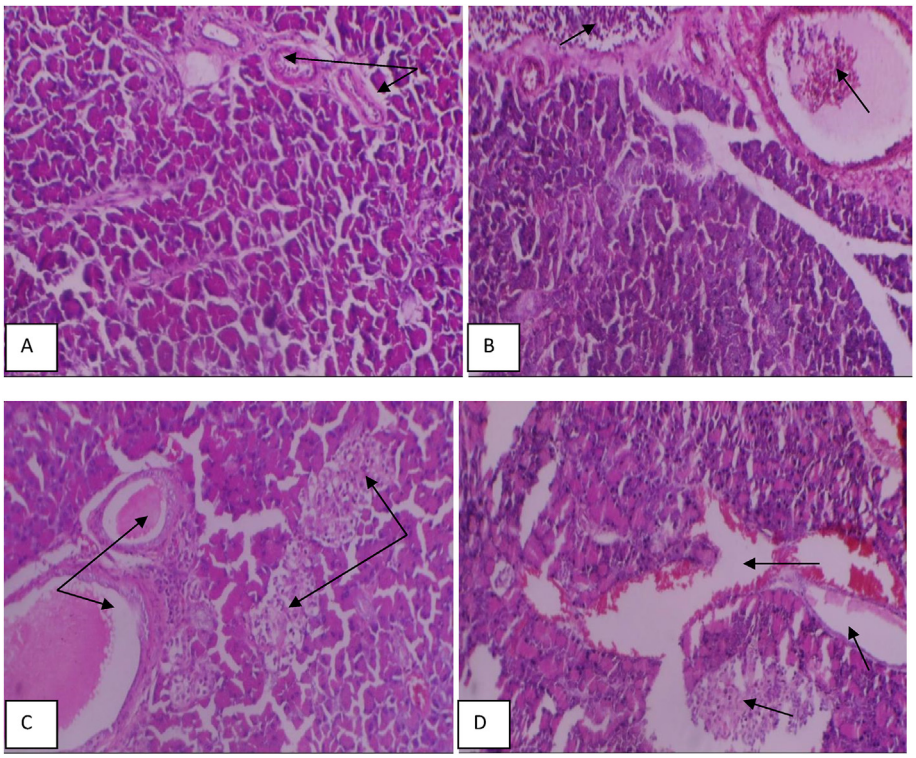

Plate 1. Effect of Desplasia dewevrei methanol seed extract on the pancreas of rats. A. Control Rat pancreas induced with Streptozotocin: A, vascular stenosis and ulceration, with paucity of islets of Langerhans. B. Rat pancreas induced and given 30 mg/kg D. dewevrei methanol seed extract A, activated lymphoid aggregates, B, vascular dilatation and active congestion. C. Rat pancreas induced and given 50 mg/kg D. dewevrei methanol seed extract: A, dilated ducts containing proteinaceous material and B, markedly luxuriant islets. D. Rat pancreas induced and given 100 mg/kg D. dewevrei methanol seed extract: A, vasodilatation and congestion, B, ductal dilation and C, luxuriant islet (H&E x 100).

housed in a conducive cages in the Phytomedicine research Unit animal house. They were placed in a maintained and standard environmental condition with free access to water and standard rodent feeds. They were acclimatized for 2 weeks with free access to Bendel pelleted food and water. The animals were handled using a standard Laboratory protocols for the use of animals, and the ethical committee of Life Sciences, issued ethical number of LS21206.

2.4. Experimental design

Forty-five (45) mg/kg dose of Streptozotocin was administered for 48 h to induced diabetes across the five (5) groups (n = 8) such as; group A (45 mg/kg Streptozotocin 1.p), group B (10 mg/kg Gliberclamide o.p) and group C- E at graded doses of the treatment groups (30, 50 and 100 mg/kg p.o) of *D. dewevrei* seed methanol extract. The animals in their respective groups were fasted overnight prior to the administration of Streptozotocin according to their body weight, the sugar level was checked to ascertain the baseline [7]. Afterwards treatment followed and the sugar level were observed for 24 h, days 7 and 14. The animals were sacrificed on day 15, blood, liver, kidney, spleen, and pancreas samples were analyzed.

2.5. Initiation of diabetes

Before the initiation of diabetes, the glucose point level and the weights of the rats was tested and was found to be normal. The STZ was diluted with phosphate buffer, and was administered directly to peritoneal region of the rats [8]. *Diabetes mellitus* was experimentally induced in the animals across the groups, after being fasted overnight. After 3 days of induction, the blood glucose measurements were monitored with a glucometer, and the rats with plasma glucose level greater than 200 mg/dl were labelled diabetic.

2.6. Determination of biochemical analysis

Blood samples taken were spun in a centrifuge. The serum was extracted and used for biochemical analysis.

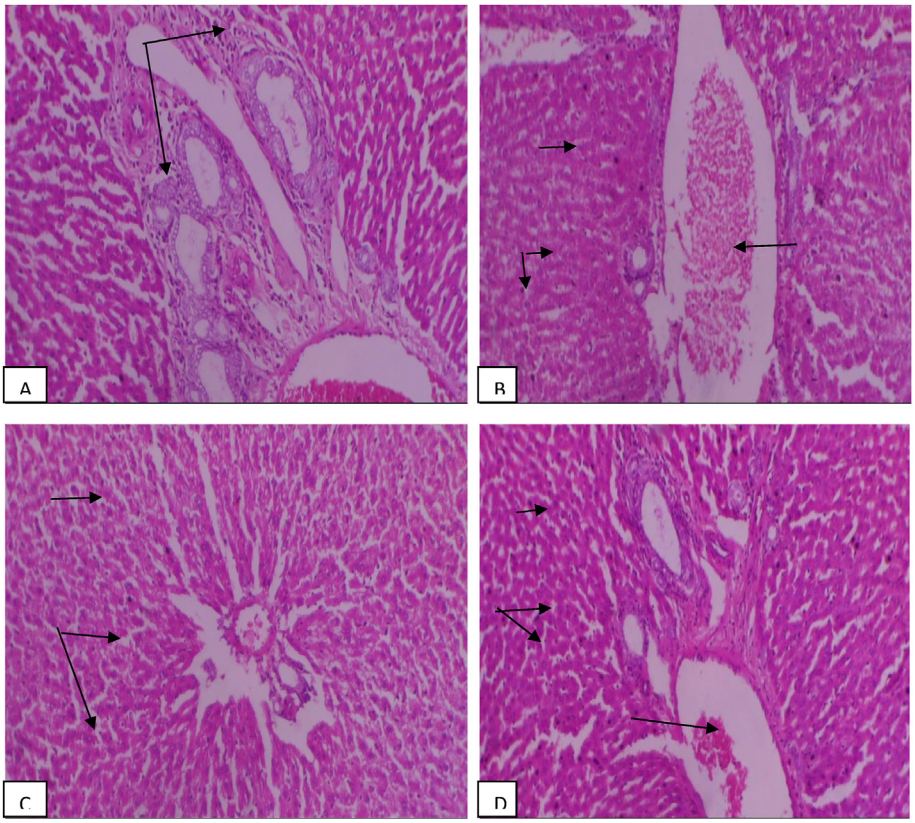

Plate 2. Effect of Desplasia dewevrei methanol seed extract on the liver cells of rats. A. Control Rat liver induced with Streptozotocin: A, periportal infiltrates of inflammatory Cells, B, portal vascular ulceration and congestion. B: Rat liver induced and given 30 mg/kg D. dewevrei methanol seed extract: A, normal hepatocytes and B, kupffer cell activation. C: Rat liver induced and given 50 mg/kg D. dewevrei methanol seed extract: A, normal hepatocytes and B, kupffer cell activation. D: Rat liver induced and given 100 mg/kg D. dewevrei methanol seed extract: A, normal hepatocytes and B, portal architecture (H&E x 100).

2.7. Renal function test

The colourmetric method was used in measuring the level of the creatinine in the plasma of the rat. The method was outlined in the manufacturing kit which was used to ascertain the urea concentration (Randox Laboratory Limited). The method as outlined by the manufacturer (Teco diagnostic, USA) was used to determine the level of potassium in plasma. The level of chloride was determined by the method of the manufacture. Sodium in plasma was determined by the methods of Brzoska et al. [9].

2.8. Total cholesterol

The total cholesterol in the plasma was determined using a standard protocol. The amount of triglycerides in plasma was determined by Gopalakrishnan et al. [10]. The high density lipoprotein (HDL) in plasma was assayed by using the instruction by the manufacturer, kin the manufacture's kit. The formula as outlined in the manufacture's kit was LDL cholesterol (mg/dl) = Total cholesterol − triglycerides - HDL cholesterol.

2.9. Histological study

The organs (liver, heart, lungs kidney, ovary, and pancreas) were carefully removed and weighed individually and fixed in 10 % (vol/vol) formaldehyde, cleaned up in xylene and embedded in a paraffin wax (melting point at 56 percent). Tissue sections were stained with eosin/hematoxylin. Photomicrographs were taken at × 400 using a digital camera. Histology was carried out at the University of Benin Teaching Hospital, Department of Histology [11].

2.10. Statistical analysis

Data were presented as Mean ± SEM of the respective replicates. The means of different groups were compared using ANOVA using 2009 version of

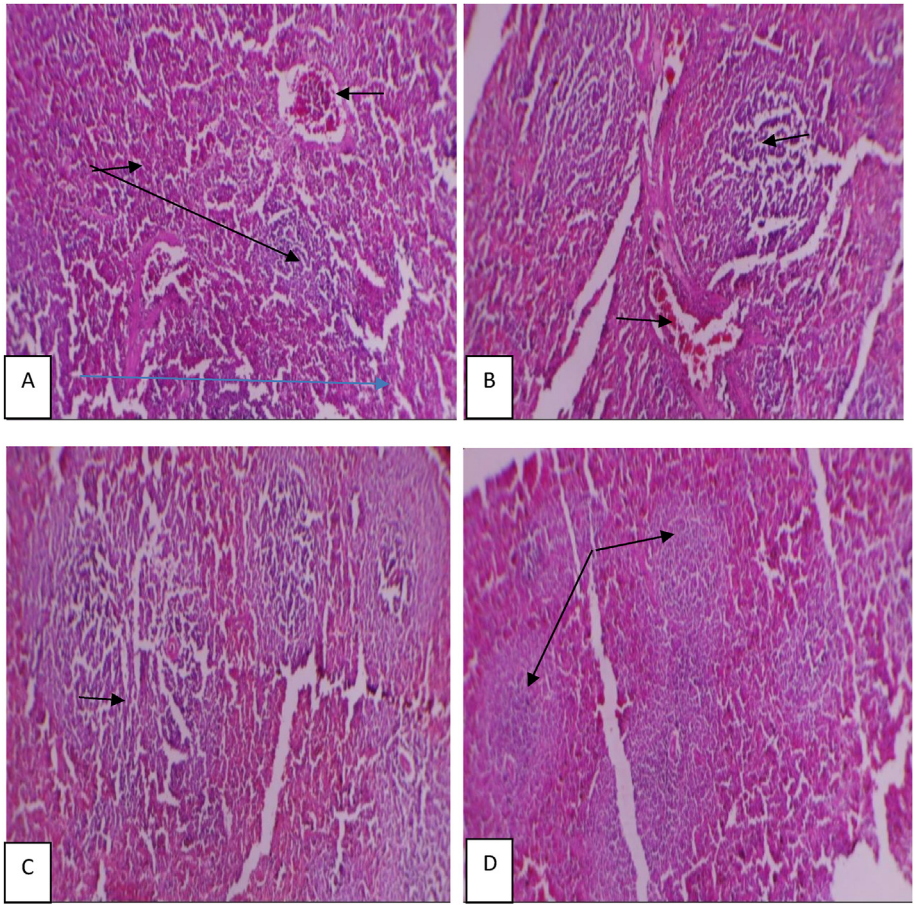

Plate 3. Effect of Desplasia dewevrei methanol seed extract on the spleen cells of rats. A. Control Rat spleen induced: A, activated lymphoid follicles. B: 30 mg/kg D. dewevrei methanol seed extract Rat spleen: A, marked lymphoid follicular activation. C: Rat spleen induced and given 50 mg/kg D. dewevrei methanol seed extract: A, moderated follicular activation. D: Rat spleen induced and given 100 mg/kg D. dewevrei methanol seed extract: A, marked follicular activation (H&E x 40).

graph pad prism computer software packages. P-values $\leq$0.05 (95% confidence interval) was considered significant.

3. Results

The study investigates the anti-hyperglycemic effect of *Desplatsia dewevrei* methanol extract on diabetic rat as shown in Table 1, the effect of 30, 50, and 100 mg/kg *D. dewevrei* extract on streptozotocin induced diabetes exhibited a significant decreases in the blood glucose eve in days 7 and 14 respectively when compared with the untreated control. The effect was pronounce more on the standard drug (Glibenclamide) because it has an onset of action the sugar level.

Table 2 showed the effect of *D. dewevrei* methanol extract on body weight on hyperglycemic rats. The dosage of 50 mg/kg shows an increase in the body weight from 164 to 166 at 24 h and 14 days respectively as opposed to 30 mg/kg which declined in the body weight after 14 days.

Table 3 showed the effect of *D. dewevrei* methanol extract on kidney function on hyperglycemic rats. The results showed that the creatinine, urea, bicarbonate, sodium, potassium and chloride level had no significant increase across the parameters of the kidney function test when compared with the control.

Table 4 showed the effect of *D. dewevrei* methanol extract on lipid profile test on hyperglycemic rats. The graded doses of the extract showed that the cholesterol, triglyceride, HDL and LDL level had no significant increase across the parameters of the kidney function test when compared with the control.

Figure 1 showed the effect of *D. dewevrei* methanol extract on organs rats' weight with no significant increase across the graded doses of the extract when compared with the control.

Plate 1 showed the effect of 50 mg/kg of the extract with an increased dilation of blood vessels; in the islet of Langerhans and richer endocrine gland when compare with the untreated control. At

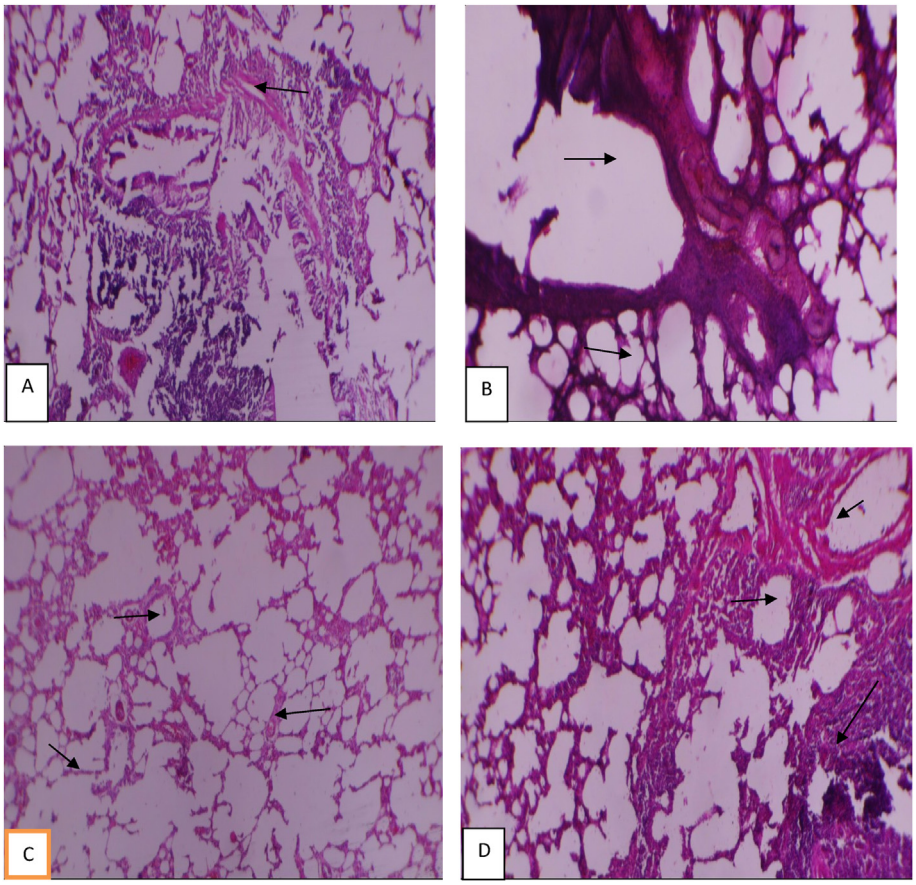

*Plate 4. Effect of Desplasia dewevrei methanol seed extract on the lungs cells of rats. A. Control Rat lungs: A, bronchiolar dilation, B, normal alveoli and C, artery. **B**: Rat lungs induced and given 30 mg/kg D. dewevrei methanol seed extract: A, normal alveoli, B, vasodilatation and C, bronchiolar dilation. **C**: Rat lungs induced and given 50 mg/kg D. dewevrei methanol seed extract: A, normal alveoli, B, bronchiolar and C, vascular architecture. **D**: Rat lungs induced and given 100 mg/kg D. dewevrei methanol seed extract: A, normal alveoli, B, dilated bronchiole and C, active interstitial congestion (H&E x 40).*

100 mg/kg of the methanol extract of the pancreas elicited an increased in size and number of the islet of Langerhans, which, thereby increased the blood flow and proper dilation of blood vessels in them when compared with the control.

Plate 2 showed the effect of 30, 50 and 100 mg/kg of the extract on the liver cells with the immune activated of kupffer cells helping the cells to fight foreign pathogens in the immune system resulting in normal hepatocytes of the liver when compared with the control.

Plate 3 showed the effect of 30, 50 and 100 mg/kg of the extract increase the activation of white blood cells as the white pulp dominant on the spleen and also an increase in size of the spleen when compared with the control.

Plate 4 showed the effect of 30, 50 and 100 mg/kg of the extract terminal vessels, blood vessels and alveoli appeared well and the bronchioles are more dilated, with a better appearance and dilation of bronchioles, blood vessels and alveoli when compared with the control.

Plate 5 showed the effect of 30, 50 and 100 mg/kg of the extract with the appearance of the kidney had several glomeruli and blood vessels were present when compared with the control.

Plate 6 showed the effect of 30, 50 and 100 mg/kg of the extract a normal functioning of the ovary that promote fertility with normal sequential maturation too when compared with the control (see Plate 7).

4. Discussion

Diabetes has been associated with an increased generation of oxygen-derived free radicals through autoxidation of glucose. According to the results obtained from this present study, high-dose of treated groups showed a rapid loss in insulin secretion (rapid onset of diabetes) [12]. It was found that (30 and 50 mg/kg) had a remarkable effect on glucose reuptake by cells after 24 h when compared with the standard drug but at 50 mg/kg of the seed methanol extract showed elicited a significant

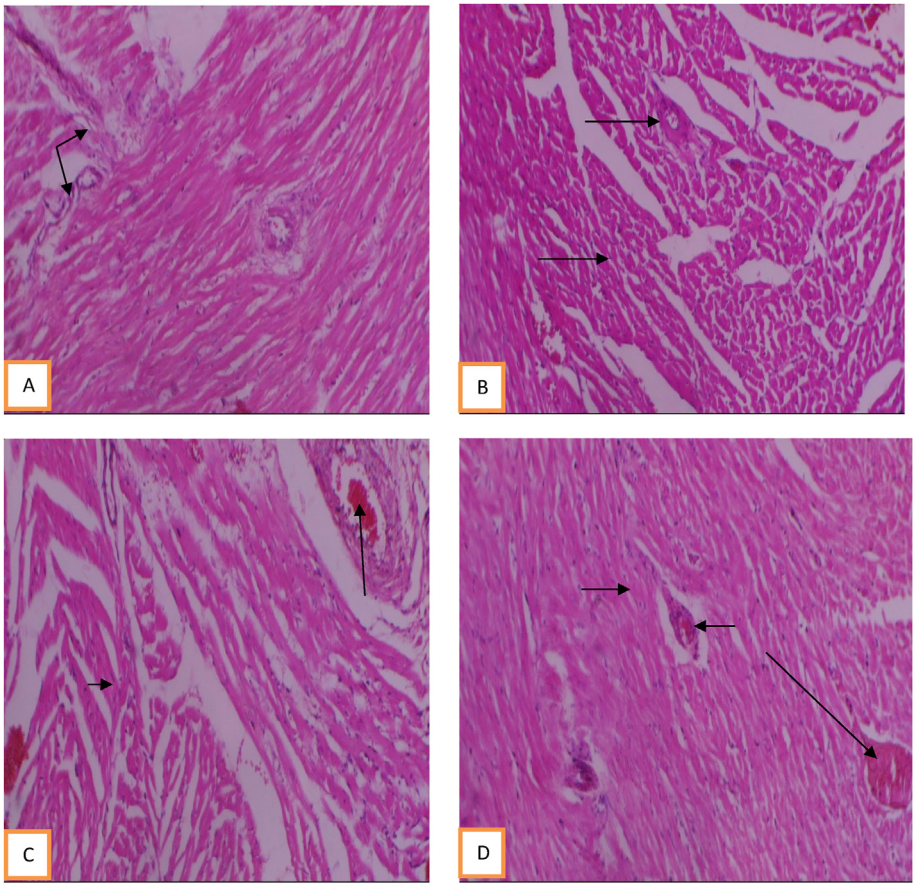

Plate 5. Effect of Desplasia dewevrei methanol seed extract on the heart muscles of rats. A. Control Rat heart: A, normal vascular and B, myocardiac architecture. B: Rat heart induced and given 30 mg/kg D. dewevrei methanol seed extract: A, normal myocardial and B, vascular architecture. C: Rat heart induced and given 50 mg/kg D. dewevrei methanol seed extract: A, normal myocardial and B, vascular architecture. D: Rat heart induced and given 100 mg/kg D. dewevrei methanol seed extract: A, normal vascular and B, myocardial architecture (H&E x 100).

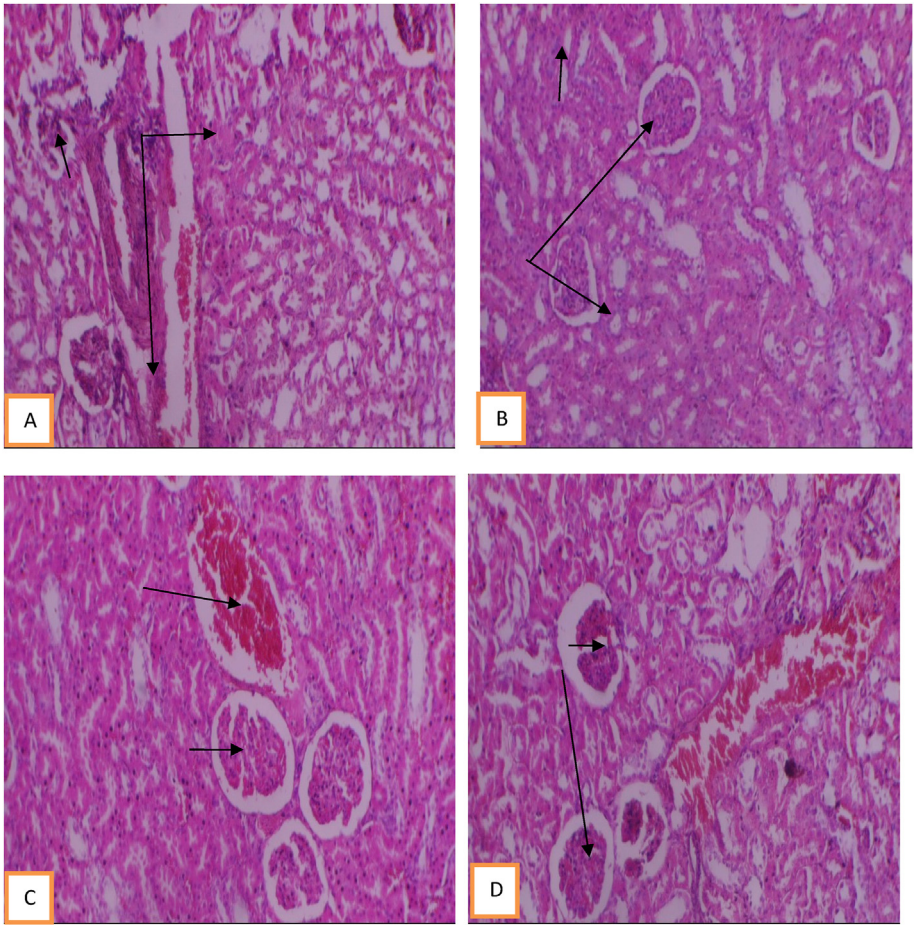

Plate 6. Effect of Desplasia dewevrei methanol seed extract on the kidney cells rats. A. Control rat kidney induced with Streptozotocin: A, glomerular nodule and B, severe vascular ulceration. B: Rat kidney induced and given 30 mg/kg D. dewevrei methanol seed extract: A, normal glomerular and B, vascular architecture. Rat kidney induced and given 50 mg/kg D. dewevrei methanol seed extract: A, normal glomerular architecture. D: Rat kidney induced and given 100 mg/kg D. dewevrei methanol seed extract: A, normal glomeruli and B, active interstitial congestion (H&Ex100).

hypoglycemic effect in STZ-induced hyperglycemia in rats at 24 h and 10 days of the treatment. This is in ine with the report of Eidi et al. [13] Antidiabetic effect of *Oleae uropaea* L. in normal and diabetic rats. The anti-diabetic effect of the extract was more effective than that observed with glibenclamide when compared with the control. This agreed with Emordi et al. [14], which the observable effect was comparable to previous study conducted on diabetic rats which reported that oral administration of the *D. dewevrei* extract (0.1, 0.25 and 0.5 g/kg body wt) for 14 days had a significant decreased in serum total cholesterol, triglycerides with a significant increase in the serum insulin of diabetic rats. The report by Muhammad et al. [15] that showed aminotransferase levels with a significant increase in the control kidney function test rats. An increase in aminotransferases levels may be due to the cellular damage in the kidney caused by STZ-induced diabetes [16].

Streptozotocin selectively destroys pancreatic insulin secreting β-cells. In this study, histological sections revealed a severe islet cell necrosis by the lymphocyte [17]. Methanol extracts of *D. dewevrei* may act on the regenerative of the pancreatic cells via exocrine cells which lead to the positive effects of its compounds on the production of insulin. Liver and kidney are important organs of storage, detoxification, metabolism, and excretion of many metabolites, so they are particularly vulnerable to oxidative damage [18–21]. Infiltration of lymphocytes and congestion were observed in the sinusoidal spaces and portal veins that increased with the increase in streptozotocin-induced hyperglycemia or in untreated group. These findings of present study are in agreement with the findings of Ramesh et al. [22] and Muhammad et al. [15] mentioned. The use of *D. dewevrei* methanol extract for the treatment of diabetic rats, reduced the histological changes in the tissues, this may be due to the presence of

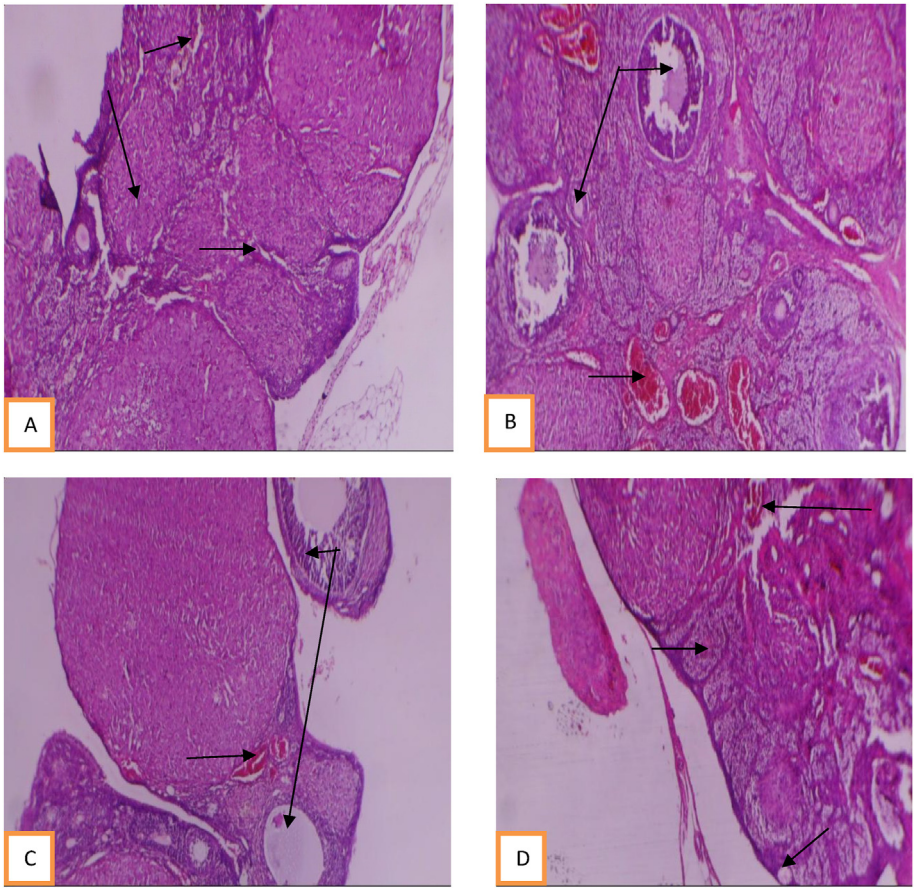

Plate 7. Effect of Desplasia dewevrei methanol seed extract on the ovary cells rats. A. Control Rat ovary induced and given: A, follicles in different stages and B, vasodilatation and active congestion. B. 30 mg/kg D. dewevrei methanol seed extract Ovary reveals prominent numerous corpus luteum (short arrow). There is thick germinal epithelium and zona granulosa with corona with varying eccentrically located oocyte (long arrow). C. 50 mg/kg D. dewevrei methanol seed extract Ovary above reveals prominent large corpus luteum with visible luteal cells (long black arrow. There is thick germinal epithelium and zona granulosa (short arrow) with corona with a small eccentrically located oocyte (short arrow). D. 100 mg/kg D. dewevrei methanol seed extract Ovary above reveals prominent large corpus luteum with visible luteal cells (long black arrow. There is thick germinal epithelium and zona granulosa (short arrow) with corona with a small eccentrically located oocyte (short arrow).

phenolic in this plant. As mentioned above, there was a slight significant alteration of hepatic proteins level and this may be due to the protective and safety effects of the administered plant extracts on hepatic tissues. In addition, the methanol extract inhibits lipid peroxidation and induces the activity of antioxidant enzymes such as catalase [23–26].

From the study, *Desplatsia dewevrei* has been found to have anti-hyperglycemic effects on diabetic rats. Plants possess easier, cheaper and relatively less stressful means of treating diabetes; since the model orthodox medicine maybe even expensive for the average Nigerian [27–29]. This is in accordance with the report of Sharma et al. [30] whose research was carried on anti-diabetic potential of alkaloid rich fraction from *Capparis decidua* on diabetic mice.; which stated that the extract of *C. decidua* acted on the regeneration of the pancreatic cells via exocrine cells which lead to the positive effects of its compounds on the production of insulin. Liver and kidney are important organs of storage, detoxification, metabolism, and excretion of many metabolites, so they are particularly vulnerable to oxidative damage [31,32]. Infiltration of lymphocytes and congestion were observed in the sinusoidal spaces and portal veins that increased with the increase in streptozotocin-induced hyperglycemia or in untreated group. These findings are in agreement with the work of Ramesh et al. [22] and Muhammad et al. [15]. The use of methanol extract for the treatment of diabetic rats, reduced the histological changes in the tissues, this may be due to the presence of phenolic in this plant. In the STZ-induced diabetic animals, lower levels of activities of endogenous antioxidant enzymes such as SOD and CAT were shown [33–35]. Subsequently, these reductions can cause tissue degradations. There were no histological changes noticed in pancreatic tissues of the control

groups. However the pancreas was disappeared in groups where there was destruction of Islets of Langerhans [36,37]. Whereas, sections of pancreas from the treated animals groups showed streaky inflammation by lymphocytes in the Islets region. The examination of the livers sections showed no change in the hepatocytes architecture except the sinusoidal spaces and portal veins which were congested in all the groups. When compared to control group, focal lymphocyte cells infiltration was abundant in untreated animals [38].

5. Conclusion

In conclusion, *Desplatsia dewevrei* significantly and effectively reduced the sugar level of the test animal; even at lower doses. These properties may have been due to the metabolic contents present in the extracts. In addition more research and studies should be done in exploiting other natural means of controlling and curing diabetes.

Statement & declarations

We the authors submitted our manuscript to your reliable journal, and a copy of this manuscript is not under consideration or published elsewhere. No issue concerning the Journal competing interest. All authors have agreed to the publication of this manuscript.

Informed consent

Not applicable for this section.

Funding

Not applicable for this section.

Data availability statement

Data obtained from this study were presented as Tables and Figures. The materials used for this study, such as; chemicals, medicine, kits, and experimental animals, were procured standard stores within and outside the country.

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