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# Comparative Effects of Ethanolic Leaf Extracts of *Gongronema latifolium Benth* and *Bryophyllum pinnatum (Lam.) Oken* in The Management of Diabetes Mellitus in Albino Rats

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**ABSTRACT**

**Introduction:** Diabetes is a multifactorial metabolic disorder characterized by hyperglycemia, which is the primary factor in preventing glucose from achieving its desired levels in patients with the condition. Hyperglycemia results from a lack of insulin secretion, inadequate insulin action or both.

**Materials and Methods:** The comparative effects of ethanolic leaf extracts of The comparative effects of ethanolic leaf extracts of Gongronema latifolium (*G. latifolium*) and Bryophyllum pinnatum (*B. pinnatum*) on some biochemical parameters in diabetic induced albino rats were investigated. Two different concentrations of ethanolic leaves extracts of both plants were used to treat alloxan-induced diabetic rats.

**Results:** The study found that alloxan administration significantly increased blood sugar levels in diabetic rats, with the highest reduction in group 7 and the lowest in group 5. The ethanolic extracts of *B. pinnatum* and *G. latifolium* leaves showed potential hepatoprotective and renal protective activities, but mild urea level alteration was observed. The study suggests that these extracts may be beneficial for diabetic rats.

**Conclusion:** The study reveals that alloxan monohydrate can induce diabetes in animals, and ethanolic extracts from *B. pinnatum* leaves and *G. latifolium* leaves may reduce blood sugar levels in diabetic rats. Glibenclamide showed better hypoglycaemic effects. Alloxan may cause hepatotoxicity and renal toxicity, but the extracts may also cause mild urea level alteration.

**Keywords:** Gongronema latifolium, Bryophyllum pinnatum, Rats, Plant

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## 1. Introduction

Plants possess very great potential for the treatment and management of certain disease conditions. Many plants have been used by tribal and folklore in different countries for the treatment and management of different diseases (1).

Currently, many plant materials including *B. pinnatum* and *G. latifolium* are being investigated for their potential effects in healthcare. For a long time, there has been a resurgence of interest in the investigation of natural materials, especially plants, as a source of potential drug. *B. pinnatum* belongs to the Crassulaceae family, commonly used in traditional medicines. It is also known as the air plant, life plant, cathedral bells and miracle leaf. It is a succulent plant native to Madagascar and has become naturalized in tropical and subtropical areas. *B. pinnatum* also popularly known as "resurrection plant" is a perennial herb used in folkloric medicine in tropical Africa. It is classified as a weed and the plant flourishes throughout the southern regions of Nigeria (2).

It has been reported to contain a wide range of active compounds such as alkaloids, glycosides, flavonoids, triterpenes, steroids, lipids, and organic acids. The plant is widely used in traditional medicine for the treatment of variety of ailments and well known for its haemostatic and wound healing properties(3). *B. pinnatum* leaves is astringent, sour in taste, sweet in the post digestive effect and has hot potency. The plant has considerable attention for their medicinal properties and application in folk medicine, as well as in the contemporary medicine (3).

Some traditional practitioners in various parts of the world use this plant for numerous conditions such as hypertension, asthma, cold, skin disorders, insect stings, abscesses, etc (4). In traditional medicine, the leaves of this plant have been used for antimicrobial (5), antifungal(6), antiulcer, potent anti-histamine, anti-allergic (7), anti -inflammatory, analgesic (8), and antihypertensive (9). *G. latifolium* (G.L) is a herbaceous shrub with yellow flowers and the stem yields milky exudates when cut (10). It is locally called *"Utazi"* by Igbos and "Arokeke" by the Yorubas in Nigeria. The Igbos in the South-Eastern Nigeria use the *G. latifolium* crude leaf extract for the treatment of diabetes, malaria, hypertension and as laxative in folk medicine. It is also used as spice and vegetable (11).

Diabetes mellitus (DM), commonly known as diabetes, is a group of metabolic disorders which is characterized by a high blood sugar level over a prolonged period. Symptoms associated with DM include frequent urination, increased thirst, and increased hunger. Many complications may arise if diabetes is left untreated. The quest for the discovery of more and better herbal remedies for the treatment of certain disease conditions such as diabetes mellitus warranted this study.

There are strong evidence to support that medicinal plants are very effective in the management and treatment of many disease conditions and can be substituted for orthodox medicine which have many adverse side effects on the liver, kidneys and other organs of the body. This study was born from the desire to use medicinal plants in the management of diabetes mellitus which is a disease suffered by a high percentage of people in Nigeria. Hence, the choice of *B. pinnatum* and *G. latifolium*, two readily available plants consumed as vegetables locally. This study also compares the efficacy of ethanolic leaf extracts of B.p and G.l in the management of diabetes mellitus induced in albino rats.

## 2. Material and methods

### 2.1. Plant materials and extraction

The leaves of *G. latifolium* were harvested in Umuahia, Abia State, Nigeria while the leaves of *B. pinnatum* was harvested in Wukari,

Taraba State, Nigeria. The plant materials were harvested in February, 2020. The materials were rinsed. sun-dried, and milled to a powder. About 250g of each powder was extracted with 625ml of ethanol (70%) by cold maceration for 48 hours and filtered (12). The filtrates were evaporated to dryness using water bath. The concentration of the extracts was made in normal saline for the experiment: 200 mg/mL and 400 mg/mL.

### 2.2. Kits for Biochemical Analysis

ACCU-CHEK Active and its strips (product of Roche Diagnostics GmbH, Germany) were used for the determination of the blood sugar level. The Kits for the biochemical analysis were purchased from a standard laboratory: Randox Laboratories Limited, 55 Diamond Road, *Crumlin*, *Country* Antrim, BT29 4QY, United Kingdom.

### 2.3. Experimental animals

Thirty-five healthy male albino rats aged 8 weeks were used in this study. The rats were kept in the animal house, Department of Biochemistry, Faculty of Pure and Applied Sciences, Federal University Wukari, Taraba State. The animals were allowed to acclimatize for 14 days under standard laboratory conditions with free access to commercial rat feed and water before the experiment.

### 2.4. Induction of diabetes

The experimental rats were induced by injection of 100mg/kg bw alloxan monohydrate intraperitoneally after they were fasted for 18hrs.

### 2.5. Experimental design

The animals were randomly placed into seven (7) groups with five rats in each group. Group 1 served as the control group (received a placebo of normal saline). Group 2 received alloxan monohydrate (100 mg/kg b.w.) only: as negative control. Group 3 received alloxan monohydrate (100 mg/kg b.w.) and leaves extract of *B. pinnatum* (200 mg/kg b.w.). Group 4 received alloxan monohydrate (100 mg/kg b.w.) and leaves extract of *B. pinnatum* (400 mg/kg b.w.). Group 5 received alloxan monohydrate (100 mg/kg b.w.) and leaves extract of *G. latifolium* (200 mg/kg b.w.). Group 6 received alloxan monohydrate (100 mg/kg b.w.) and leaves extract of *G. latifolium* (400 mg/kg b.w.). Group 7 received alloxan monohydrate (100 mg/kg b.w.) and standard drug: glibenclamide 10 mg/kg bw).

Groups 2, 3, 4, 5, 6 and 7 received the alloxan monohydrate once intraperitonially. After the animals were confirmed to be diabetic, the test animals (groups 3, 4, 5 and 6) received the leaves extracts as stated above for 21 days. The extracts were administered through oral route using a gavage tube. All animals were allowed free access to food and water ad libitum.

### 2.6. Determination of blood glucose level

The method reported by Imo et al. (13) was used. ACCU-CHEK Active (glucometer) test strips for quantitative blood glucose level were used. Blood was collected from the rats through tail puncture. The ACCU-CHEK Active was activated, the blood was placed on the test strip and slotted into the ACCU-CHEK Active and blood glucose level read on the meter.

### 2.7. Blood collection

After administration of the extracts, the animals were fasted overnight, anaesthetized with chloroform, and sacrificed. Blood was collected by cardiac puncture from each animal and was allowed to stand for about 15 minutes to clot and further spun in a centrifuge. Serum was separated from the clot with Pasteur pipette into sterile sample test tubes for the measurement of selected biochemical indices.

### 2.8. Biochemical analysis

The serum activities of Aspartate transaminase (AST), Alanine transaminase (ALT) and Alkaline phosphatase (ALP); concentrations of urea, creatinine, albumin, sodium, potassium, total bilirubin, and direct bilirubin were

determined using an auto-analyzer (Selectra Pro).

### 2.9. Ethical Consideration

All protocols in this study were conducted under supervision and approved by the Committee on the Ethics of Animal Experiments of the Department of Biochemistry, Faculty of Pure and Applied Sciences, Federal University Wukari, Taraba State, Nigeria.

### 2-10 Statistical analysis

Statistical analysis was carried out on the biochemical results with the use of one-way Analysis of Variance (ANOVA) and further with Duncan Multiple Comparisons with the use of Statistical Package for Social Science (SPSS) version 23. The means were compared for significance at $p \leq 0.05$ and the group results presented as mean ± standard deviation.

## 3. Results

The differences in blood sugar levels of all the rats before administration of alloxan and after treatment with the plant extracts were not statistically significant ($p>0.05$). The increased blood sugar levels in all the test animals (group 2, 3, 4, 5 and 6) after administration of alloxan were statistically significant ($p<0.05$) when compared with the normal control (group 1).

The percentage reduction in blood sugar concentration after treatment among the test groups were highest in group 7, followed by group 6 when compared with the normal control. The least in percentage reduction of blood sugar among the test groups (when compared with the normal control) is group 5. Albumin level increased significantly ($p<0.05$) in groups 2, 3, 5 and 6, but increased non-significantly ($p>0.05$) in groups 4 and 7 compared to the control. ALP activity decreased significantly ($p<0.05$) in groups 2, 3 and 7, but decreased non-significantly ($p>0.05$) in groups 5 and 6 compared to the control. There was a non-significant increase in the ALP activity in group 4 when compared to the normal control. ALT activity increased significantly ($p<0.05$) in groups 2, 5, 6 and 7, but increased non-significantly ($p>0.05$) in groups 3 and 4 compared to the control. There was no significant alteration of AST, total bilirubin, creatinine, potassium and urea levels in the test groups when compared with the normal control. Direct bilirubin increased non-significantly ($p>0.05$) in all the test groups except group 2 (where it increased significantly) when compared with the normal control. Sodium increased non-significantly ($p>0.05$) in all the test groups, except group 5 (where it increased significantly) when compared with the normal control.

## 4. Discussion

The measurement of blood sugar level in animals can help the prediction of health status of the animals regarding hypoglycaemic conditions. Diabetes is a serious health challenge and may lead to death if not treated. In this study, blood sugar levels of the animals were measured and used to confirm that administration of alloxan monohydrate actually induced diabetes in the animals. This is evident with the result of high blood sugar levels of the test animals following the administration of alloxan monohydrate. The result confirmed that administration of alloxan monohydrate induced diabetes in the test animals. Diabetes is a lifelong disease which is a group of metabolic disorder characterized by high levels of sugar in the blood (hyperglycemia) (14). Following daily treatment of the diabetic rats with two doses of the two different plant extracts and glibenclamide, there was a reasonable reduction in the blood sugar level of the test animals when compared with the normal control animals. This is an indication that some of the constituents of the plant extracts may have hypoglycaemic effect. This gradual reduction was also observed in group 7 administered glibenclamide. The result (Table 1) confirmed glibenclamide as hypoglycaemic.

Table 1: Concentrations of blood sugar in alloxan-induced diabetic rats treated with ethanolic extracts of *B. pinnatum* and *G. latifolium* leaves

| Group/ Parameters | Normal control | Alloxan monohydrate (100 mg/kg bw) | Alloxan monohydrate (100 mg/kg bw.) + *B. pinnatum* (200 mg/kg bw) | Alloxan monohydrate (100 mg/kg bw.) + *B. pinnatum* (400 mg/kg bw) | Alloxan monohydrate (100 mg/kg bw.) + *G. latifolium* (200 mg/kg bw) | Alloxan monohydrate (100 mg/kg bw.) + *G. latifolium* (400 mg/kg bw) | Alloxan monohydrate (100 mg/kg bw.) + standard drug:glibenclamide 10 mg/kg bw) |
|---|---|---|---|---|---|---|---|
| Blood sugar before administration of alloxan (mmol/L) | $6.22 \pm 0.52^{a}$ | $5.86 \pm 1.46^{a}$ | $5.28 \pm 0.73^{a}$ | $5.28 \pm 0.70^{a}$ | $6.04 \pm 0.91^{a}$ | $5.20 \pm 0.26^{a}$ | $5.28 \pm 0.40^{a}$ |
| Mean blood sugar concentration for two days after administration of alloxan (mmol/L) | $5.88 \pm 0.59^{a}$ | $23.84 \pm 7.05^{b}$ | $18.66 \pm 6.65^{b}$ | $24.96 \pm 6.83^{b}$ | $21.13 \pm 4.60^{b}$ | $24.32 \pm 7.18^{b}$ | $21.00 \pm 1.87^{b}$ |
| Mean blood sugar concentration after the experiment (mmol/L) | $5.90 \pm 0.34^{a}$ | $12.14 \pm 8.80^{a}$ | $10.22 \pm 5.93^{a}$ | $13.64 \pm 10.14^{a}$ | $12.34 \pm 11.06^{a}$ | $9.36 \pm 5.69^{a}$ | $5.20 \pm 0.83^{a}$ |
| Increase/reduction in concentration after treatment (mmol/L) | 0.02 | -11.70 | -8.44 | -11.32 | -8.79 | -14.96 | -15.80 |
| Percentage increase/reduction in concentration after treatment (%) | 11.76 | 49.08 | 45.23 | 45.35 | 41.60 | 61.51 | 75.24 |

Data are shown as Mean±SEM (n=5).
Mean in the same row, having different letters of the alphabet are statistically significant ($p<0.05$).

Table 2: Concentrations of selected biochemical parameters in alloxan-induced diabetic rats treated with ethanolic extracts of *B. pinnatum* and *G. latifolium* leaves

| Group/ Parameters | Normal control | Alloxan monohydrate (100mg/kg bw) | Alloxan monohydrate (100mg/kg bw.) + *B. pinnatum* (200 mg/kg bw) | Alloxan monohydrate (100mg/kg bw.) + *B. pinnatum* (400 mg/kg bw) | Alloxan monohydrate (100mg/kg bw.) + *G. latifolium* (200 mg/kg bw) | Alloxan monohydrate (100mg/kg bw.) + *G. latifolium* (400 mg/kg bw) | Alloxan monohydrate (100 mg/kg bw.) + standard drug:glibenclamide 10 mg/kg bw) |
|---|---|---|---|---|---|---|---|
| ALB (g/L) | $33.87 \pm 1.88^{a}$ | $45.43 \pm 1.31^{c}$ | $42.43 \pm 2.89^{b,c}$ | $38.30 \pm 5.37^{a,b}$ | $40.83 \pm 1.25^{b,c}$ | $39.13 \pm 1.48^{b}$ | $37.10 \pm 2.79^{a,b}$ |
| ALP (U/L) | $474.17 \pm 46.25^{a}$ | $248.43 \pm 28.82^{b}$ | $249.53 \pm 80.17^{b}$ | $489.37 \pm 109.99^{a}$ | $320.83 \pm 64.28^{a,b}$ | $314.23 \pm 115.45^{a,b}$ | $219.60 \pm 81.15^{b}$ |
| ALT (U/L) | $3.80 \pm 1.56^{a}$ | $118.70 \pm 16.05^{d}$ | $26.57 \pm 13.27^{a,b}$ | $19.93 \pm 3.15^{a,b}$ | $39.57 \pm 3.22^{b}$ | $37.23 \pm 12.92^{b}$ | $79.10 \pm 27.38^{c}$ |
| AST (U/L) | $256.07 \pm 35.15^{a}$ | $296.27 \pm 31.18^{a}$ | $256.50 \pm 68.78^{a}$ | $287.83 \pm 95.31^{a}$ | $244.00 \pm 67.93^{a}$ | $274.10 \pm 163.13^{a}$ | $306.30 \pm 71.32^{a}$ |
| Total bilirubin (mg/dL) | $0.12 \pm 0.03^{a}$ | $0.31 \pm 0.02^{a}$ | $0.21 \pm 0.08^{a}$ | $0.29 \pm 0.12^{a}$ | $0.27 \pm 0.10^{a}$ | $0.31 \pm 0.17^{a}$ | $0.31 \pm 0.10^{a}$ |
| Direct bilirubin (mg/dL) | $0.08 \pm 0.03^{a}$ | $0.41 \pm 0.07^{b}$ | $0.26 \pm 0.18^{a,b}$ | $0.25 \pm 0.14^{a,b}$ | $0.29 \pm 0.09^{a,b}$ | $0.29 \pm 0.19^{a,b}$ | $0.30 \pm 0.07^{a,b}$ |
| Creatinine (mmol/L) | $29.10 \pm 6.15^{a}$ | $43.37 \pm 0.90^{a}$ | $34.13 \pm 11.47^{a}$ | $32.77 \pm 11.60^{a}$ | $32.33 \pm 18.56^{a}$ | $29.90 \pm 18.70^{a}$ | $23.07 \pm 9.34^{a}$ |
| Potassium (mmol/L) | $2.53 \pm 0.50^{a}$ | $2.97 \pm 0.11^{a}$ | $2.97 \pm 0.90^{a}$ | $2.33 \pm 0.49^{a}$ | $2.67 \pm 0.49^{a}$ | $2.43 \pm 0.74^{a}$ | $2.03 \pm 0.21^{a}$ |
| Sodium (mmol/L) | $132.60 \pm 2.11^{a}$ | $135.67 \pm 1.15^{a,b}$ | $135.47 \pm 4.46^{a,b}$ | $137.47 \pm 5.00^{a,b}$ | $150.07 \pm 9.87^{b}$ | $145.00 \pm 14.51^{a,b}$ | $139.20 \pm 13.95^{a,b}$ |
| Urea (mmol/L) | $2.67 \pm 0.12^{a}$ | $2.87 \pm 0.12^{a}$ | $3.10 \pm 0.66^{a}$ | $2.83 \pm 0.23^{a}$ | $3.10 \pm 0.82^{a}$ | $3.03 \pm 0.81^{a}$ | $2.67 \pm 1.00^{a}$ |

Data are shown as Mean±SEM (n=5).

Mean in the same row, having different letters of the alphabet are statistically significant ($p<0.05$).

The increased blood sugar levels of all the animals in the test groups (group 2, 3, 4, 5, 6 and 7) after administration of alloxan were statistically significant ($p<0.05$) when compared with the normal control (group 1). The result of this study predicts that daily consumption of the extracts of *B. pinnatum* leaves and *G. latifolium* leaves could reduce blood sugar level. However, it was also observed that the blood sugar level of the negative control animals (group 2) reduced without administration of any treatment after administration of alloxan. This shows that the body may have a natural mechanism of reversing hyperglycemia resulting from alloxan intake.

It is possible that the chemical constituents of the two plant extracts may be contributing to the effects observed in this study. There was a non-significant increase ($p>0.05$) in blood sugar levels of all the test groups and glibenclamide. This non-significant increase suggests that the extracts of *B. pinnatum* leaves and *G. latifolium* leaves may regulate blood sugar level. A comparative analysis of the substances administered showed that glibenclamide exhibited better hypoglycaemic effect, while among the two plants and four concentrations of the plant extracts administered, 400 mg/kg body weight of *G. latifolium* leaves extract exhibited better hypoglycaemic effect.

The results obtain in this study (table 2) showed an increase in the serum activities of serum aspartate aminotransaminase (AST) and alanine aminotransaminase (ALT) and a reduction in the activity alkaline phosphatase (ALP) in the negative control when compared with the normal control. The elevation in the levels of liver enzymes in serum have been reported as an indication showing cellular leakage and malfunctioning of cell membrane in the liver (13,15).

There was a significant increase in ALT activity after administration of alloxan, but administration of the various plant extracts caused a significant reduction in ALT activity when compared with the negative control (table 2). The reduction was better in group 4 (administered 400 mg/kg bw of *B. pinnatum* leaves extract) when compared with other test groups against normal control. The significant increase in ALT level in the negative control showed the evidence of possible hepatotoxicity and the possibility of cellular leakage of this liver enzyme into the blood which is caused by the administration of alloxan. The significant reduction of ALT activities in all the treated test groups showed that the extracts of *B. pinnatum* and *G. latifolium* leaves, and glibenclamide possess possible hepatoprotective activity in diabetic rats. It is possible that the extracts possess the mechanism to repair the possible liver damage which may have caused the enzyme to leak into the blood. The liver is an organ that plays many roles in humans and some other animals, including metabolic functions. As a result, it is likely to suffer xenobiotic injury since it plays a central role in the metabolism of xenobiotics (16). The hepatotoxicity observed in this study is believed to be as a result of the alloxan administered which may have altered certain liver functions.

The AST activity increased non-significantly in the negative control compared with the normal control and reduced non-significantly in the test groups treated with the various plant extracts when compared with the negative control. This non-significant reduction in AST activity also supports the possible hepatoprotective effects of the ethanolic extracts of *B. pinnatum* leaves and *G. latifolium* leaves. However, the reduction in the activity of serum ALP in the negative control and in all the test groups (except group 4 where it increased non-significantly when compared with the normal control) showed that despite the hepatotoxic effects the administration of alloxan caused by elevating the ALT activity, it may not have negative effect on certain part of the liver, especially on the portal tract or bile duct. Rather, administration of the plant extracts may cause and increase in ALP activity (Table 2).

The concentration of albumin improved in the negative control administered alloxan only when compared with the normal control but reduced in all test groups compared with the negative control. This suggest that despite the negative effect of alloxan, it may promote the processes involved in the synthesis of albumin which is one of the functions of the liver. But the result also showed

that administration of the plant extracts and glibenclamide reduced the albumin levels when compared with the negative control It is possible that the reduction of albumin levels in the test groups when compared with the negative control may be due to degenerations of some hepatocytes, among other causes, since most proteins found in the plasma are mostly synthesized by the hepatocytes and thereafter secreted into circulation (17). A previous study has reported that serum protein level is a marker of the synthetic function of the liver and is used as a very helpful guide in assessing the severity of the liver damage (18).

Administration of alloxan caused an increase in the concentrations of total bilirubin and direct bilirubin when compared with the normal control, but treatment with the various doses of the plant extracts reduced this increase. The elevation of bilirubin concentration above normal level in the serum or tissues may be referred to as jaundice. Jaundice can exist due to toxic or infectious diseases of the liver. The disease conditions may include obstruction of the flow of bile from bile duct and hepatitis *B. Bilirubin* is produced in the liver as an intermediate product of haemoglobin breakdown (19). The elevated levels of total and direct bilirubin in the negative control are believed to be caused by toxic effect of the alloxan which may have resulted to destruction of some haemoglobin and possibly damaging some red blood cells. If the hepatocytes are destroyed, the liver may therefore not have the adequate ability to handle bilirubin properly. The ethanolic extracts of *B. pinnatum* leaves and *G. latifolium* leaves showed mild ability to reverse the alteration of the bilirubin level exerted by alloxan.

The liver and kidneys work in synergy to maintain homeostasis in the body. This ensures the proper excretion of waste materials and reabsorption of some useful materials by the kidneys. Creatine is produced in the liver before being distributed into circulation. Creatine phosphate metabolism produces the waste product creatinine which should be excreted by the kidneys. When creatinine and urea are retained in the blood, it shows a possible impairment of the kidneys (20). The results of this study (table 2) showed creatinine was retained in the negative control animals administered alloxan only but were moderated towards normal level in the treated groups when compared with the normal control. Administration of *G. latifolium* leaves extracts showed better effect in moderating the creatinine levels than *B. pinnatum* leaves extracts. This showed the constituents of *B. pinnatum* leaves and *G. latifolium* leaves extracts may possess renal protective effect in diabetic rats. However, the result also suggests that administration of alloxan and the plant extracts may cause mild alteration of urea levels in animals. Renal diseases that reduce glomerular filtration may result in retention of urea which is the major end product catabolism (21). The result of this study showed urea was not properly excreted in groups 3, 5 and 6 when compared to the normal control. This showed that leaves extract of *G. latifolium* and 200 mg/kg bw of leaves extract of *B. pinnatum* do not encourage elimination of urea by the kidney when compared with the normal control, but treatment with glibenclamide was able to normalize the urea level. Increase in the level of blood urea has been reported to result from inability of impaired kidney to filter urea up to normal levels (22).

It has been reported that healthy functioning of the kidneys, heart and liver can be assessed using the electrolytes balance in the blood. This is because when the level of serum or plasma electrolytes are abnormal, it is believed that the kidney function may have been impaired (23). Electrolyte balance could also show the possibility of proper maintenance of homeostasis. The results of potassium and sodium in this study (table 2) showed that the concentrations of the serum electrolytes were not significantly altered in all test groups administered different doses of the plant extracts when compared with the control. This shows that the different plant extracts do not adversely interfere with electrolytes balance in diabetic rats, thereby suggesting a possible good interaction between the liver and the kidneys.

**Conclusion**

This study has shown that the administration of alloxan monohydrate could induce diabetes in

animals. Administration of ethanolic extracts of *B. pinnatum* leaves and *G. latifolium* leaves may reduce blood sugar levels in alloxan-induced diabetic rats. Glibenclamide exhibited better hypoglycaemic effect than the two plant extracts, while among the two plants and four concentrations of the plant extracts administered, 400 mg/kg body weight of *G. latifolium* leaves extract exhibited better hypoglycaemic effect. Administration of alloxan could cause some levels of hepatotoxicity and renal toxicity. The results also showed that constituent of ethanoli extracts of *B. pinnatum* leaves and *G. latifolium* leaves, and glibenclamide possess possible hepatoprotective and renal protective activities in diabetic rats. However, the result also suggests that administration of alloxan and the plant extracts may cause mild alteration of urea levels in animals.

**Recommendations**

There is need to evaluate the mechanism of action of the constituents of ethanolic extracts of *B. pinnatum* leaves and *G. latifolium* leaves. Further research should be carried out on hypoglycaemic effect of more doses of different solvent extracts of *B. pinnatum* leaves and *G. latifolium* leaves on alloxan-induced diabetic rats.

**Conflict of interest**

We declare that we have no conflict of interest.

**Data availability statement**

The data that support the findings of this study are available from the corresponding author, upon reasonable request.

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