Effect of *Colocasia esculenta* (L.) shoot inflorescence Aqueous Extracts on Streptozotocin-induced Diabetic Albino rats

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Abstract: *Colocasia esculenta* (L) is a medicinal plant whose shoot inflorescence has not been reported for detailed anti-diabetic properties. Hence, this study investigated the anti-diabetic properties of the aqueous shoot extract of *Colocasia esculenta* (L) inflorescence and its effect on biochemical parameters in streptozotocin induced diabetic rats. Twelve albino rats were used for acute toxicity test while thirty five were divided randomly into seven groups of five in each group. The animals were starved for 48 hours before commencement of treatment. Group 1: Served as normal control, Group 2 serves as diabetic control, Group 3 treatment with glycinorm at 50mg/kg body weight, Group 4 treatment with extractat 200mg/kg body weight, Group 5 diabetic group treatmentat 400mg/kg body weight, Group 6 treatmentat 600mg/kg body weight and Group 7 treatmentat 800mg/kg body weight by oral administration respectively. Diabetes was induced in albino rats by intraperitoneal injection of streptozotocin at a single dose of 120mg/kg body weight into group 3 to 7 and were fed with aqueous shoot inflorescence extract of *Colocasia esculenta* for a period of 28 days. Serum biochemical parameters were analysed. The oral acute toxicity study showed that the aqueous shoot inflorescence extract of *Colocasia esculenta* did not cause mortality to any experimental animals even at the highest dose of 5000mg/kg. Body weight and glucose levels were measured on days 0, 7, 14, 21, and day 28. Animal were sacrificed on day 28 and body weight, glycated hemoglobin level, Liver enzymes such as Aspartate Transaminase (AST), Alanine Transaminase (ALT) and alkaline Phosphate (ALP), bilirubin were determined. Also the renal function test to include potassium, sodium, chloride, levels and protein and albumin levels were determined. The study also evaluated hematological parameters in the animals that were fed with the aqueous shoot inflorescence extract of *Colocasia esculenta*. The animals that received different aqueous shoot extract of *Colocasia esculenta* showed significant (P<0.05) reduction of blood glucose, serum liver enzymes, renal function biomarkers, packed cell volume and platelet counts and improved body weight. Conclusively From this study it has been demonstrated that aqueous shoot inflorescence extract of *Colocasia esculenta* may possess the weight enhancing, antihyperglycemic, hepatoprotective, improved hematological values, cells and organ protective activities.

Key words: *Colocasia esculenta*, Diabetes, Glycated hemoglobin

I. INTRODUCTION

Diabetes is a disease associated with glucose metabolism resulting from defects in insulin secretion and action. Such a deficiency results in increased concentrations of glucose in the blood, which in turn damage many of the body's systems, in particular the blood vessels and nerves. It is characterized by hyperglycemia, glucosuria and several microvascular and macrovascular complications (Brownlee, 2001; Virella-Lopes and Virella, 2003).

The quest for the scientific understanding of the etiopathogenesis of diabetes mellitus (DM) and the ultimate development of definitive curative and/or prophylactic options in its management have stimulated great scientific research interest in recent years (Bailey, 2001). Drug management of DM without associated untoward effect has also remained a challenge for orthodox medical practice. This has necessitated exploration and screening of medicinal plants with acclaimed therapeutic efficacies in DM management as recommended by the (World Health Organization) WHO Expert Committee on DM (WHO, 1980; WHO, 2002).

*Colocasia esculenta* is a tropical plant grown primarily for its edible corms, a root vegetable most commonly known as taro. It has tuberous or a stout short caudex, leafing and flowering. It is the most ancient cultivated crops (Denham 2011). The flowering part is known as cocoyam inflorescence. Cocoyam inflorescence is an edible flower. It is consumed as delicacies in the southern part of Nigeria. Cocoyam inflorescence is locally referred to as “Akpuruede”, “Opere”, “Efuruede”, “Ogbalaede”, ‘Opiede’, by the Igbo tribes. Among the four species of cocoyam that produce inflorescence, only NCE005 is used for this work and is the most common species used in the southern parts of Nigeria and has the highest yield during the season (Okechukwu et al., 2019). Cocoyam inflorescence is used fresh as a culinary vegetable. It is also dried, milled and used as a spice in some communities to impact good flavor.

The aim of this study is to evaluate the effect of Cocoyam (*Colocasia esculenta* (L.) shoot inflorescence on streptozotocin induced-diabetic Albino Rat.
II. MATERIALS AND METHODS

Plant Materials

Cocoyam (Colocasia esculenta (L.)) shoot inflorescence were obtained from Ifihe in IsialaNgwa North L.G.A, Abia State. The plant was identified and authenticated at the Department of Plant Sciences and Biotechnology, Abia State University, Uturu, Nigeria, by Prof. I.C. Ogbonna. Voucher specimens were number: ABSU/PSB/68 and was deposited at the Departmental Herbarium.

Preparation of plant extract

The extracts were prepared using method described by Jones and Kinghorn (2012) with slight modifications. Powdered Cocoyam (Colocasia esculenta (L.)) shoot inflorescence of 1000g was soaked in 300ml of water for 24 hours and strained with muslin cloth, then filtered using what man no. 1 filter paper. The filtrate was allowed to dry in open air and a dark greenish residue was left which is the extract which gave a yield of 53.10g after extraction.

Experimental Animals

Thirty (35) male albino rats of the same stock assumed healthy were obtained from the animal house of Abia State University, Uturu. The animals were taken to the laboratory where they were housed in plastic cages and placed on commercial feeds bought from the local market as produced by Nigeria Flour Mills, and were allowed food and water ad libitum. Ethical principles in animal handling was adhered to strictly.

Induction of Diabetes:

The rats were fasted for 18 h, and diabetes was induced by a single intravenous injection of freshly prepared solution of Streptozotocin (55 mg/kg of body weight) in 0.1 M citrate buffer (pH 4.5) (Ravi et al., 2004). The animals were allowed water (5% glucose solution) to protect them against the diabeticogenic action of Streptozotocin and subsequently kept fasting in order to avoid excessive accumulation of feeding glucose which may antagonize Streptozotocin effect. Control rats were injected with citrate buffer alone. After 24 h of injection, fasting blood glucose level was checked, and animals with levels above 13.9 d/L were considered diabetic (Ravi et al., 2004).

Determination of blood glucose

Blood glucose was determined by pricking the tail of the rats with a needle after massaging. Glucose concentration was determined using On-Call Plus glucometer on weekly basis for four weeks. The weight of the rats was also noted.

Measurement of Body Weight

Body weight was measured on days 0, and 28. Body weight noted was expressed as mean body weight (g).

Experimental design

Animal Grouping

The animals were randomly placed into seven groups of ten animals each. Group 1: Served as normal control and were fed with rat feeds and water ad libitum. No diabetes was induced. Group 2: Diabetic control group were fed rat feeds and water ad libitum after inducing diabetes. Group 3: Diabetic group were fed with rat feeds and were given oral glycinorm at 80mg/kg body weight and allowed water and feed ad libitum after induction of diabetes. Group 4: Diabetic group were fed with rat feeds and aqueous extracts of Colocasia esculenta (L.) shoot inflorescence at 200mg/kg body weight by oral administration and allowed feed and water ad libitum. Group 5: Diabetic group were fed with rat feeds and aqueous extracts of Colocasia esculenta (L.) shoot inflorescence at 400mg/kg body weight by oral administration and allowed feed and water ad libitum. Group 6: Diabetic group were fed with rat feeds and aqueous extracts of Colocasia esculenta (L.) shoot inflorescence at 600mg/kg body weight by oral administration and allowed feed and water ad libitum. Group 7: Diabetic group were fed with rat feeds and aqueous extracts of Colocasia esculenta (L.) shoot inflorescence at 800mg/kg body weight by oral administration and allowed feed and water ad libitum.

Blood Collection

After 28 days of treatment with the extract, the animals were starved overnight; anaesthetized with chloroform and sacrificed. Blood from each animal was collected by cardiac puncture and blood samples from each animal collected into dry test tubes. The blood sample was divided into two. The first was dispensed into heparinized tubes (EDTA) bottles for haematological analysis. The second 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 and evaluation of liver enzymes, antioxidant activities and serum electrolytes.

Estimation of Other Biochemical Parameters

On the 28th day, animals were sacrificed, following ether anesthesia and blood collected via cardiac puncture. Blood samples collected was used to estimate the following:

Glycated Hemoglobin (HBA1c)

Glycated Hemoglobin (HBA1c) was estimated using the appropriate commercial kits (Randox Laboratory UK). (Little et al., 2008).

Liver enzymes
Determination of Aspartate Aminotransferase (AST) and Alanine Aminotransferase (ALT)
The method employed was the colourimetric method described by Reitman and Frankel (1957).

Estimation of Alkaline Phosphatase (ALP) Activity
Alkaline phosphatase (ALP) activity was estimated by using ALP test kit (Randox Diagnostics Ltd.) (Vroon, 1990).

Determination of Bilirubin
The method employed was the colourimetric method described by Jendrassik and Grof (1938).

Determination of Serum Potassium
The method employed was a modification of the colourimetric method described by Terri and Sesin, (1958).

Determination of Serum Sodium
The method employed was a modification of the colourimetric method described by Maruna (1958) and Trinder, (1951).

Determination of Serum Chloride
A modification of the colorimetric method described by Skeegs and Hochestrassser (1964) was used.

Determination of Serum Bicarbonate
The method employed was a modification of the enzymatic procedure described by Forrester et al., (1976).

Hematological analysis: A portion of the blood samples collected from the rats was dispensed into Ethylene Diamine-Tetra-Acetic Acid (EDTA) anticoagulant bottle from where Red Blood Cell (Erythrocyte) count, White Blood cell (Leucocyte) count, Differential Leucocyte count, Relative Volume of corpuscles to plasma (Packed Cell Volume or Haematocrit) and hemoglobin count were determined.

III. RESULTS AND DISCUSSION

Acute toxicity profile of Colocasiaesculenta (L.) shoot inflorescence aqueous extracts

<table>
<thead>
<tr>
<th>Doses (mg/kg bw)</th>
<th>Mortality</th>
<th>Physical observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>0/3</td>
<td>No sign of toxicity</td>
</tr>
<tr>
<td>100</td>
<td>0/3</td>
<td>No sign of toxicity</td>
</tr>
<tr>
<td>1000</td>
<td>0/3</td>
<td>No sign of toxicity</td>
</tr>
<tr>
<td>1600</td>
<td>0/3</td>
<td>No sign of toxicity</td>
</tr>
<tr>
<td>2900</td>
<td>0/3</td>
<td>Weakness</td>
</tr>
<tr>
<td>5000</td>
<td>0/3</td>
<td>Weakness, redness of the eye</td>
</tr>
</tbody>
</table>

Values are mean ± SD for n=5. Values in the same column bearing the same letter of the alphabets are not significantly different (P >0.05) from each other.

There was significant increase (P<0.05) in body weight of animals that were fed with different (groups 3 to 7). While there was a significant (P<0.05) reduction in weight in diabetic animal in group two (2) when compare to group one (1) which are normal control groups. Therefore from this study it was observed that there was a general improvement in body weight between the control diabetic group when compared with animals in the other groups feed with different extracts from the different parts of Colocasiaesculenta (L.)
shoot inflorescence aqueous extracts. The test diabetic group had significant (P<0.05) reduction of weight probably because of the diabetic condition. While the animals from the other groups had a non-significant (P>0.05) increase in weight probably because of the administration of aqueous extract of different parts of *Colocasia esculenta* (L.) shoot inflorescence aqueous extracts. (Akhere and Iyere, 2008).

Fig 2: Effects of *Colocasia esculenta* (L.) shoot inflorescence aqueous Extracts on Blood Glucose Levels (mg/dl)

Values are mean ± SD, n=5. Values in the same column bearing the same letter of the alphabets are not significantly different (P >0.05) from each other.

The result of the effect of *Colocasia esculenta* (L.) shoot inflorescence aqueous extracts on blood glucose level of streptozotocin – induced diabetic rats is presented in Fig 2. The result revealed that the streptozotocin significant, increased (P<0.05) the blood glucose level of the animals when compared to the normal control at days 7, 14, 21 and 28. Glycinorm (standard drug) and plant extract significantly (P<0.05) reduced the glucose levels at different days. However, there was significant (P>0.05) difference in the blood glucose level of the animal between the normal and positive control.

Fig 3: Effects of *Colocasia esculenta* (L.) shoot inflorescence aqueous extracts Glycated Hemanoglobin (%) Day 28.
Values are mean ± SD for n=5. Values in the same column bearing the same letter of the alphabets are not significantly different (P >0.05) from each other.

The results of glycated hemoglobin shows elevated values in group 2 (diabetic control) while the standard drug was able to reduce significantly (P<0.05) the glycated hemoglobin below those of the normal. The groups treated with different plant part had the glycated hemoglobin levels significantly reduced (P<0.05).

It is therefore possible that the different plant parts of aqueous extract of *Colocasiaesculenta* (L.) shootin florescenceaqueous extracts plants may possess active substances which scavenges the free radicals of glucose oxidation protein glycation and oxidative degeneration or probably an up regulation in insulin secretion

![Graph showing blood indices](image1)

**Fig 4.** Effect of *Colocasiaesculenta* (L.) shoot in florescenceaqueous extracts on the Hematological indices on Streptozotocin- induced Diabetic rats

Values are means of triplicate determinations ± standard deviation. Means in along the same column with different superscripts are significantly different (p<0.05).

![Graph showing renal biomarkers](image2)

**Fig 5:** Effect of *Colocasiaesculenta* (L.) shoot in florescenceaqueous Extracts on renal Biomarkers of Streptozotocin- induced Diabetic rats

There was a significant (P<0.05) increase was observed in Hb, RBC neutrophils and lymphocyte counts in the test animals when compared with diabetic untreated.
The result of the effect of *Colocasiaesculenta* (L.) shoot inflorescence aqueous extracts on the renal biomakers of streptozotocin – induced diabetic rats. The result revealed that the streptozotocin caused a significant increase (P<0.05) in the renal biomarkers of the experimental animals when compared to the normal control. The administration of Glycinorm and *Colocasiaesculenta* (L.) shoot inflorescence aqueous extracts at varying concentration of the extract significantly (P<0.05) reduced serum levels of urea and creatinine. However, a non-significant difference (P>0.05) was observed in the serum levels of Sodium, and Bicarbonate following the administration of the plant extract and standard drug. The result further revealed that there was no-significant difference (P>0.05) in the serum level of chloride and Potassium ions among the experimental groups.

![Fig 6: Effect of *Colocasiaesculenta* (L.) shoot inflorescence aqueous extracts on the Liver enzymes indices of Streptozotocin- induced Diabetic rats](image)

Values are means of triplicate determinations ± standard deviation. Means in along the same column with different superscripts are significantly different (p<0.05)

**Discussion**

The preliminary toxicity study of the extract showed that in single dose the plant extract had no adverse effect up to concentration of 5000 mg/kg.bwt.

The result of the effect of *Colocasiaesculenta* (L.) shoot inflorescence aqueous extracts on blood glucose level of streptozotocin – induced diabetic rats is presented in Table 2. The result revealed that the streptozotocin significant, increased (P<0.05) the blood glucose level of the animals when compared to the normal control at days 7, 14, 21 and 28. Glycinorm (standard drug) and plant extract significantly (P<0.05) reduced the glucose levels at different days. However, there was significant (P>0.05) difference in the blood glucose level of the animal between the normal and positive control.

This study also showed that the *Colocasiaesculenta* (L.) shoot inflorescence aqueous extracts significantly reduced blood glucose levels (p<0.05) in diabetic rats. This reduction is similar to the one reported for other plants Perez *et al.*, (2003); Islam, (2011); Sasidharan *et al.*, (2011) and Gaamoussi *et al.*, (2010). Such effect may be explained in part by either a decrease in the rate of intestinal glucose absorption.
absorption (Hamden et al., 2011 and Gupta et al., 2012) or an increase in peripheral glucose utilization, Porchezhan et al., (2000); Gupta et al., (2012). Some authors have proposed increased catabolism of glucose due to GLUT4 translocation to the plasma membrane in muscle and brown adipose cells (Adisa et al., 2011; Shen et al., 2010), with up-regulation of the uncoupling protein-1 in brown adipose tissue and hepatic gluconeogenesis (Gupta et al., 2012), causing as a result hyperinsulinemia or enhancement of peripheral glucose utilization (Adisa et al., 2011; Adeneye et al., 2010).

Moreover, a possible stimulatory mechanism on the few surviving β-cells has been considered, which could allow the release of more insulin (Pepeto et al., 2004). Our results suggest that the Colocasiaesculenta (L.) shoot inflorescence aqueous Extracts may act by stimulating the few remaining β-cells with the subsequent release of more insulin, instead of pointing to the regeneration of β-cells of the islets as responsible for the insulin increase.

Increasing blood glucose levels in diabetes leads to overproduction of free radicals, defined as an imbalance between oxidants and antioxidants. Glucose auto-oxidizes in the presence of transition metal ions generating oxygen-free radicals making the membrane vulnerable to oxidative damage (Bakirel et al., 2008). Insulin and C-peptide are the products of the enzymatic cleavage of proinsulin and are secreted into the circulation in equimolar concentrations.

Glycated hemoglobin (hemoglobin A1c, HbA1c, A1C) is a form of hemoglobin that is covalently bound to glucose (WHO, 2018). Glycated hemoglobin causes an increase of highly reactive free radicals inside blood cells. Radicals alter blood cell membrane properties. This leads to blood cell aggregation and increased blood viscosity which results in impaired blood flow (Saleh, 2015). The results of glycated hemoglobin show elevated values in group 2 (diabetic control) while the standard drug was able to reduce significantly (P<0.05) the glycated hemoglobin below those of the normal. The groups treated with different plant part had the glycated hemoglobin levels significantly reduced (P<0.05).

It is therefore possible that Colocasiaesculenta (L.) shoot inflorescence aqueous extracts may possess active substances which scavenge the free radicals of glucose oxidation, protein glycation and oxidative degeneration or probably an up regulation in insulin secretion.

The assessment of haematological parameters to determine possible alterations in the levels of biomolecules such as enzymes, metabolic products haematology and normal function (Magalhaes et al., 2008). The occurrence of anaemia in diabetes mellitus has been reported to be due to the increased non-enzymatic glycosylation of RBC membrane proteins (Oyedemiet al., 2011). Oxidation of these proteins and hyperglycaemia in diabetes mellitus causes an increase in the production of lipid peroxides that leads to haemolysis of RBC (Arun and Ramesh, 2002). Diabetes mellitus causes the development of hypochronic anaemia due to a fall in the iron content of the body resulting from oxidative stress associated with the condition (Colak et al., 2012). In this study, the red blood cells parameters such as Hb were studied to investigate the beneficial effect of Colocasiaesculenta (L.) shoot inflorescence aqueous extracts on the anaemic status of the diabetic rats. These may be attributed to infection on the normal body systems of the rats. Also, a significant (P<0.05) increase was observed in neutrophils and lymphocyte counts in the test animals when compared with diabetic untreated. The presence of some bioactive compound with the ability to stimulate the production of white blood cells in the extract could be cause for the observed result in the treated rats. The extract at different dosages significantly increase the levels of WBC and lymphocytes as well standard drug when compared with diabetic untreated group. The neutrophils increased significantly in the standard drug group as compared to the normal. The RBC and Hb parameters are used mathematically to check the concentration of haemoglobin and to look at the restoration of oxygen-carrying capacity of the blood.

It was also observed in this study that there was a significant reduction of Glycatedhaemoglobin (Table 3.8) in the test diabetic control group when compared with animals in the test groups fed with Colocasiaesculenta (L.) shoot inflorescence Aqueous Extracts at (P<0.05). It is therefore possible that the Colocasiaesculenta (L.) shoot inflorescence Aqueous Extracts may possess active substances which scavenge the free radicals of glucose oxidation, protein glycation and oxidative degeneration or probably an improvement in insulin secretion. The result of this study is however supported by the work of (Gupta et al., 2001) which demonstrated that Fenugreek seeds showed improved glycemic control with (significant decrease in HBA1c) on day 28 of treatment as compared with n-STZ control rats.

Hepatic impairment is one problem of diabetes mellitus and it obvious by elevation of these liver biomarkers like; ALT, ALP, AST activities so increase in these liver biomarkers will provides a reliable or good indicator of functional integrity of liver as well as treatment outcome (Shittus et al., 2017; Shittu et al., 2015 and Yusuf et al., 2018) in diabetes condition. In this study the elevation levels of ALT activities in diabetic untreated rat is a remark of plasma membrane and hepatic impairment, these will adversely prevent amino acid and carbohydrate metabolism and thus effect ATP production (Yusuf et al., 2018). This observation of ALT and AST activities is an indication that diabetes selectively effect transaminase activities (Lawal et al., 2015).

The administration of the extract and the standard drug caused a significant restoration of the plasma membrane and liver functional integrate as evident by decrease ALP AST and ALP activities.

Bilirubin is an endogenous anion product of hemoglobin degradation of the red blood cell. The improvement in the concentrations of bilirubin in rats test with group is an
indication of increase glucose mobilization into cells leading to more efficient glucose utilization (Lin et al., 2010).

Also, total protein plays major roles in assessing the integrity of kidney and liver (Lawal et al., 2016). The observed increase in diabetic untreated rate could be attributed to elevation of different acute phase protein like globulin and fibrinogen in diabetes mellitus (Malawed and Usha, 2011).

This is in accordance with the finding of Ladea et al., 2006 who reported increase plasma levels of acute phase proteins in type 1 and 2 diabetes adult patients. Therefore, the increase in total protein is seen in this study could lead to dehydration which is injurious to cellular hemostasis, which will harmfully compromise the normal metabolic activities of liver and consequently the health of the animals (Shittu et al., 2015). The reduction in total protein which involved the mechanisms responsible for alterations, including change in relative abundance of specific m RNAs and a decrease in total cellular RNA.

The kidneys eliminate metabolic wastes such as urea nitrogen, uric acid, creatinine and ions and thus optimum chemical composition of body fluids is maintained (Shokeen et al., 2008). Hyperglycemia causes renal dysfunction such as acute glomerulonephritis, nephrosclerosis and even tubular necrosis resulting in abnormal excretion of urea and creatinine thereby elevating serum urea nitrogen and creatinine (Stambe et al., 2003, Cheng et al., 2005 and Jaramillo-Juarez et al., 2008). An elevation in the serum levels of urea and creatinine in clinical analyses presupposes renal dysfunction (Sood, 2006 and Mehrdad et al., 2011). Creatine is a break down waste product formed in the muscle in creatine phosphate metabolism. It is synthesized in the liver, passes into circulation and is taken up almost entirely by skeletal muscle for energy production. While urea is the main end product of protein catabolism, amino acid deamination takes place in the liver which is also the site of urea cycle, where ammonia is converted into urea and excreted through urine. In this study, blood urea and creatinine and sodium levels were increased (Fig 5) following the induction of diabetes indicating renal dysfunction.

Creatinine and urea concentration are useful clinical indicator of renal integrity (Bashir et al., 2015). Creatinine is a waste product of muscular metabolism while urea is a by-product of protein metabolism. During renal impairment, the excretion of these metabolite by the kidney is alter and thus accumulate in the plasma (Lawal et al., 2016).

The observed significant increase in urea and creatinine concentration in diabetes is an indication of renal impairment. The disease condition must have either alter the metabolism of creatinine leading to increase syntheses or decrease tubular excretion (Zilva et al., 1991).

These finding corroborated with the studies by Aldle et al., 2003 and Jukkay et al., 2017 which showed that raised plasma urea level in diabetes patients may indicate a prerenal problem. Furthermore, the significant alteration in the concentration of sodium, chloride and carbonate suggest that the integrity of renal tubular as regard to the excretion and maintenance of normal levels of these electrolytes in the system of the animal have been compromised (Bashir et al., 2015).

IV. CONCLUSION

Colocasiaesculenta (L.) shoot aqueous extracts can reverse the hyperglycemia associated with diabetes mellitus, the ability of Colocasiaesculenta (L.) shoot aqueous extracts to reduce the levels of glycated haemoglobin which is a marker showing effective diabetic control and management was also demonstrated. This study also showed the reduction in levels of AST, ALT and ALP, Bilirubin level (liver enzymes) which are markers of cellular damage following the induction of diabetes and complications associated with the disease state by treatment with aqueous extract of Colocasiaesculenta (L.) shoot inflorescence aqueous extracts. Also this study demonstrated the reno-protective potentials of Colocasiaesculenta (L.) shoot inflorescence aqueous extracts by decreasing the levels of urea and creatinine, improved protein and albumin levels and also marked improvement in electrolyte levels.

The study also demonstrated marked improvement in hematological parameters especially the red blood cell count and enhanced platelet count.

REFERENCES


