

Plasma electrolyte concentrations in normal and streptozotocin-induced diabetic rats treated with extracts of *Triplochiton scleroxylon* K. Schum

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Abstract

This study investigated the effect of aqueous and ethanolic extracts of *Triplochiton scleroxylon* on plasma electrolyte concentrations in normal and streptozotocin-induced diabetic rats after 28 days of administration. The rats of Wistar strain used, weighed between 130 to 186 g. Test rats were administered 200 mg/kg body weight of extracts (p. o) twice daily. Plasma samples were analysed for all experimental parameters by methods requiring spectrophotometry. Analysis of data showed that extracts caused a significant increase in plasma sodium relative to normal control. Increase in bicarbonate concentration obtained was not significant. Plasma chloride and potassium concentrations however, decreased in treated rats when compared to normal control ($P < 0.05$). In untreated diabetic rats plasma electrolyte concentrations were observed to decrease. Treatment with aqueous and ethanolic extracts of *Triplochiton scleroxylon* significantly reversed the decrease in the concentrations of plasma electrolytes (Na^+ , K^+ , Cl^- and HCO_3^-) caused by streptozotocin-induced diabetes when compared to diabetic control ($P < 0.05$). Histological analysis of tissues showed no adverse changes in the hearts, kidneys and livers of normal rats.

However, in treated diabetic rats, the hearts presented with normal histology while fatty changes were resolved in the livers. Treatment with aqueous extract lowered the severity of necrosis in the kidneys than ethanolic extract of *Triplochiton scleroxylon*.

Extracts of *Triplochiton scleroxylon* did not show any predisposition towards the disturbance of acid-base balance in treated normal and streptozotocin-induced diabetic rats. Aqueous extract however, was safer and more effective than ethanolic extract in ameliorating the adverse effect on the kidneys due to streptozotocin-induced diabetes mellitus in rats.

Keywords: Diabetes, plasma electrolytes, *Triplochiton scleroxylon*, streptozotocin

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1. Introduction

The use of natural plant products for therapeutic purposes is an age long existence and their demand is on the increase daily (Calixto, 2000). Arising from their increasing demand, medicinal plants are now steadily being explored in nearly all the countries of the world as the panacea for different animal and human diseases. India has about 45000 plant species and among them, several thousands have been claimed to possess medicinal properties (Grover *et al.*, 2002). In United States of America, for example, medicinal plants constitute about 25% of all newly refined prescriptions dispensed from community pharmacies. World Health Organization has so

far recorded the use of about 20,000 medicinal plants worldwide. In Britain alone, an estimated 6,000 – 7,000 tonnes of herbs are used annually as ingredients in some 5500 different herbal products (Alberti and Zimmet, 1998). Nearly about three quarters of the World's population relies on plants and their extracts for health care (Premanathan *et al.*, 2000; Gabhe *et al.*, 2006). Most of these herbal remedies have stood the test of time, particularly for the treatment of allergic, metabolic and cardiovascular diseases (Igoli *et al.*, 2005). The preference for medicinal plants in most cases is due to the fact that other therapeutic options are either more expensive or are often thought to be more associated with serious side effects (Ndiaye *et al.*, 2008; Agbaje *et al.*, 2009). One of the challenges of using plant materials as medicines is that in many cases no definite doses are prescribed, often resulting in overdoses.

Triplochiton scleroxylon is a deciduous forest tree of kingdom: plantae, division: magnoliophyta, class: magnoliopsida, order: malvales, family: sterculiaceae, genus: triplochiton and species: T. scleroxylon (Raju and Mandala, 2005). Some Nigerians suffering from diabetes frequently use the aqueous extract of the bark of *Triplochiton scleroxylon* as a respite. Its use is common amongst the rural and poor urban dwellers that cannot afford orthodox medications to treat their ailments. Preliminary studies on aqueous extract of *Triplochiton scleroxylon* showed significant hypoglycaemic and anti-diabetic properties in normal and alloxan induced-diabetic rabbits (Prohp *et al.*, 2006), no significant effects on the liver and heart enzymes (Prohp and Onoagbe, 2009a, b), hematological parameters (Prohp *et al.*, 2006; Prohp and Onoagbe, 2011, 2012a), plasma urea and creatinine levels in normal and treated streptozotocin-induced diabetic rabbits (Prohp and Onoagbe 2012b). Histological studies of tissues showed no adverse changes in the livers, kidneys and hearts of rabbits investigated (Prohp and Onoagbe, 2008). It is the objective of this study to investigate the effect of extracts of *Triplochiton scleroxylon* on plasma electrolyte

concentrations in normal and streptozotocin induced diabetic rats. This is with the view of assessing possible relationship between extracts and body fluid osmolarity as well as acid-base homeostasis.

2. Materials and Methods

2.1 Ethics on the use of animals in experimental studies

The experimental protocols were according to our Institutional Animal Ethics Committee guidelines as well as internationally accepted practices for use and care of laboratory animals as contained in US guidelines (NIH, 1992).

2.2 Experimental Animals

Male albino rats (Wistar strain) obtained from the animal house of the College of Medicine, Ambrose Alli University, Ekpoma, Edo State, Nigeria, were used in this study. The rats weighed between 130 to 186 g and were housed in clean cages under standard laboratory conditions of temperature, humidity and light. They were then allowed for a period of 2 weeks to acclimatize to the new environment during which they were given distilled water and standard laboratory diet procured from Ewu Feeds Ltd. Ewu, Edo State, Nigeria. All animals were handled with humane care (Prohp and Onoagbe, 2012a).

2.3 Chemicals/Reagents

Electrolyte (Na^+ , K^+ , Cl^- and HCO_3^-) kits obtained from Randox Laboratories United Kingdom were used. Glass-distilled water was used. Other reagents and chemicals were of analytical grade.

2.4 Medicinal plant

The forest of Uokha, Owan - East local government area, Edo State, Nigeria was the source of the barks of *Triplochiton scleroxylon* used in this study. Following the identification of the sample by experts in the Department of Botany, University of Ibadan, Ibadan, Oyo State, Nigeria, as *Triplochiton scleroxylon* K. Schum, a voucher specimen (UIH – 22329) was deposited there (Prohp and Onoagbe, 2012a).

2.5 Extraction and Preparation of Plant Extracts

The barks of *Triplochiton scleroxylon* were washed with clean water, dried and cut into tiny pieces. They were pulverized into powder and 1000 g of powdered bark of this plant was then extracted separately in 7000 ml of aqueous (distilled water) and 50 % ethanol in cold percolation by maceration technique under room temperature. This was followed by periodic stirring. The macerated samples were filtered with sintered glass funnel under suction to eliminate particles after 72 hours. The filtrates collected were then concentrated on a reduced pressure using the rotary evaporator to yield thick brown viscous pastes which were further dried under vacuum with the aid of a freeze dryer. The freeze dried samples were then kept in the freezer at -21 °C until used (Prohp and Onoagbe, 2012a, b).

2.6 Blood collection

The tail of the restrained rat was cleansed with a ball of cotton wool soaked in methylated spirit. A little vaseline was then smeared on the tail to reduce friction while massaging to redness. Gentle massage towards the tip of the tail continued until the tip became red as a sign of blood

accumulation. The red tip of the tail was then slightly and carefully incised with new and sterilized blade and further massaged gently as the blood trickled into immobilized sample tubes containing lithium heparin and fluoride oxalate for electrolyte and glucose assays respectively. Cotton wool soaked in methylated spirit was again used to cleanse the incised area of the tail. Blood samples collected were subjected to centrifugation for 10 minutes at 3,000 g to obtain the plasma for all biochemical analyses. Analyses were carried out immediately after centrifugation (Prohp and Onoagbe, 2012a, b).

2.7 Streptozotocin injection

100 mg of streptozotocin (1 vial) dissolved in commercial saline was administered to overnight fasted rats at the dose of 65 mg/kg body weight by intra-peritoneal route. Rats with blood glucose level two or three times the basal values, seven days after injection were selected for the experimental study (Ballester *et al.*, 2005; Tanko *et al.*, 2007; Prohp and Onoagbe, 2009a, b).

2.8 Experimental procedure

2.8.1 Toxicological studies

A total of twelve male albino rats (Wistar strain) after acclimatization for a period of two weeks were fasted overnight and randomly divided into three groups of four rats each. Group 1 served as normal control and received distilled water while the test groups received 200 mg/kg body weight (p. o.) of aqueous and ethanolic extracts of *Triplochiton scleroxylon* respectively.

Plasma electrolytes (Na^+ , K^+ , Cl^- and HCO_3^-) were monitored periodically at intervals of six days for 28 days according to the colorimetric method of Tietz *et al.*, (1986) as outlined in Randox Laboratories manual.

2.8.2 Diabetic studies

A total of sixteen male albino rats (Wistar strain) after acclimatization for a period of two weeks, were fasted overnight and randomly divided into four groups of four rats each. Diabetes was induced in rats in groups 2, 3 and 4 with the aid of streptozotocin at the dose of 65 mg/kg body weight (i.p.). Groups 1 and 2 served as the normal and diabetic controls respectively and received distilled water while treated diabetic groups (3 and 4) received 200 mg/kg body weight of aqueous and ethanolic extracts of *Triplochiton scleroxylon* respectively. Plasma electrolytes (Na^+ , K^+ , Cl^- and HCO_3^-) were monitored periodically at intervals of six days for 28 days according to the colorimetric method of Tietz *et al.*, (1986) as outlined in Randox Laboratories manual.

2.9 Administration of extracts

Aqueous and ethanolic extracts of *Triplochiton scleroxylon* were administered to experimental rats orally (p. o.) with the aid of the gavage.

2.10 Statistical analysis

Data were expressed as mean \pm S. E. M. of three separate determinations. The statistical significance was evaluated by one-way ANOVA using SPSS (statistical package for social sciences) version 17.0, followed by post-hoc LSD and Turkey tests for individual comparisons. Values lower than 0.05 probabilities were accepted as statistically significant (SPSS, 2007).

3.0 Result

Results are presented in tables (Tables 1 - 8) and figures (Figures 1 - 8). Treatment with extracts of *Triplochiton scleroxylon* reversed the increases ($P < 0.05$) in plasma electrolyte concentrations observed in untreated diabetic rats when compared to the diabetic controls respectively (Tables 1 - 8; Figures 1 - 8). Photomicrographs of histological sections of the hearts, kidneys and livers in normal rats (Plates 1 – 9), the hearts of treated streptozotocin-induced diabetic rats (Plates 10 – 13), the livers of diabetic rats treated with aqueous and ethanolic extracts (Plates 18 – 21) and the kidneys of treated diabetic rats (Plates 14 – 17) are also presented. The use of aqueous extract was observed to be more efficient in resolving adverse effects in the livers and kidneys of diabetic rats in contrast to ethanolic extract of *Triplochiton scleroxylon*.

Table 1: Mean plasma sodium ion concentrations (mEq/L) of normal and treated normal rats

S/N. Treatments	Day 0	Day 1	Day 6	Day 12	Day 18	Day 24	Day 28
1. Normal control	70.61±0.54 ^a	70.92±0.27 ^a	71.10±0.52 ^a	74.04±0.49 ^a	75.46±0.39 ^a	75.67±0.04 ^a	75.95±0.44 ^a
2. Aqueous extract treated	70.83±0.48 ^a	70.77±0.27 ^a	71.88±0.38 ^a	73.59±0.48 ^a	74.00±0.70 ^a	81.13±0.56 ^a	81.85±0.61 ^a
3. Ethanolic extract treated	70.91±0.47 ^a	70.74±0.60 ^a	71.89±0.36 ^a	73.31±0.35 ^a	73.93±0.34 ^a	76.83±0.61 ^a	80.17±0.28 ^a

Data are mean ± S.E.M. (n = 4). Mean in the same column with different superscript letters are significantly different, $P < 0.05$ (one way ANOVA followed by post-hoc LSD) when compared to normal control. Dose of aqueous and ethanolic extracts used = 200 mg/kg body weight.

Table 2: Mean plasma potassium ion concentrations (mEq/L) of normal and treated normal rats

S/N. Treatments	Day 0	Day 1	Day 6	Day 12	Day 18	Day 24	Day 28
1. Normal control	10.67±0.27 ^a	10.83±0.24 ^a	10.86±0.26 ^a	12.10±0.63 ^a	10.95±0.31 ^a	12.15±0.33 ^a	11.83±0.44 ^a
2. Aqueous extract treated	10.70±0.32 ^a	10.78±0.25 ^a	10.14±0.33 ^a	9.94±0.08 ^b	8.82±0.26 ^b	7.59±0.51 ^b	7.16±0.37 ^b
3. Ethanolic extract treated	10.65±0.30 ^a	10.88±0.15 ^a	8.98±0.31 ^b	8.77±0.14 ^b	8.61±0.19 ^b	6.47±0.21 ^b	6.05±0.10 ^b

Data are mean ± S.E.M. (n = 4). Mean in the same column with different superscript letters are significantly different, $P < 0.05$ (one way ANOVA followed by post-hoc LSD) when compared to normal control. Dose of aqueous and ethanolic extracts used = 200 mg/kg body weight.

Table 3: Mean plasma chloride ion concentrations (mEq/L) of normal and treated normal rats

S/N. Treatments	Day 0	Day 1	Day 6	Day 12	Day 18	Day 24	Day 28
1. Normal control	80.81±0.25 ^a	80.78±0.49 ^a	80.98±0.41 ^a	80.93±0.40 ^a	81.18±0.51 ^a	82.03±0.31 ^a	82.17±0.14 ^a
2. Aqueous extract treated	81.21±0.65 ^a	81.96±0.19 ^a	81.26±0.33 ^a	80.98±0.55 ^a	80.32±0.32 ^a	78.94±0.36 ^b	76.65±0.30 ^b
3. Ethanolic extract treated	81.22±0.47 ^a	80.56±0.22 ^a	80.51±0.31 ^a	78.96±0.31 ^b	78.07±0.12 ^b	75.31±0.36 ^c	74.28±0.24 ^c

Data are mean ± S.E.M. (n = 4). Mean in the same column with different superscript letters are significantly different, P<0.05(one way ANOVA followed by post-hoc LSD) when compared to normal control. Dose of aqueous and ethanolic extracts used = 200 mg/kg body weight.

Table 4: Mean plasma bicarbonate concentrations (mEq/L) of normal and treated normal rats

S/N. Treatments	Day 0	Day 1	Day 6	Day 12	Day 18	Day 24	Day 28
1. Normal control	63.56±0.16 ^a	63.38±0.19 ^a	63.42±0.11 ^a	63.38±0.19 ^a	63.67±0.30 ^a	63.49±0.11 ^a	63.41±0.08 ^a
2. Aqueous extract treated	63.19±0.23 ^a	63.42±0.15 ^a	63.34±0.16 ^a	63.60±0.13 ^a	63.67±0.17 ^a	63.81±0.29 ^a	64.38±0.13 ^a
3. Ethanolic extract treated	63.52±0.18 ^a	63.35±0.14 ^a	63.32±0.22 ^a	63.05±0.08 ^a	63.08±0.08 ^a	63.25±0.13 ^a	64.71±0.20 ^a

Data are mean ± S.E.M. (n = 4). Mean in the same column with different superscript letters are significantly different, P<0.05(one way ANOVA followed by post-hoc LSD) when compared to normal control. Dose of aqueous and ethanolic extracts used = 200 mg/kg body weight.

Table 5: Mean plasma sodium ion concentrations (mEq/L) of controls and treated streptozotocin-induced diabetic rats

S/N. Treatments	Day 0	Day 1	Day 6	Day 12	Day 18	Day 24	Day 28
1. Normal control	70.76±0.58 ^a	71.52±0.82 ^a	72.20±0.97 ^a	74.72±0.65 ^a	75.89±0.45 ^a	76.51±1.06 ^a	77.24±0.76 ^a
2. Diabetic control	71.54±1.11 ^a	62.65±0.98 ^b	53.68±1.44 ^b	43.13±2.03 ^b	35.45±1.44 ^b	30.96±0.65 ^b	27.05±1.08 ^b
3. Aqueous extract treated diabetes	70.61±0.65 ^a	60.21±0.78 ^b	61.16±0.75 ^c	61.48±0.33 ^c	63.33±0.56 ^c	66.07±0.64 ^c	68.20±1.40 ^c
4. Ethanolic extract treated diabetes	69.97±0.52 ^a	60.99±1.07 ^b	61.67±0.96 ^c	63.22±1.20 ^c	65.16±0.94 ^c	67.58±1.58 ^c	69.68±0.64 ^c

Data are mean ± S.E.M. (n = 4). Mean in the same column with different superscript letters are significantly different, P<0.05(one way ANOVA followed by post-hoc LSD) when compared to diabetic control. Dose of aqueous and ethanolic extracts used = 200 mg/kg body weight.

Table 6: Mean plasma potassium ion concentrations (mEq/L) of controls and treated streptozotocin-induced diabetic rats

S/N. Treatments	Day 0	Day 1	Day 6	Day 12	Day 18	Day 24	Day 28
1. Normal control	6.39±0.23 ^a	6.25±0.35 ^a	6.29±0.25 ^a	6.18±0.25 ^a	6.24±0.28 ^a	6.43±0.14 ^a	6.44±0.14 ^a
2. Diabetic control	6.18±0.11 ^a	5.14±0.05 ^b	4.10±0.06 ^b	4.05±0.06 ^b	3.99±0.06 ^b	3.92±0.07 ^b	3.62±0.17 ^b
3. Aqueous extract treated diabetes	6.32±0.16 ^a	6.15±0.09 ^b	6.03±0.02 ^a	6.05±0.01 ^a	6.07±0.02 ^a	5.92±0.20 ^a	6.10±0.02 ^c
4. Ethanolic extract treated diabetes	6.05±0.05 ^a	5.94±0.08 ^b	5.88±0.13 ^a	5.85±0.15 ^a	5.89±0.12 ^a	5.94±0.11 ^a	6.01±0.10 ^c

Data are mean ± S.E.M. (n = 4). Mean in the same column with different superscript letters are significantly different, P<0.05(one way ANOVA followed by post-hoc LSD) when compared to diabetic control. Dose of aqueous and ethanolic extracts used = 200 mg/kg body weight.

Table 7: Mean plasma chloride ion concentrations (mEq/L) of controls and treated streptozotocin-induced diabetic rats

S/N. Treatments	Day 0	Day 1	Day 6	Day 12	Day 18	Day 24	Day 28
1. Normal control	73.46±1.24 ^a	72.39±0.99 ^a	75.82±0.68 ^a	76.84±1.00 ^a	74.09±1.35 ^a	76.19±1.51 ^a	74.11±1.44 ^a
2. Diabetic control	74.86±0.79 ^a	47.30±1.85 ^b	41.37±0.48 ^b	36.04±1.54 ^b	31.64±1.19 ^b	29.37±0.94 ^b	27.31±1.24 ^b
3. Aqueous extract treated diabetes	73.54±1.15 ^a	49.11±2.57 ^b	50.66±1.36 ^c	52.73±1.10 ^c	54.86±0.89 ^c	63.57±1.51 ^c	67.42±1.29 ^c
4. Ethanolic extract treated diabetes	73.60±1.54 ^a	51.69±1.29 ^b	56.14±1.73 ^d	59.50±1.51 ^d	62.56±1.09 ^d	65.07±1.11 ^c	69.07±0.54 ^c

Data are mean ± S.E.M. (n = 4). Mean in the same column with different superscript letters are significantly different, P<0.05(one way ANOVA followed by post-hoc LSD) when compared to diabetic control. Dose of aqueous and ethanolic extracts used = 200 mg/kg body weight.

Table 8: Mean plasma bicarbonate concentrations (mEq/L) of controls and treated streptozotocin-induced diabetic rats

S/N. Treatments	Day 0	Day 1	Day 6	Day 12	Day 18	Day 24	Day 28
1. Normal control	65.89±0.72 ^a	65.74±0.37 ^a	68.25±0.35 ^a	69.10±0.28 ^a	67.94±0.90 ^a	69.62±0.33 ^a	70.28±0.58 ^a
2. Diabetic control	58.26±1.50 ^a	82.54±1.21 ^b	78.54±1.35 ^b	68.39±1.37 ^a	58.64±0.40 ^b	50.59±0.26 ^b	39.26±0.96 ^b
3. Aqueous extract treated diabetes	60.23±0.98 ^a	79.38±0.40 ^b	76.20±2.72 ^b	77.57±0.42 ^b	70.42±2.35 ^a	68.13±2.30 ^a	65.60±2.76 ^a
4. Ethanolic extract treated diabetes	58.15±1.23 ^a	80.34±1.33 ^b	79.89±1.07 ^b	79.07±0.90 ^b	75.15±2.45 ^a	74.19±3.09 ^a	68.64±2.85 ^a

Data are mean ± S.E.M. (n = 4). Mean in the same column with different superscript letters are significantly different, P<0.05(one way ANOVA followed by post-hoc LSD) when compared to diabetic control. Dose of aqueous and ethanolic extracts used = 200 mg/kg body weight.

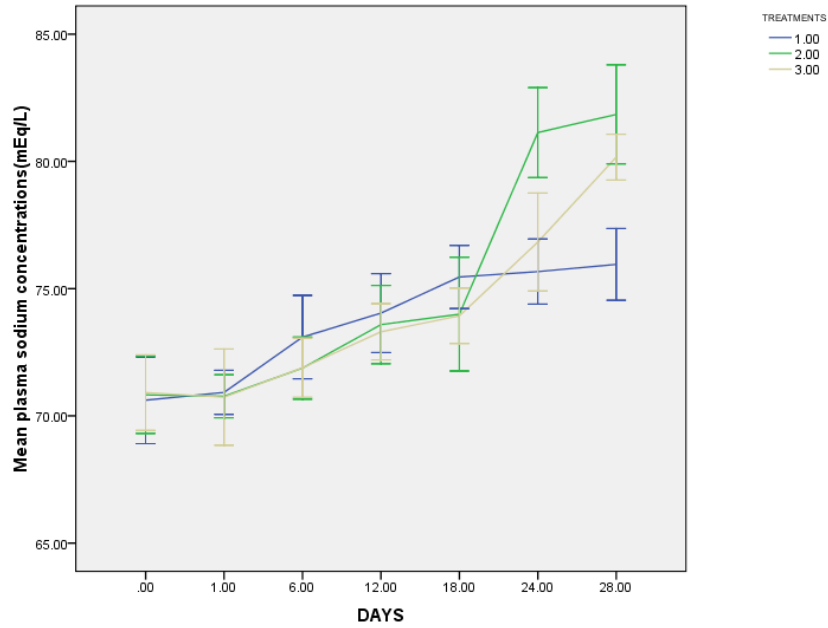


Fig. 1: Mean plasma sodium concentration (mEq/L) of normal and treated normal rats. Treatments (200mg/kg b.w.): (1) Control; (2) Normal rats + Aqueous extract; (3) Normal rats + Ethanol ic extract. P<0.05.

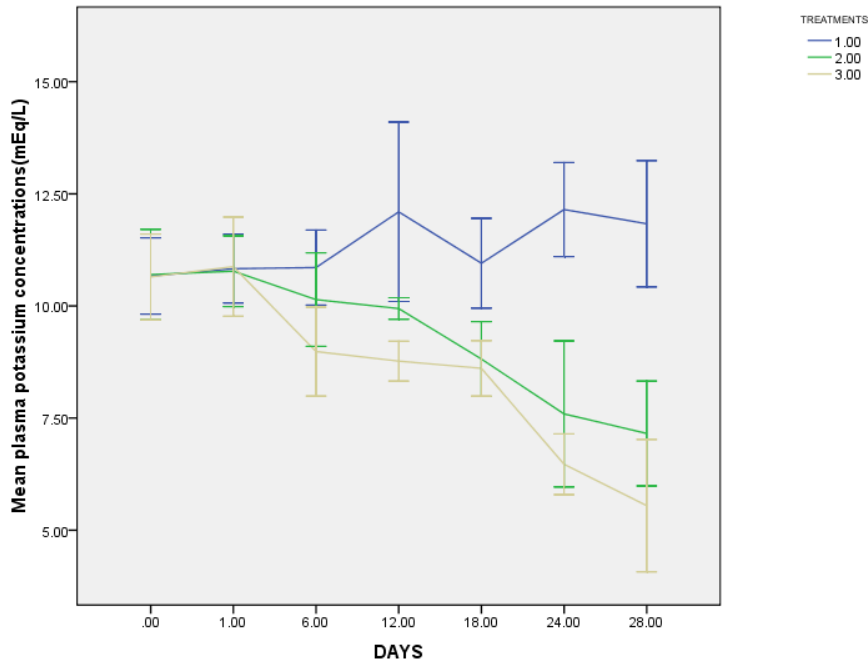


Fig. 2: Mean plasma potassium concentration (mEq/L) of normal and treated normal rats. Treatments (200mg/kg b.w.): (1) Control; (2) Normal rats + Aqueous extract; (3) Normal rats + Ethanolic extract. P< 0.05.

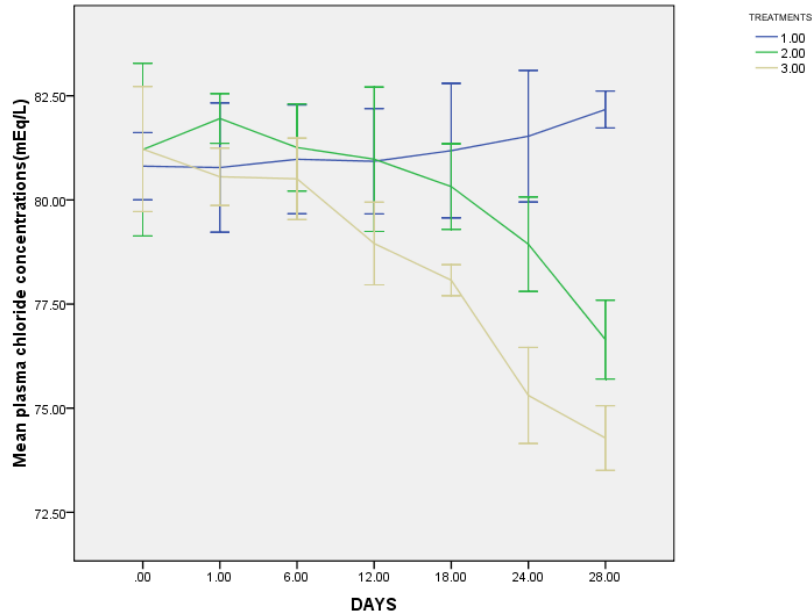


Fig. 3: Mean plasma chloride concentration (mEq/L) of normal and treated normal rats. Treatments (200mg/kg b.w.): (1) Control; (2) Normal rats + Aqueous extract; (3) Normal rats + Ethanolic extract. P<0.05.

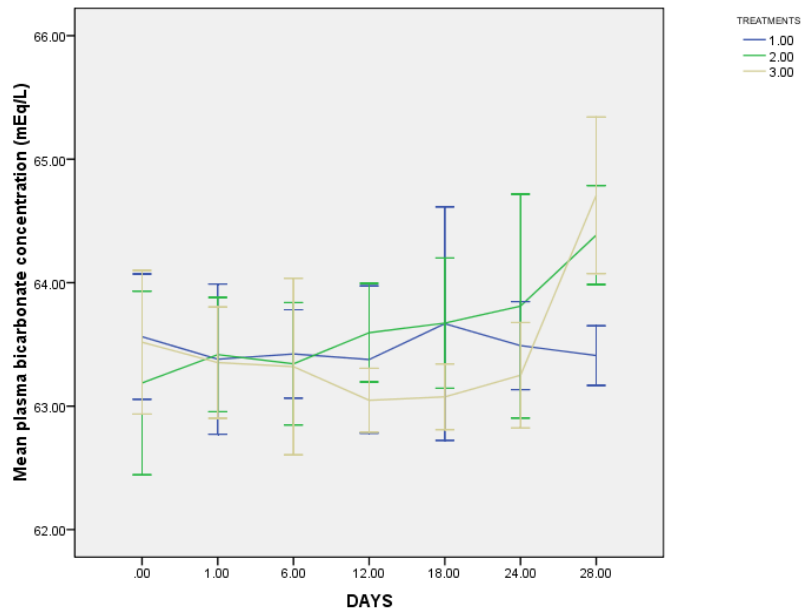


Fig. 4: Mean plasma bicarbonate concentration (mEq/L) of normal and treated normal rats. Treatments (200mg/kg b.w.): (1) Control; (2) Normal rats + Aqueous extract; (3) Normal rats + Ethanolic extract. P>0.05.

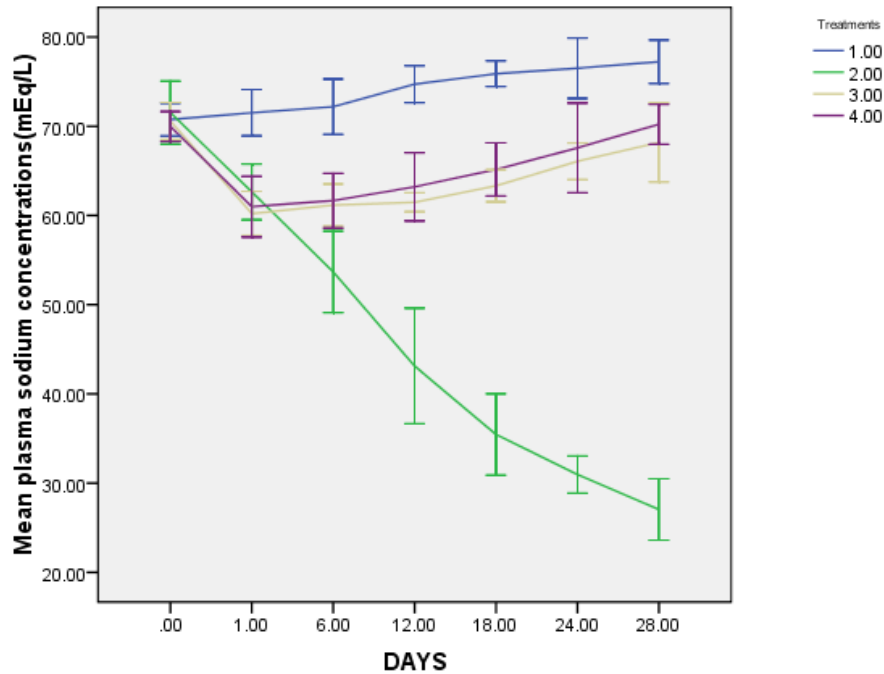


Fig.5: Mean plasma sodium concentrations (mEq/L) of controls and treated streptozotocin-induced diabetic rats. Treatments (200mg/kg b. w.): (1) Control; (2) Diabetic control; (3) Diabetic rats + Aqueous extract; (4) Diabetic rats + Ethanolic extract. P<0.05.

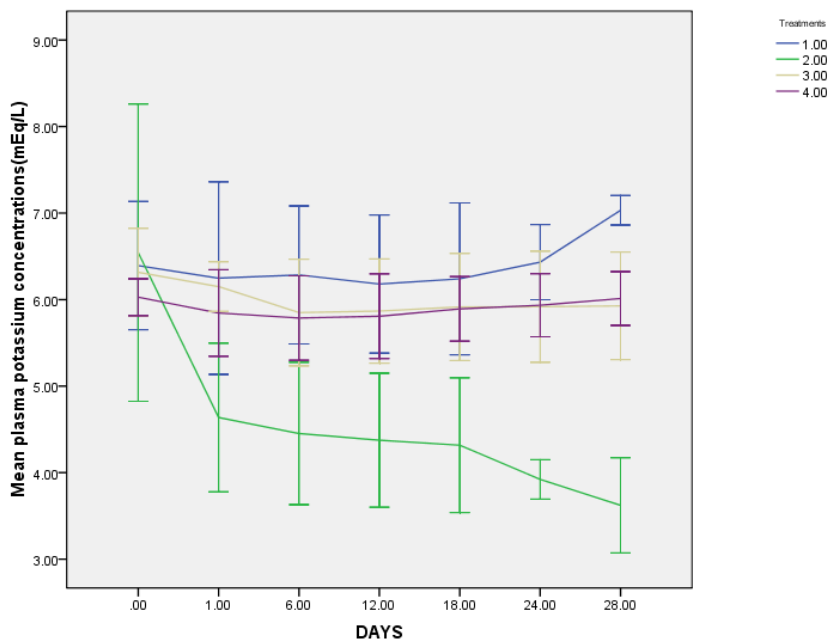


Fig.6: Mean plasma potassium concentrations (mEq/L) of controls and treated streptozotocin-induced diabetic rats. Treatments (200mg/kg b. w.): (1) Control; (2) Diabetic control; (3) Diabetic rats + Aqueous extract; (4) Diabetic rats + Ethanolic extract. P<0.05.

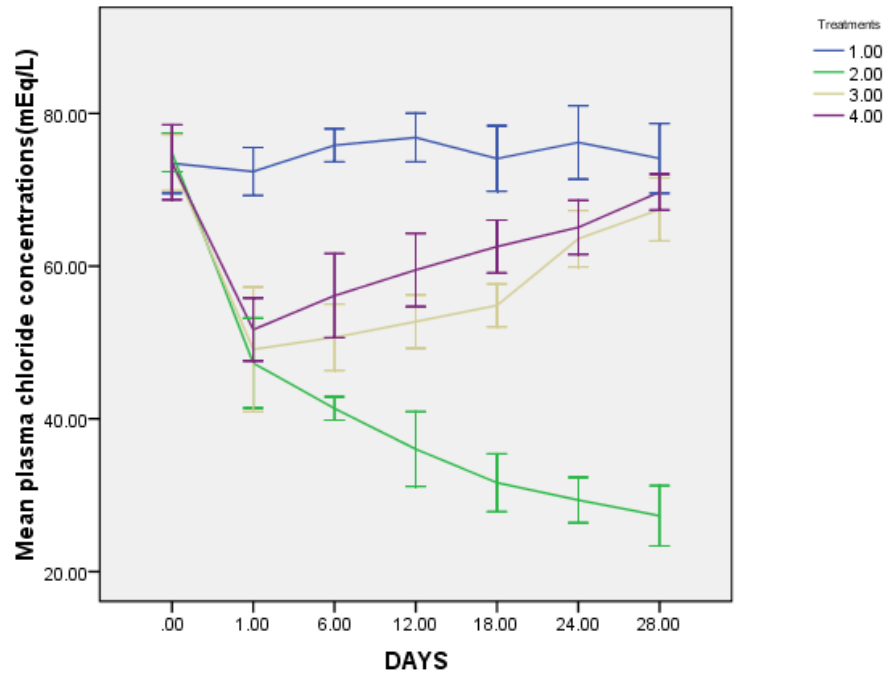


Fig.7: Mean plasma chloride concentrations (mEq/L) of controls and treated streptozotocin-induced diabetic rats. Treatments (200mg/kg b. w.): (1) Control; (2) Diabetic control; (3) Diabetic rats + Aqueous extract; (4) Diabetic rats + Ethanolic extract. P<0.05.

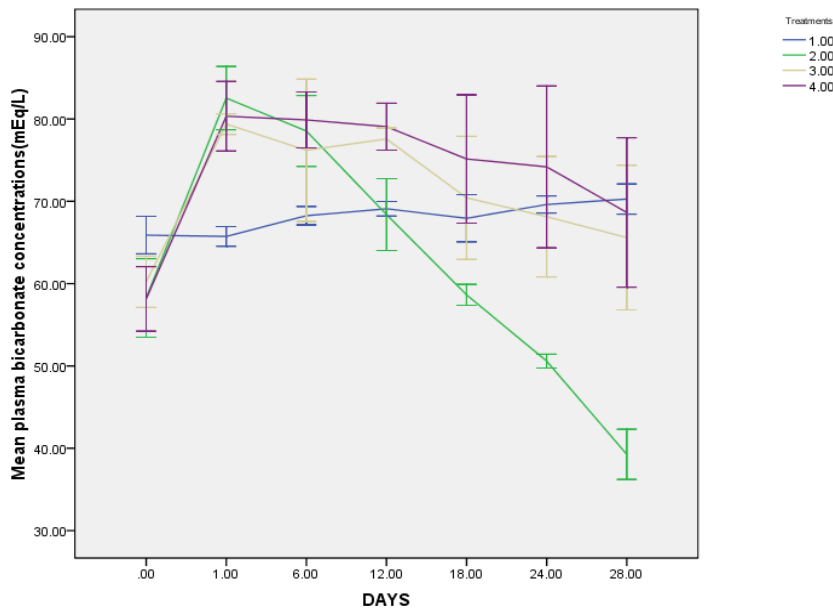
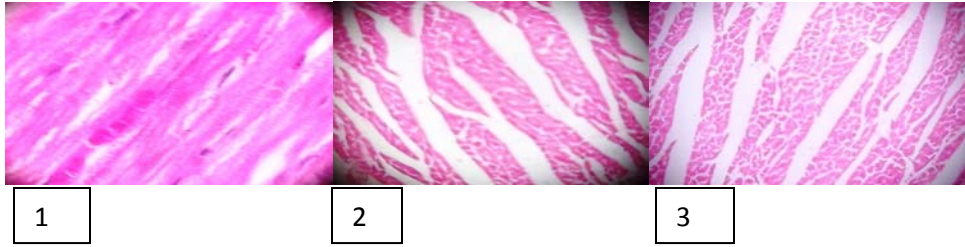
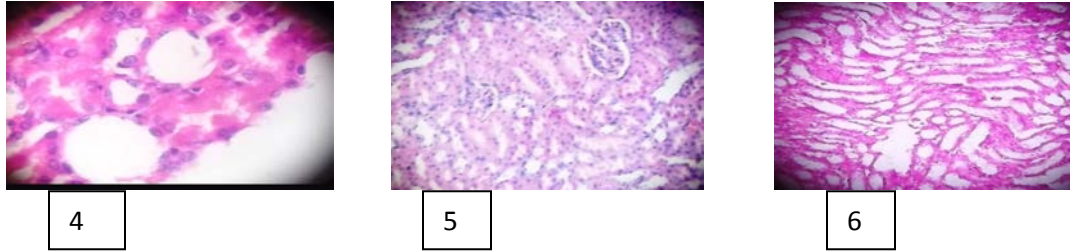


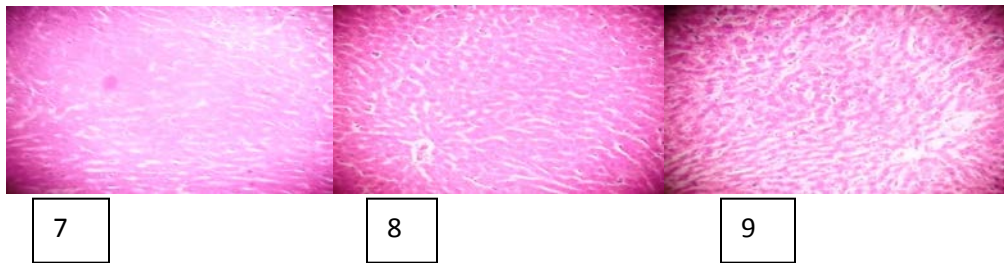
Fig.8: Mean plasma bicarbonate concentrations (mEq/L) of controls and treated streptozotocin-induced diabetic rats. Treatments (200mg/kg b. w.): (1) Control; (2) Diabetic control; (3) Diabetic rats + Aqueous extract; (4) Diabetic rats + Ethanolic extract. P<0.05.



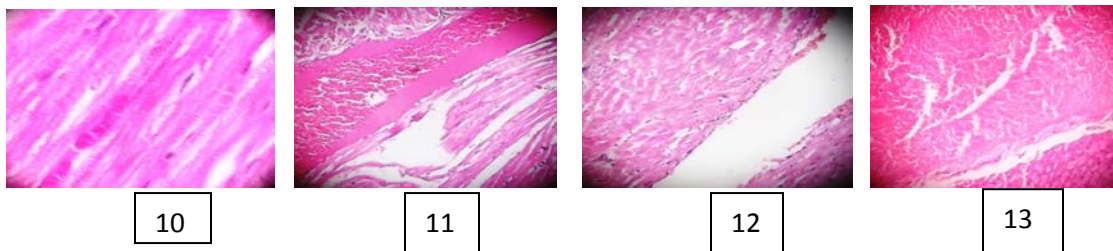
Photomicrographs of heart sections of normal control (1), aqueous (200 mg/kg bw) (Normal histology) (2) and ethanolic (200 mg/kg bw)(Normal histology) (3) extract treated rats respectively. H & E Stain. X 100



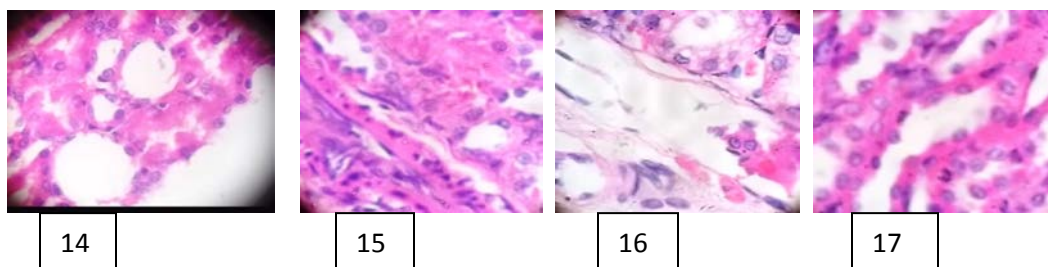
Photomicrographs of kidney sections of normal control (4), aqueous (200 mg/kg bw) (Normal histology with glomerulus well demarcated) (5) and ethanolic (200 mg/kg bw) (Normal histology) (6) extract treated rats respectively. H & E Stain. X 100



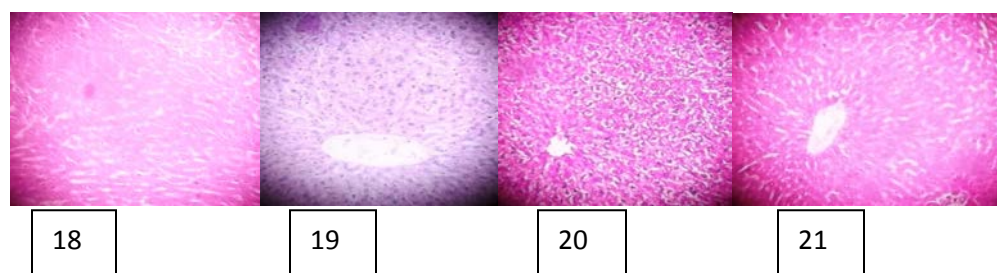
Photomicrographs of liver sections of normal control (7), aqueous (200 mg/kg bw) (Normal histology) (8) and ethanolic (200 mg/kg bw) (Normal histology) (9) extract treated rats respectively. H & E Stain. X 100.



Photomicrographs of heart sections of normal control (Normal histology) (10), diabetic control (Mild hemorrhage) (11), aqueous (200 mg/kg bw) (Normal histology) (12) and ethanolic (200 mg/kg bw) (Normal histology) (13) extract treated diabetic rats respectively. H & E Stain. X 100



Photomicrographs of kidney sections of normal control (Normal histology) (14), diabetic control (Severe tubular necrosis with infiltrations of inflammatory cells) (15), aqueous (200 mg/kg bw) (Vacuolation of tubular epithelium with areas of mild necrosis) (16) and ethanolic (200 mg/kg bw) (Moderate tubular necrosis and infiltrations of inflammatory cells) (17) extract treated diabetic rats respectively. H & E Stain. X 100



Photomicrographs of liver sections of normal control (Normal histology) (18), diabetic control (fatty changes) (19), aqueous (200 mg/kg bw) (Normal histology) (20) and ethanolic (200 mg/kg bw) (Normal histology) (21) extract treated diabetic rats respectively. H & E Stain. X 100.

4.0 Discussion

The kidneys work to keep the electrolyte concentrations in the blood constant despite changes in the body (<http://ucsdlabmed.wikidot.com/chapter10>). So plasma electrolyte values are usually indicative of the renal functions or dysfunctions. Significant increase in plasma sodium (Table 1; Figures 1) on the 24th and 28th days was obtained while increase in bicarbonate concentrations was not significant when compared to control ($P>0.05$) (Table 4; Figure 4). In normal rats aqueous and ethanolic extracts of *Triplochiton scleroxylon* caused significant decrease ($P<0.05$) in plasma potassium (Table 2; Figure 2) and chloride (Table 3; Figure 3) concentrations when compared to control. Significant hyperkalaemia and hyponatremia in the blood following drug

administration characterize drugs that have hypotensive properties. Hyperkalaemia or excess potassium in the blood occurs in cases of renal failure as the kidney loses the ability to excrete the mineral. Severe dehydration will also produce this condition resulting in muscle weakness and cardiac arrhythmias that lead to heart failure (Kruetler, 1980; Abubakar and Sule, 2010). Abnormal concentration of sodium and/or potassium in the blood can affect the osmotic pressure of the body fluid which is related to blood pressure (Healy, 1995; Cheesbrough, 2002). Sodium attracts water and so when sodium level rises in the blood, the body retains water, thereby decreasing sodium concentration. Blood pressure which depends in part on blood volume increases as retained water rises (Kruetler, 1980). It has been reported that increasing concentrations of aqueous seed extract of *Cassia occidentalis* L. resulted in significant increase in serum potassium and a decrease in sodium ion concentrations in rats (Abubakar and Sule, 2010). The same authors have also reported that oral administration of aqueous extract of *Cassia occidentalis* seeds at a daily dose of 60 mg/kg for one week showed no significant changes in serum potassium, chloride and bicarbonate levels relative to control. Significant decrease in chloride and bicarbonate concentrations in the blood could lead to disturbance in acid-base balance (Abubakar and Sule, 2010). Extracts of *Triplochiton scleroxylon* at 200 mg/kg body weight were safe as result obtained did not show that extracts could predispose to renal failure and disturbance in acid-base balance in normal rats.

In untreated diabetes, analysis of result showed a decrease in the plasma electrolyte concentrations. This is consistent with reports of Eteng *et al.*, (2008) and Ikpi *et al.*, (2009). It is well known that in untreated diabetes (diabetic control) kidney function is compromised (Ikpi *et al.*, 2009). Glycosuria which causes dehydration via glucose osmotic diuresis is accompanied with severe loss of electrolytes including sodium, potassium, calcium, chloride and phosphates

(Eteng *et al.*, 2008). Treatment with aqueous and ethanolic extracts of *Triplochiton scleroxylon* however, improved the decrease in plasma electrolyte concentrations caused by streptozotocin-induced diabetes (Tables 5 – 8; Figures 5 - 8). This is indicative of ability of extracts of *Triplochiton scleroxylon* to improve on the compromise of the kidneys and restore both acid-base balance and renal functions in experimental diabetes in rats.

Extracts of *Triplochiton scleroxylon* did not have adverse effects in the hearts, kidneys and livers of normal rats (Plates 1 – 9) and also in the hearts of treated streptozotocin-induced diabetic rats (Plates 10 – 13). Fatty changes however, were resolved in the livers of diabetic rats treated with aqueous and ethanolic extracts (Plates 18 – 21). Treatment with aqueous extract lowered the severity of necrosis in the kidneys than ethanolic extract of *Triplochiton scleroxylon* (Plates 14 – 17). In several studies aqueous extract of *Triplochiton scleroxylon* has been reported to be safer than ethanolic extract in preserving the integrity of tissues in experimental rats (Prohp and Onoagbe, 2012c, d; 2013a, b).

In conclusion, aqueous extract of *Triplochiton scleroxylon* has shown to be protective against disturbance of acid-base balance in treated diabetic rats and also exhibited a greater effectiveness in resolving adverse effects in the livers and kidneys of streptozotocin-induced diabetic rats. The safety of use of the aqueous extract portrayed in this study and in several of our reports in literature justify its popularity in some urban and rural areas in the southern part of Nigeria where it is accepted as an antidote to diabetes mellitus.

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