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RESPONSE OF ALBINO RATS TO AQUEOUS LEAF EXTRACT OF ANNONA SENEGALENSIS ON BIOCHEMICAL PARAMETERS AND SOME ELECTROLYTES

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Abstract: The utilization of plant parts or substances as spices, condiments and for medicinal purposes has received so much acceptability leading to more investigation and usage of wild plants. This study investigated the biochemical parameters and some electrolytes which are necessary for understanding the wellbeing of an individual organ of the body and wellness of an organism. The plant leafs were harvested and identified by a taxonomist and extracted. The biochemical parameters were evaluated using standard procedures for 28 days duration. There were decreases of total protein and cholesterol mean values in some doses, whereas the elevation of glucose may suggest the reason behind the natives using it as food and vegetable as the plant leaf may be rich in carbohydrate and the end product of carbohydrate metabolism is glucose. The increases in sodium and potassium may suggest renal impairment however there were decreases in some doses. Thus such doses are recommended. In conclusion, the extract is having the potential of reducing the risk of cardiovascular diseases due to its ability to reduce cholesterol and sodium.

Key Words - *Annona senegalensis*, biochemical parameters, aqueous extract, electrolytes

INTRODUCTION

The high and fascinating use of medicinal plants is not of any surprise. This may be contributed by the increase in cases of drug resistance, cost and multiple side effects being exerted with most orthodox medicines (Akomas *et al*., 2014). The utilization of plant parts or substance as spices, condiments and for medicinal purposes has become more acceptable leading to exploitation of many wild plants. Thus, undoubtedly orthodox medicine seems to be majorly depending on traditional medicine (Akomas *et al*., 2014)

Plants are gifts from nature with various benefits to man through their use for medicinal purposes. There are many ingredients in plants from which pharmaceutical industries derive their drugs from and so do folkloric medical practictioners (Anon, 2014; Orwa *et al*., 2009). The Latin word 'anon', meaning 'annual produce' (annual harvest) referring to the production nature of fruits of the various species in this Genus Annona (Pinto, 2005; Orwa *et al*., 2009).The traditional people in Africa use this plant mainly for food, fruit rich in nutrient,

boost food security, support rural development and sustainable land care (Anon, 2014). Its adaptation is within the range of very low to moderately high rainfall regimes which occurs in areas having 600-2,500 mm, while around Africa the requirements are more than 600 mm annual rainfall. It can endure a relative humidity as low as 44 % at midday. The optimal mean temperatures for wild soursop growth are within the range of 16ºC and 30ºC (FAO, 1983, 1988; Anon, 2014). It is a solitary plant within woodland savannah, swamp forests, river banks and former crop land left fallow for some years (Anon, 2014). The flower is added to spice meals or garnish the meals; leaves are eaten as vegetables by the natives, or browsed by livestock (Anon, 2014). The leaves are also important for making a general health tonic useful in the treatment of pneumonia, diseases of the eye, stomach and intestines (Cordeiro *et al*., 2005). The leaves contain an essential oils with parasiticide, antidiarrhoea, rheumatological and antineuralgic properties (Cordeiro *et al*., 2005). Boiled water infusions of the leaves have anti-spasmodic, astringent and gastric properties (Calzavara and Miiller, 1987; Khan *et al*., 1997), which help in the treatment of diabetes and abdominal upsets (Calzavara and Miiller, 1987) and are used in kidney ailments (Cordeiro *et al*., 2005). The cooked flowers and petals are being used for treatment of eye inflammations; the treatment involves 2-3 washes a day (Calzavara and Miiller, 1987).

The liver is very important organ in the maintenance of metabolic functions and detoxification from the substances like xenobiotics, drugs, viral infections and chronic alcoholism (Madukwe *et al*., 2014). Hepatic damage involves the distortion of metabolic functions. Mostly, hepatotoxic chemicals damage the liver cells by inducing lipid peroxidation and other oxidative damages (Madukwe *et al*., 2014).The kidney is a vital organ having many functions such as excretory, synthesis of the materials that activates a living body, enzymatic reaction, immunization, etc(Madukwe *et al*., 2014). The concentrations of creatinine and urea in the plasma could be indicators of nephrotoxicity (Madukwe *et al*., 2014). Reduced clearance level of creatinine or/and urea shows a diminished impaired capacity of the kidneys to sieve these waste products from the blood and excrete them in urine (Madukwe *et al*., 2014). As their clearance values reduce, their blood levels increase. Thus, an abnormally increased blood creatinine level is diagnostic of an impaired renal function (Madukwe *et al*., 2014). Unused cholesterol that circulates in the blood can bind to the walls of the arteries resulting to making the person more vulnerable to cardiovascular diseases. This study, therefore, investigated the effects of aqueous leaf extract on biochemical parameters and some electrolytes in albino rats.

RESEARCH METHODS

Study Area

Maiduguri metropolis is located at the semi-arid north-east region of Nigeria. Its fond within latitudes 11º04'N and 11º44'N; and between longitudes 13º04'E and 13º44'E, having an area of 543 km^2. The metropolis city is located in four Local Government Areas (LGA): Maiduguri Metropolitan Area, Jere LGA, Konduga LGA and to a little extent Mafa LGA. Maiduguri is located on the plain with a flat or slightly undulating terrain, formed mostly on the young sedimentary rock of the Chad formation. This terrain is sloppy skewing towards the Lake Chad with an average relief ranging between 300 m and 600 m (Daura, 2001). The climate in the area covers the dry and wet seasons with four (4) different seasons as classified by natives of the city. These are: cool dry (harmattan season) from December to February; hot dry season from March to late May; raining season from June to September; and humid dry transitional period between September and November (Waziri, 2009). The timing of the seasons are not rigid due to climatic fluctuations. The rainfall is one type rising gradually to the peak from late June to maximum in August and with 60 % to 70 % of the annual rainfall within the two months of July and August (Daura, 2001).

Collection and Identification of Plant Sample

Annona senegalensis leafs were harvested from the Girei Local Government Area of Adamawa State in July, 2014. The leafs were identified and authenticated by a Taxonomist in the Department of Forestry and Wild Life Management of the Modibbo Adama University of Technology, Yola. Voucher specimen (PG/15/CHM/008) was deposited in the Departmental herbarium. The leafs of the plant were air dried under shade, ground into powder and kept.

Experimental Animals

The biological models used for the experiment were albino rats ranging from 90 – 120 g and gotten from the Department of Biochemistry, Laboratory Animal House, University of Maiduguri and caged in the Postgraduate Veterinary Anatomy Research Laboratory, Faculty of Veterinary Medicine, University of Maiduguri. The rats were fed with pelletized growers mash 120 g daily (Vital feeds Nigeria Ltd) and water was given *ad libitum*. One hundred (100) rats were used for the study. There were five (5) groups and each containing twenty five (25) rats. Group 1 was the control and groups 2, 3, 4 and 5 were the treatment groups which were administered the aqueous leaf extract at 100, 200, 300 and 400 mg/kg respectively, from which the samples required for the experiments were harvested.

Plant Extraction

Soxhlet extractor and distilled water as the solvent were used for the aqueous leaf extraction of the plant, *Annona senegalensis*. Water bath was used to evaporate the extract to almost a state of dryness, weighed and kept at 4°C in refrigerator until required (Evans, 2009; Zade and Dabhadkar, 2013).

Serum Chemistry

Total protein, urea, creatinine, glucose, cholesterol, sodium and potassium were determined. The concentrations of total proteins and cholesterol were determined by the Biuret and a modification of the Libermann-Burchard methods respectively as described by Toro and Ackermann (1975). Glucose concentration was estimated instantaneously by using orthotoluidine method as described by Yee *et al*. (1971) and Na^+ and K^+ concentrations were determined by flame photometry. Urea and creatinine were determined by the method of Eun *et al*. (2009). The values were measured at the end of every week.

DETERMINATION OF BIOCHEMICAL PARAMETERS

Determination of Serum Total Protein

The total protein was estimated by Biuret method (Tietz, 1994). The principle is based on colour change. Serum protein and peptides react with an alkali copper sulphate solution with a resultant violet coloured complex, that is, Biuret reaction. Other non protein compounds such as creatinine, urea etc do not exhibit such reaction.

Procedure: Three different test tubes were used and to each was dispensed the reagents with the aid of pipettes. The test tubes were labeled as follows: blank (5ml each of Biuret reagent and saline), Standard (200ml of standard serum and 5ml each of Biuret reagent and saline) and test sample (200 ml of test serum and 5ml each

of Biuret reagent and saline). The contents of each of the test tubes (the three test tubes) were mixed and placed in a water bath at 37ºC for 15 minutes. Spectrometer (Boeringer 4010, West Gerrmany) was used to read the optical density (O.D) of the standard and test samples against the blank at 546 nm. The protein concentration was expressed in g/dl and was calculated using the standard formula:

$$\frac{O.D\ test\ sample}{O.D\ standard} X\ concentration\ of\ standard\ (g/dl) = protein\ concentration\ (g/dl)$$

Serum Cholesterol Estimation

The method described by Richmond (1973) was used to determine the serum cholesterol; this involves serum oxidase method following specimen saponification.

Principle: It involves enzymatic hydrolysis and oxidation after which the cholesterol is determined. Quinoxamine is an indicator formed from hydrogen peroxide and 4-aminoantipyrine in the presence of phenol and peroxidase.

Procedure: Reagents were dispensed into three different cuvettes using pipettes and the cuvettes were labeled as, blank (10µl of saline and 1000µl of reagent), standard (10µl of standard and 1000µl of reagent) and test sample (10µl of serum and 1000µl of reagent). The contents of the three cuvettes were each mixed and incubated for 10 minutes at 37ºC. The absorbance of the sample (Asample) against the reagent blank was measured using spectrometer (Boeringer 4010, West Germany) within 60 minutes at 546 nm. Calculation of cholesterol concentration was done using the formula:

$$Conc.\ of\ cholesterol\ in\ sample\ (mmol/L) = \frac{A_{sample}}{A_{standard}} x\ conc.\ of\ standard$$

Determination of Serum Urea

Serum urea was determined using diacetylmonoxamine method as described by Afonja (1997).

Principle: When urea is heated in strongly acidic conditions with a substance such as diacetyl containing two adjacent carbonyl groups or its monoxine, a yellow condensation compound is formed. The reaction is intensified by the presence of polyvalent ions such as ferric ions which will form a red coloured complex. The intensity of the red complex is proportional to the concentration of urea and this can be measured colorimetrically.

Procedure: Ten (10) mls of distilled water each was placed into three test tubes labeled 'test', 'standard' and 'blank'. 20µl of the serum sample and 0.01 ml of 10 mmol/L of standard reagent was pipetted into the 'test' and 'standard', respectively. This was followed by adding 1 ml of the working coloured reagent (5mg/ml diacetylmonoxamine) and 1ml of mixed acid reagent (5g of ferric chloride hexahydrate and 85% phosphoric acid in 25 ml of distilled water) in all the three test tubes. Each test tube was shaken thoroughly then placed in boiling water or incubator at 100ºC for 20 minutes. Thereafter, the tubes were cooled and the optical density of the content read at 520 nm using the blank as control. The level of the urea in the serum samples were calculated using the formula:

$$Urea\ (mmol/L) = \frac{Sample\ O.D}{Standard\ O.D} X\ 10$$

Determination of Serum Creatinine:

The levels of serum creatinine were measured by the Jaffe reaction method as described by Seaton and Ali (1984). This involves adding 0.5 ml of the test serum to 1.5 ml of distilled water and then 0.5 ml of 10% sodium tungstate and an equal volume (0.5 ml) of NH_2SO_4. The mixture was then centrifuged for 3 minutes. Similarly, 2 ml of distilled water was mixed with 0.5 ml of 10% sodium tungstate and 0.5 ml NH_2SO_4, vigorously mixed and centrifuged for 3 minutes to serve as control. To 1.5 ml of the supernatant of the sample and control above were added 0.5 ml of the standard solution, 0.5 ml of 0.75N NaOH and 0.5 ml picric acid. The mixture was left to stand for 15 minutes, thereafter read at 520 nm. The level of the creatinine in the serum sample was then calculated using the following formula:

$$\frac{Sample\ O.D}{Standard\ O.D}\ X\ \ Conc.\ of\ standard = creatinine\ (mmol/L)$$

Determination of Serum Glucose:

Principle: Glucose is oxidized into gluconic acid and hydrogen peroxide. The hydrogen peroxide further reacts with phenol and 4-amino antipyrine by the catalytic action of peroxidase to form a red coloured quinoamine dye complex.

Procedure: The glucose reagent supplied along with the kit (M/s. Crest Biosystems, Goa, India) was aliquoted (300 µL) into 3 different flat bottom microwells of 96 well plate out of which 20 were used and the wells were marked as blank, test and standard (Std). An aliquot of 3 µL of distilled water was added to the well marked as blank, later aliquots of 3 µL of sample and 3 µL of glucose standard (supplied with the kit) were dispensed into the test and standard wells respectively. The absorbance of the test was measured at 492 nm against a reagent blank and the concentration of glucose is calculated using standard reference. The results obtained through the procedure were compared with the normal colorimetric method using the same kit (Srikanth *et al*., 2004). The calculation was done using the formula below:

$$Glucose\ (mmol/L) = \frac{Absorbance\ of\ Test}{Absorbance\ of\ Std}\ X\ Conc.\ of\ Std$$

DETERMINATION OF SERUM ELECTROLYTES

Determination of Serum Sodium

Flame photometry was used to determine the amount of sodium ion (Na^+) in the serum sample as described by Henry (1991) and Tietz (1994).

Principle: Solutions containing sodium under carefully controlled conditions, when finely sprayed (aspirated) into a burner, is de-solvated by leaving solids (salts) which dissociate to give neutral ground state atom. Some of these atoms are excited in the flame thus moving into a higher energy state. When these excited atoms fall back to the ground state, light of characteristic wavelength (590 nm) is emitted. This light then passes through a suitable Na^+ filter onto a photosensitive element and the amount of current thus produced is measured using a galvanometer. This is proportional to the amount of sodium in the sample.

Procedure: Three universal bottles were labeled test, standard and blank with each containing 9.9 ml of distilled water. One micro liter (0.1 ml) of serum sample was added to test bottle while 0.1ml of standard

working solution and water were added to standard and blank respectively. The tubes were shaken and allowed to settle down on the bench and the galvanometer reading taken. The concentration of sodium in the serum samples was then obtained using the following formula:

$$Sodium\ (mmol/L) = galvanometer\ reading\ x\ 2$$

Determination of Serum Potassium

The amount of potassium in the serum sample was determined by flame photometry (Tietz, 1994). The principle is similar to that of serum sodium determination above.

Procedure: To 0.1 ml of serum sample in a universal bottle, 9.9 ml of deionised distilled water was added and the solution was mixed by inversion several times. Distilled water was used as the blank while 0.1 ml of the standard working solution served as the standard. The potassium light filter was inserted into the galvanometer at air pressure of 10 1b/sq inch. The concentration of potassium in the serum sample was then obtained by the following formula:

$$Potassium\ (mmol/L) = galvanometer\ x\ 2$$

STATISTICAL ANALYSIS

Data harvested from this study were expressed as Mean ±standard Deviation (S.D). The differences in means among the groups were analysed by one-way analysis of variance(ANOVA) using GraphPad InStat version 3.0 computer software (GraphPad, 2003). Mean values were considered significant at $P<0.05$.

RESULTS AND DISCUSSION

Effects of Aqueous Leaf Extract of *Annona senegalensis* on some Serum Biochemical Parameters.

The effects of aqueous leaf extract of *Annona senegalensis* on some serum biochemical parameters are presented in Table 1. The mean value of total protein in weeks 1, 3 and 4 significantly decreased in all the treated rats as compared to the control. Whereas in week 2 there was no significant change at doses 100, 200 and 300 mg/kg but significantly decreased at 400 mg/kg (21.80±0.837 g/dl) as compared to control. The mean values in week 1 in the doses of 100, 200, 300 and 400 mg/kg are 32.20±1.304, 31.80±3.899, 32.60±1.517 and 22.40±2.191 g/dl respectively. The mean values in week 3 in the doses of 100, 200, 300 and 400 mg/kg are 32.00±1.581, 31.00±0.707, 27.20±2.683 and 24.20±0.837 g/dl respectively. The mean values in week 4 in the doses of 100, 200, 300 and 400 mg/kg are 29.20±1.483, 28.20±1.095, 27.60±1.949 and 25.40±1.140 g/dl respectively. The decrease in mean values of total protein observed may suggest that the extract might have interfered with intestinal absorption of protein. The liver may also have inadequate supply of amino acids to synthesize serum proteins, leading to a decrease in serum total protein level. This agrees with the report of Grant and Kachmar (1987) who noted that, the decrease in serum protein resulting from the administration of an extract suggests impaired absorption of protein in the intestine or liver damage. The liver damage may have impaired the synthesis of serum total proteins in the liver, thereby leading to low serum levels. Extract administration produced a significant decrease in the total protein concentration in all the dose groups throughout the 28 days (4 weeks) of administration. Hence, the aqueous leaf extract might inhibit the synthesis

of some proteins, thereby resulting in the decrease in serum total protein. It has been reported that low protein level results when there is extensive liver damage (Wada and Snell, 1962).

The urea mean values in the treated rats varied significantly ($P<0.05$) compared to the control. There were significant ($P<0.05$) increases in week 1 at the dose of 400 mg/kg (6.940±0.39 mmol/L), week 3 at the dose of 300 mg/kg (7.600±0.48 mmol/L) and week 4 at the dose of 100 mg/kg (8.520±0.90 mmol/L), and significant ($P<0.05$) decrease in week 2 at the doses of 100, 200, 300 and 400 mg/kg with the values of 5.260±0.59, 4.360±0.71, 4.960±0.55 and 4.980±0.34 mmol/L respectively and also in week 3 at 200 mg/kg (5.740±0.54 mmol/L) compared to the control. The marked elevation in serum urea level in this study may suggest that the extract caused renal impairment in the rats or it may be as a result of increased protein catabolism and renal retention of the proteinaceous materials as reported by Nduka (1999) who showed increased catabolism and renal retention of protein materials. However, since urea is not a complete estimation of renal function, the observed significant increase in creatinine may further buttress the fact that the extract might probably have caused kidney dysfunction.

The extract did not produce any change in cholesterol level in weeks 1 and 4 in the treated groups compared to the control. The extract however, produced a significant ($P<0.05$) decrease in weeks 2 and 3 at 100 mg/kg (1.840±0.2608 mmol/L) and 300 mg/kg (2.040±0.3435 mmol/L) respectively. Alterations in the concentration of major lipids like cholesterol, high-density lipoprotein cholesterol, low density lipoprotein cholesterol and triglycerides can give useful information on the lipid metabolism as well as predisposition of the heart to atherosclerosis and its associated coronary heart diseases (Yakubu *et al*., 2008). Therefore, the significant ($P<0.05$) decrease in the mean values of total cholesterol observed in the 100 and 300 mg/kg groups at weeks 2 and 3 of the extract administration may be clinically beneficial to the animals as the extract is unlikely to be associated with cardiovascular risk at these doses which agrees with Abolaji *et al*. (2007) who reported that high blood cholesterol concentrations are an important risk factor for cardiovascular disease. Hesperidin is regarded as the most important flavone in oranges and has been reported to lower high blood pressure as well as cholesterol (CSIRO, 2004). Thus, the presence of flavonoids in the extract could be responsible for the decreased mean values of cholesterol as reported by Mbaya *et al*. (2019) for presence of flavonoids in the extract.

The mean values of creatinine in week 1 in the doses of 100, 200, 300 and 400 mg/kg are 98.400±3.98, 83.000±4.69, 84.000±7.75 and 63.400±7.93 mmol/L respectively and week 2 in the doses of 100, 200, 300 and 400 mg/kg are 78.000±7.28, 63.400±4.10, 52.200±5.07 and 67.000±2.35 mmol/L respectively which decreased significantly ($P<0.05$) compared to control. In week 3 at the dose of 300 mg/kg (122.20±2.28 mmol/L) and week 4 in the doses of 100, 200 and 400 mg/kg (106.40±5.81, 101.40±3.05 and 97.200±3.70 mmol/L respectively), there was significant ($P<0.05$) increase in the mean values of creatinine compared to control. Creatinine is a fairly indicator of kidney function. Its elevation however signifies impaired kidney function, due to poor clearance of creatinine. Abnormally high levels of creatinine are a sign of warning that there is malfunction or failure of the kidneys. In weeks 1 and 2 there were no raise in the levels of creatinine but decrease thus, no suspicion of kidney impairment but in weeks 3 and 4 significantly increased thus, there was suscipicion of kidney malfunction or failure as reported by Nduka (1999).

The mean values of glucose concentration significantly ($P<0.05$) increased in the entire 4 weeks of extract administration compared to control. The mean values in week 1 in the doses of 200, 300 and 400 mg/kg are 5.020±0.52, 6.120±0.45 and 7.080±0.91 mmol/L respectively. The mean values in week 2 at the dose of 400 mg/kg is 6.860±0.33 mmol/L. The mean values in week 3 at the doses of 200, 300 and 400 mg/kg are 6.060±0.93, 7.220±0.53 and 7.560±0.99 mmol/L respectively. The mean values in week 4 in the doses of 100, 200, 300 and 400 mg/kg are 5.240±0.38, 6.660±0.50, 5.580±0.53 and 6.180±0.46 mmol/L respectively. The mean values of serum glucose concentration was significantly ($P<0.05$) increased in the present study which may suggest that the extract might be a carbohydrate enriched plant, this is supported by the presence of carbohydrates in the extract as reported by Mbaya *et al*. (2019), that the extract contains carbohydrate, or may suggest an impairment of glucose homeostasis by the extract. This is in agreement with the report of Dieudonne *et al*. (2012) that high blood glucose levels may be dependent on the duration of exposure to large amounts of carbohydrates.

Table 1: Effects of prolong administration of aqueous leaf extract of *Annona senegalensis* on some serum biochemical parameters of albino rats (g)

Parameters	Dose (mg/kg)	Period of Treatment (weeks)			
		1	2	3	4
Protein (g/dl)	Control(0)	37.00±3.391^a	34.20±0.837^a	36.40±3.209^a	36.00±2.550^a
	100	32.20±1.304^c	33.60±1.673	32.00±1.581^c	29.20±1.483^c
	200	31.80±3.899^c	34.40±1.517	31.00±0.707^c	28.20±1.095^c
	300	32.60±1.517^c	32.40±0.894	27.20±2.683^c	27.60±1.949^c
	400	22.40±2.191^c	21.80±0.837^c	24.20±0.837^c	25.40±1.140^c
Urea (mmol/L)	Control(0)	4.860±0.30^a	6.100±0.79^a	6.400±0.50^a	7.160±1.15^a
	100	4.520±0.18	5.260±0.59^c	6.580±0.42	8.520±0.90^b
	200	5.080±0.35	4.360±0.71^c	5.740±0.54^c	6.240±0.51
	300	5.160±0.28	4.960±0.55^c	7.600±0.48^b	5.960±0.47
	400	6.940±0.39^b	4.980±0.34^c	6.200±0.39	6.700±0.66
Cholesterol (mmol/L)	Control(0)	2.660±0.5128	2.820±0.4147^a	3.300±0.6164^a	1.880±0.3194
	100	2.740±0.6229	1.840±0.2608^c	3.700±0.4472	2.060±0.3286
	200	2.820±0.4817	2.280±0.5675	2.860±0.3782	1.940±0.2608
	300	2.320±0.1483	3.040±0.5459	2.040±0.3435^c	2.340±0.5367
	400	2.680±0.4919	2.400±0.4000	2.920±0.4604	2.020±0.3033
Creatinine (mmol/L)	Control(0)	109.40±3.51^a	114.60±6.69^a	58.600±3.85^a	80.600±5.27^a
	100	98.400±3.98^c	78.000±7.28^c	61.400±3.85	106.40±5.81^b
	200	83.000±4.69^c	63.400±4.10^c	63.000±3.16	101.40±3.05^b
	300	84.000±7.75^c	52.200±5.07^c	122.20±2.28^b	81.200±2.68
	400	63.400±7.93^c	67.000±2.35^c	62.200±4.09	97.200±3.70^b
Glucose (mmol/L)	Control(0)	3.780±0.34^a	3.940±0.54^a	4.660±0.43^a	4.160±0.34^a
	100	3.700±0.12	3.720±0.34	4.820±0.46	5.240±0.38^b
	200	5.020±0.52^b	3.720±0.56	6.060±0.93^b	6.660±0.50^b
	300	6.120±0.45^b	4.320±0.70	7.220±0.53^b	5.580±0.53^b
	400	7.080±0.91^b	6.860±0.33^b	7.560±0.99^b	6.180±0.46^b

Different superscripts in the same column are significantly different at P<0.05.

Key: a = for control groups

b = significantly increased

c = significantly decreased

Effects of Aqueous Leaf Extract of *Annona senegalensis* on some serum electrolytes.

The effects of aqueous leaf extract of *Annona senegalensis* on some serum electrolytes is presented in Table 2. The mean values of potassium significantly (P<0.05) increased in week 1 at doses of 200 mg/kg (7.600±0.61 mmol/L) and 300 mg/kg (7.420±0.76 mmol/L) and significantly (P<0.05) decreased in all the

treated groups in week 2. It significantly ($P<0.05$) increased in week 3 at 300 mg/kg (8.400±3.29 mmol/L) and produced no significant change in week 4 as compared to the control.

The extract did not produce any significant change in the mean values of sodium in weeks 1 and 4 while the values significantly ($P<0.05$) decreased in week 2 at the doses of 100, 300 and 400 mg/kg (150.20±4.21, 154.80±5.68 and 147.80±2.59 mmol/L) respectively and increased significantly ($P<0.05$) in week 3 at 300 mg/kg (178.00±5.70 mmol/L) as compared to the control. The significant decrease in sodium and potassium concentrations in the 100 mg/kg at week 2 and the significant decrease in cholesterol observed on administration of the extract could be beneficial in the management of hypertension. Sodium is responsible for water homeostasis and its increase suggests increased water into the plasma thus, increasing the blood pressure. Cholesterol also increases the risk of cardiovascular risk, its decrease suggests reduction of the cardiovascular risk (Abolaji *et al*., 2007; Ochei and Kolhatkar, 2007; Sembulingam and Sembulingam, 2012). The significant increase in serum sodium ions observed in the 300 mg/kg dose at week 3 with a concomitant increase in potassium ion levels in the 200 and 300 mg/kg groups at week 1 and in the 300 mg/kg group at week 3 may be due to renal dysfunction resulting from the inability of the kidney to effectively regulate electrolyte balance. The extract may also interact with specific hormone receptors resulting in increased production of aldosterone and mineralocorticoids which may be responsible for the observed hypernatraemia (Abolaji *et al*., 2007; Nduka, 1999). It may also be due to selective toxicity which is dose dependent, due to the fact that there was significant decrease in week 2 for both potassium and sodium respectively.

In conclusion, the aqueous leaf extract of *Annona senegalensis* should be handled with care due to its low protein mean value and increase in urea level may suggest renal impairment. However, the extract suggests that its decrease in cholesterol level in some doses could be beneficial in reducing cardiovascular disease risk so also its decrease in some electrolyte especially sodium could be beneficial to person with high blood pressure towards lowering it. Studying of the activity of the extract on the various organs of the body is recommended to understand the level of damage to the organs.

Table 2: Effects of aqueous leaf extract of *Annona senegalensis* on some serum electrolytes in albino rats (mmol/L).

Parameters/ Weeks of Treatment	Extract Dose (mg/kg)				
	Control(0) (Distil water)	100	200	300	400
potassium 1	5.480±0.73[a]	6.260±0.57	7.600±0.61[b]	7.420±0.76[b]	6.300±0.66
2	7.800±0.35[a]	6.500±0.78[c]	6.720±0.67[c]	7.020±0.71[c]	6.060±0.56[c]
3	6.860±0.75[a]	6.100±0.84	6.600±0.79	8.400±3.29[b]	6.920±0.44
4	5.700±0.52	6.000±0.49	5.720±0.48	5.920±0.45	6.280±0.72
sodium 1	146.40±7.40	141.00±4.18	152.20±5.26	147.40±2.51	145.00±3.08
2	171.80±9.42[a]	150.20±4.21[c]	174.00±8.22	154.80±5.68[c]	147.80±2.59[c]
3	155.80±4.55[a]	153.20±6.10	153.00±5.70	178.00±5.70[b]	154.80±5.26
4	150.40±3.72	155.00±6.44	148.80±4.15	154.40±7.02	157.20±7.69

Different superscripts in the same row are significantly different at $P<0.05$.

Key: a = for control groups

b = significantly increased

c = significantly decreased

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