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Effects of Aqueous Extract of *Solanum macrocarpum* Linn. Fruit on Serum Creatinine, Urea and Some Electrolytes in Rats Pre-fed 1% Cholesterol and Groundnut Oil

O. A. Sodipo [1], F. I. Abdulrahman[2], U. K. Sandabe[3], and J. A. Akinniyi[2]

[1]Department of Clinical Pharmacology and Therapeutics, College of Medical Sciences; [2]Department of Chemistry, Faculty of Science; and [3]Department of Veterinary Physiology and Pharmacology, Faculty of Veterinary Medicine, University of Maiduguri, P. M. B. 1069, Maiduguri, Nigeria

ABSTRACT

Studies were conducted on the effect of the aqueous fruit extract of *Solanum macrocarpum* Linn. in hypercholesterolaemic rats. The plant material was Soxhlet-extracted with distilled water and the extract was concentrated *in vacuo* with a yield of 15.34 % $^{w}/_{w}$. The extract was stored in a specimen bottle at room temperature until when required. The kidney function parameters-serum creatinine, urea and electrolytes (sodium, potassium, calcium and phosphates) were determined. The results showed that with increase in extract dose, the creatinine level increased significantly ($p<0.05$) whilst the change in urea was not significant ($p>0.05$). The effect of the aqueous extract on the electrolytes showed that both sodium and phosphate dose-dependently increased and the increase was significant ($p<0.05$). Calcium dose-dependently decreased and the decrease was not significant ($p>0.05$). The change in calcium with increase in extract dose was not statistically significant ($p>0.05$). The increase in sodium ion could be due to the high level of Sodium in the plant or as a result of loss of body fluid. Elevated levels of creatinine observed in this study may be due to impaired kidney function.

Key words: *Solanum macrocarpum* Linn., aqueous extract, creatinine, urea, some electrolytes

INTRODUCTION

Solanum macrocarpum Linn. otherwise called garden egg or *Solanum macrocarpon* L. sensu stricto or *Solanum daysphyllum* Schumach and Thonn belongs to the family *Solanaceae* and grows luxuriantly in the North East arid zone of Nigeria, Sierra Leone, Kenya and Uganda. The green unripe fruit of *S. macrocarpun* which is locally called "Gorongo" in Kanuri is used as a laxative and in the treatment of cardiac diseases and hyperlipidaemia (Bokhari and Ahmed, 1980; Grubben and Denton, 2004). In Sierra Leone, heated leaves are chewed to treat throat troubles. In Kenya, the juice of boiled roots is drunk to get rid of hook worm, while crushed leaves are taken to treat stomach troubles (Grubben and Denton, 2004). The young leaves and young fruits are cooked and consumed as a vegetable (Grubben and Denton, 2004). In view of the numerous uses of this plant, especially in lowering hyperlipidaemia in traditional medicine the present study investigated the effect of the aqueous fruit extract on biochemical kidney function indices in hypercholesterolaemic albino rats with the aim of confirming if the extract has any deleterious or beneficial effect on the kidney of rats.

MATERIALS AND METHODS

Plant collection and identification

The plant material (*Solanum macrocarpum* Linn.) used in this study was obtained from Alau in Konduga Local Government, Borno State, Nigeria, between October and November, 2007.The plant was identified and authenticated by Prof. S.S. Sanusi of the Department Biological Sciences, University of Maiduguri, Maiduguri, Nigeria. Specimen voucher No. 548 was deposited at the Research Laboratory of the Department of Chemistry.

*Author for correspondence

Extraction

The fruit of *S. macrocarpum* with the calyx removed, was air dried and pulverised by grinding using pestle and mortar. The 2.2 kg of the ground fruit was subjected to exhaustive Soxhlet-extraction in distilled water at 100°C to give the extract yield of 15.34% $^{w}/_{w}$ (Mittal *et al.*, 1981, Fernando *et al.*, 1991; Lin *et al.*, 1999). The resultant solution was concentrated *in vacuo* and it was stored in a specimen bottle at room temperature until when required.

Animals

Twenty five male albino rats of Wistar strain of both sexes weighing 160 - 200 g were used in this study. The animals were obtained from the Animal House Unit of the Department of Veterinary Physiology and Pharmacology, University of Maiduguri. The animals were housed under standard laboratory condition in plastic cages. They were fed commercial growers' mash feed (ECWA Feeds, Jos, Nigeria) and water was provided *ad libitum*. All the animals were handled according to the International Guiding Principle for Biomedical Research Involving Animals (CIOMS, 1985) as certified by the Animal Ethics Committee of the Faculty Of Veterinary Medicine, University of Maiduguri.

Administration of cholesterol and extract

Twenty five (25) albino rats were made hypercholesterolaemic by feeding them orally (p.o) with normal feed diet supplemented with cholesterol (BDH Biomedical Ltd, Poole, England) and groundnut oil at 1% each for 3 weeks *ad libitum* (Odetola *et al.*, 2004). The rats were divided into 5 groups of 5 animals each. At the end of the 3 weeks, the rats were administered with graded doses of the plant extract for 1 week. Group I was the control and it was given distilled water only. Groups II, III, IV and V were administered with geometrical doses (25 mg/kg, 50 mg/kg, 100 mg/kg and 200 mg/kg) of the fruit extract intraperitoneally (i.p.) for 7 days. One week after extract administration, the rats in each group were individually sacrificed humanely with sterile razor and blood was collected from the slashed throat into clean, labelled, centrifuge tubes without anticoagulant. The blood was centrifuged at a rate of 12,000 revolutions per minute (rpm) for 10 minutes. The clear, yellow serum was then separated from settled cellular elements.

Biochemical kidney function tests

The kidney function parameters estimated from the serum were creatinine, urea and electrolytes which included sodium ion, (Na^+) potassium ion (K^+), calcium ion (Ca^{2+}) and phosphates (PO_4^{3-}). They were estimated using standard methods (Seaton and Ali, 1984; Chaney and Marbach, 1962; Kaplan, 1965; Lorentz, 1982; Tietz, 2006).

Statistical analysis

Test of significance between control and treatment means were carried out by Analysis of Variance (ANOVA) using Graph Pad Software (1998).

RESULTS

Effect of extract on body weight of rats

The weights of the rats increased over the period of study, but the increase was not significant ($p>0.05$) when compared to the control (Table 1).

Effect of extract on kidney function indices of hypercholesterolaemic rats

The results of the various doses of aqueous fruit extract of *S. macrocarpum* on kidney function indices of hypercholesterolaemic rats are shown in Tables 2 and 3.

Serum creatinine dose-dependently increased and it was significant ($p<0.05$). Serum urea did not follow a clearly defined pattern and it was not significant ($p>0.05$) with increase in extract dose (Table 2).

The serum concentration of Na^+ ion at various dose levels of extract showed a significant increase ($p<0.05$) whilst changes in serum K^+ ion was not significant ($p>0.05$) and it did not follow a specific pattern (Table 3). With increasing dose of extract, the serum Ca^+ ion decreased significantly ($p<0.05$) while that of PO_4^{3-} ion increased significantly ($p<0.05$) (Table 3).

DISCUSSION

The increase in mean body weight of the rats before and after extract administration was not significant ($p>0.05$), probably implying that the aqueous extract of *Solanum macrocarpum* at the doses employed had no appreciable effect on cholesterol metabolism that could be statistically significant in terms of body weight.

The level of creatinine in the present study increased significantly with increase in the extract dose of *Solanum macrocarpum* fruit ($p<0.05$). Since elevated levels of creatinine are found in renal dysfunction (decreased glomerular filtration rate) then probably the kidney is damaged. Also, reduced renal blood flow (shock, dehydration,

Table 1. Effect of the aqueous extract of the fruit of *Solanum macrocarpum* on mean body weight ± SD of hypercholesterolaemic rats

Extract dose (mg/kg)	Mean body weight + SD (g)				
	Weeks of treatment				
	0	1	2	3	4
Control	180.62 ± 53.13[a]	199.54 ± 54.17[a]	203.86 ± 55.32[a]	203.86 ± 55.32[a]	226.90 ± 54.82[a]
25.00	155.82 ± 38.64[a]	164.82 ± 38.22[a]	174.52 ± 40.02[a]	176.58 ± 28.26[a]	189.40 ± 33.14[a]
50.00	164.70 ± 44.86[a]	174.45 ± 44.55[a]	183.90 ± 48.14[a]	183.95 ± 46.30[a]	185.03 ± 44.02[a]
100.00	202.10 ± 14.64[a]	211.83 ± 15.65[a]	212.70 ± 14.22[a]	219.80 ± 19.44[a]	221.72 ± 17.17[a]
200.00	152.26 ± 14.75[a]	162.16 ± 14.91[a]	173.00 ± 21.88[a]	174.20 ± 16.40[a]	179.06 ± 19.60[a]

$p>0.05$ = within rows, mean with the same superscripts are not statistically significant when compared with the control; Week 0 = immediately before cholesterol administration; Week 3 = beginning of extract administration; Week 4 = last week of extract administration; Control = not given any extract at all; n = 5; n = number of rats per group; SD = standard deviation

Table 2. Effect of the aqueous extract of the fruit of *Solanum macrocarpum* on creatinine and urea ± SD on hypercholesterolaemic rats

Extract dose (mg/kg)	µmol	
	Creatinine	Urea
Control	64.00 ± 16.71[b]	7.05 ± 0.85[a]
25.00	85.80 ± 8.79[b]	5.23 ± 1.10[a]
50.00	87.50 ± 27.10[b]	5.56 ± 0.42[a]
100.00	103.00 ± 13.29[b]	6.33 ± 1.01[a]
200.00	103.75 ± 12.47[b]	6.10 ± 1.08[a]

Within columns, mean with the same superscripts are statistically significant ($p<0.05$) when compared to control; Control = not extract was given; n = 5; n = number of rats per group; SD = standard deviation

congestive heart failure) and diabetes can lead to increased creatinine levels (Sood, 2006). Urea on the other hand is a waste product of the protein breakdown which appears in the glomerular ultra filtrate, but approximately 40% is reabsorbed in the tubule. In addition, its plasma concentration is strongly influenced by diet and other physiological conditions not connected with renal function (Mukherjee, 1988). Serum creatinine is therefore considered a better indicator of renal function. Thus, the fact that the extract did not cause any significant change in urea ($p>0.05$) does not really matter in terms of kidney function indices. However, the serum concentration of urea rises in impaired renal function just as creatinine does. Elevated levels of creatinine observed in this study may be due to impaired kidney function (Modu *et al.*, 2000; Rabo *et al.*, 2003; Biu, 2007).

Table 3. Effect of the aqueous extract of the fruit of *Solanum macrocarpum* on mean serum electrolytes ± SD on hypercholesterolaemic rats

Extract dose (mg/kg)	Electrolytes (mmol/l)			
	Na^+	K^+	Ca^{2+}	PO_4^{3-} (inorganic phosphorus)
Control	163.50 ± 3.77^a	10.20 ± 2.18^a	2.33 ± 0.05^a	0.80 ± 0.08^a
25.00	152.00 ± 3.16^b	9.50 ± 1.78^a	2.26 ± 0.05^b	0.88 ± 0.15^b
50.00	156.00 ± 2.83^b	10.25 ± 1.17^a	2.23 ± 0.05^b	0.93 ± 0.10^b
100.00	157.52 ± 1.92^b	9.25 ± 0.57^a	2.10 ± 0.12^b	0.96 ± 0.11^b
200.00	158.00 ± 2.83^b	10.96 ± 1.43^a	2.00 ± 0.20^b	1.08 ± 0.13^b

Within columns, mean with the same superscripts are statistically significant ($p<0.05$) when compared to control; Control = not extract was given; n = 5

The administration of *S. macrocarpum* fruit extract on hypercholesterolaemic rats resulted in significantly increased serum Na^+ ion ($p<0.05$). The increased serum Na^+ ion concentration could be an indication of decreased sodium excretion or dehydration (Odutola, 1992) as sodium is the major extracellular cation of the body (Mukherjee, 1988). In this study, even though the animals did not show evidence of diarrhoea, the extract exhibited laxative properties especially at 200 mg/kg extract (Sodipo *et al.*, 2008b). The dehydration may probably explain the presence of high sodium level in the blood. Also, the high level of sodium ions observed to be present in the plant sample from elemental analysis (6,238.50 ± 215.08 µg/g) could contribute to the increased sodium load in the treated animals (Sodipo *et al*, 2008a)

Unlike sodium, the effect of the extract on serum K^+ ion on hypercholesterolaemic rats did not produce any statistical significance ($p>0.05$) and the change did not follow any regular pattern. K^+ is the major cation in the extracellular fluid (Mukherjee, 1988; Odutola, 1992). The serum K^+ concentration is not a measure of total body potassium because the bulk of K^+ resides within the cells. Thus the fact that serum K^+ is not significant in the present study will not affect the acid-base balance of the physiological system because the serum K^+ only constitutes a small fraction of the total body K^+.

The fact that the significant decrease in calcium ion corresponded to significant increase in phosphate ion ($p<0.05$) on extract administration is not surprising because calcium and inorganic phosphates are the major constituents of bone and have a reciprocal relationship in serum (Mukherjee, 1988; Odutola, 1992; Sood, 2006). Increased intake of magnesium and phosphates and the excess use of laxatives may lower the blood calcium level. The extract has been found to be a laxative with maximum effect at 200 mg/kg (Sodipo *et al.*, 2008b). This occurs because of the increased intestinal loss of calcium produced by these elements (Sood, 2006). Also, decreased calcium concentration on administration of graded doses of aqueous fruit extract of *S. macrocarpum* may be due to a problem in either the production or response to Vitamin D. The abnormality in the Vitamin D system may be caused by decreased nutritional intake, decreased absorption of Vitamin D or decreased production of 25-hydroxycholecalciferol because of liver disease or increased metabolism of 25-hydroxycholecalciferol because of stimulation of microsomal enzymes (Odutola, 1992) by the extract.

CONCLUSION

The aqueous fruit extract of *Solanum macrocarpum* probably leads to impaired kidney function as there was elevated serum creatinine levels. The significant increase in serum Na^+ ion might be due to the high level of elemental sodium present in the fruit. The fruit should however be used with caution pending the outcome of histopathological studies on the kidney to confirm any probable kidney damage.

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REFERENCES

Biu, A. A. (2007). The efficacy and toxicity of neem (*Azadirachta indica* A. Juss) leaf aqueous extract against coccidiossis in chickens (*Gallus gallus domesticus*) and as a feeding deterrent to Quela (*Quelo quelea*) Birds, in Borno State, Nigeria. Ph. D. Thesis, University of Maiduguri, Maiduguri, Nigeria. 255 pp.

Bokhari, M. H. and Ahmed, Ch. M. S (1980). *Food Plants in Borno State, Nigeria*. pp. 44-45

Chaney, A. L. and Marbach, E. D. (1982). Modified reagents for the determination of urea and ammonia. *Clin. Chem*. 8: 130-132.

CIOMS: Council of International Organisations of Medical Sessions (1985). International Guiding Principles for Biomedical Research Regarding Animals $^{C}/_{O}$WHO 1211, Geneva 27, Switzerland.

Fernando, M. R., Wickramansingbe, S. M. D., Nalinle, I., Thabrew, M. I., Ariyanando,P. I. and Karunanayake, E. H. (1991). Effects of *Artocarpus heterophyllus* and *Asterachantus longifolia* on glucose tolerance in normal subjects and in maturity-onset diabetic patients. *J. Etnopharmacol.* 31*:* 277-283.

Graph Pad Software (1998). Graph Pad Software, Inc. San Diego, California, U.S.A. www.graphpad .com.

Grubben, G. J. H. and Denton, O. A. (2004). PROTA 2. *Plant Resources of Tropical Africa 2. Vegetables.* Ponem nad Looijen hv, Wagening en, Netherlands. pp. 484-487.

Kaplan, L. A., and Pesche, A. J. (1989) *Clinical Chemistry. Theory Analysis and Correlation.* 2nd ed. Mosby, Co. New York. 187pp.

Lin, J., Opuku, A. R., Gaheeb-Keller, M.,Hutchings, A. D., Terblanche, S. E., Jager, A. K., Van-Starden, J. (1999). Preliminary screening of some traditional Zulu medicinal plants for anti-inflammatory and anti-bacterial activities. *J. Ethnopharmacol.* 68*:* 267-274.

Lorentz, K. (1982). Improved determination of serum calcium with 2-cresolphthalein complexion. *Clin. Chem. Acta*. 126*:* 327-334.

Mittal, G. C., Aguwa, C. N., Ezeinu, B. U. and Akubue, P. I. (1981). Preliminary pharmacological studies on antivenom action of *Diodia scanders* leaves. *Nig. J. Pharm*. 12: 432-436.

Modu, S., Kanis, A. B. and Markus, P. Y. (2000). Some biochemical effects on aqueous pulp extraction of *Hyphaene thebiaca* (L) MART administration in rats. *J. Life and Environ. Sci.* 2/3*:*139-143.

Mukherjee, K. L. (1988). *Medical Laboratory Technology. A procedure Manual for Routine Diagnostic Tests Vol. III.* Tata McGraw-Hill Pub. Co. Ltd. New Delhi. pp. 1,005-1,009.

Odetola, A. A., Iranloye, Y. O. and Akinloye, O. (2004). Hypolipidaemic Potentials of *Solanum melongena* and *Solanum gilo* on Hypercholesterolaemic Rabbits. *Pakistan J. Nutri*: 3(3): 180-187. http:/209,85.65,154 /search? Q-http://www.pjbu.org/pipeonline/ fii.193.pdf. Access Date: 25/5/2007.

Odutola, A. A. (1992).*Rapid Interpretation of Routine Clinical Laboratory Tests.* J. Asekome and Company, Zaria, p. 112.

Rabo, J. S. Onyeyili, P. A. and Khalil, M. I.(2003). Chronic toxicity of aqueous extract of *Butyrospermum paradoxum* stem, bark in rabbit. haematology and enzymology. *Stud. Res. Vet. Med. Bucharest.* 1:: 37-46.

Seaton, B. and Ali, A. (1984). Serum creatinine level. *Med. Lab. Sci.* 41: 327-336

Sodipo, O. A., Abdulrahman, F. I., Akan, J. C. and Akinniyi, J. A. (2008a). Phytochemical screening and elemental constituents of *Solanum macrocarpum* Linn. *Continental J. Appl. Sci.* 3: 88-97.

Sodipo, O. A., Abdulrahman, F. I., Sandabe, U. K. and Akinniyi, J. A. (2008b). The Effect of aqueous fruit extract of *Solanum macrocarpum* Linn. on cat blood pressure and rat gastrointestinal tract. *J. Pharm. Biores.* (In press).

Sood, R. (2006), *Textbook of Medical Laboratory Technology,* 1st ed. Jaypee Brothers Medical Publishers (p) New Delhi. pp. 609-672.

Tietz, N. W. (2006). *Fundamentals of Clinical Chemistry,* 4th ed.. Saunders, Philadelphia. 7,235b,2317t.