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ARTICLE

Effects of the Aqueous Fruit Extract of Solanum Macrocarpum Linn on Biochemical Kidney Function of Hyperlipidaemic Rats Administered Triton-X Orally for 7 Days

SODIPO, O. A.[*1], ABDULRAHMAN, F. I. [2], SANDABE, U. K. [3] and AKINNIYI, J. A. [2]

[*1]Department of Clinical Pharmacology and Therapeutics College of Medical Sciences, University of Maiduguri, P.M.B. 1069, Maiduguri; [2]Department of Chemistry, Faculty of Scène, University of Maiduguri; [3]Deaprtment of Veterinary Physiology, Pharmacology and Biochemistry, Faculty of Veterinary Medicine, University of Maiduguri, P.M.B. 1069, Maiduguri. *Correspondence: E-mail: sodipoolufunke@yahoo.com; Tel.: +234(0)8034107098

SUMMARY

Studies were conducted on the effect of the aqueous fruit extract of Solanum macrocarpum Linn. in triton-induced hyperlipidaemic rats. The plant was Soxhlet-extracted with distilled water and the extract concentrated in vacuo with a yield of 15.34% $^{w}/_{w}$. The extract was stored in a specimen bottle at room temperature until 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 changes in serum concentration of sodium, calcium and potassium ions were not significant (P>0.05). For potassium ion however, the concentration decrease was dose-dependent and was only significant (P<0.05) at 72hrs. Creatinine increased significantly (P<0.05) throughout the period of study (24hrs, 48hrs and 72hrs) when compared to the control whilst urea did not show any change (P>0.05). Then non-significant changes in phosphate and calcium ions and a reduction in K^+ ion may probably not affect the acid-base balance of the physiological system. Elevated levels of creatinine observed in this study may be due to stimulation of muscle activity or impaired kidney function.

KEY WORDS: Solanum macrocarpum Linn, aqueous extract, triton-X, kidney function, hyperlipidaemic rats.

INTRODUCTION

Many drugs have been developed and introduced for the management of hyperlipidaemia. The commonest and most important hyperlipidaemia is hypercholesterolaemia (Lawrence *et al.,* 1997; Hardman and Limbird, 2001). Drugs that lower cholesterol level include the statins, fribric acid derivatives, bile acid sequestrants, nicotinic acid derivatives, etc. However, most of these drugs have serious side effects like aggravating deterioration in kidney function (Lawrence *et al.,* 1997; Katzong, 2004; Sodipo, 2009). In addition, they are expensive (Sodipo, *et al.,* 2009a,b). Hyperlipidaemia in rats may be induced by triton-X-100 (Polyoxyethylene octyl phenyl ether) a nonionic surfactant which interferes with uptake of plasma lipids (Williamson *et al.,* 1996). *Solanum macrocarpum* Linn, otherwise called (garden egg) also referred to as *S. macrocarpon* L. senso stricto or *S. daysphyllum* Schumach and Thonn belongs to the family *Solanaceae* and is cultivated in Borno state (Bokhari and Ahmed, 1980). The green unripe fruit of *S. macrocarpum* which is locally called "Gorongo" in Kanuri is used in the treatment of cardiac diseases and hyperlipidaemia (Grubben and Denton, 2004). The present study evaluated the effect of the aqueous extract of *S.*

macrocarpum on triton-induced hyperlipidaemic rats in an attempt to find an alternative hypolipidaemic drug that is therapeutically and cost effective but with fewer side effects than the existing ones.

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 of Biological Sciences, University of Maiduguri, Nigeria. Specimen voucher No. 548 was deposited at the Research Laboratory of the Department of Chemistry.

Extraction

The fruit of *S. macrocarpum* was air dried and pulverized by grinding using pestle and mortar. The 2.2kg of the ground fruit was subjected to exhaustive Soxhlet-extraction in distilled water at 100°C to give the extract yield of 15.3% $^{w}/_{w}$ (Mittal *et al.,* 1981, Fernando *et al.,* 1991; Lin *et al.,* 1999). The resultant solution was concentrated, it was stored in a specimen bottle at room temperature until when required.

Animals

Thirty male albino rats of Wistar strain weighing 160-200g 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 were provided *ad libitum*. All the animals were handled according to the International Guiding Principles 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 triton and extract

Before the rats were fed with triton-X, their weights were taken. The weights were also taken before and after administration of triton-X for 7 days.

Thirty (30) albino rats were made hyperlipidaemic by feeding them orally (p.o) for 1 week with normal feed diet and triton-X (Sigma Chemical Co. St. Louis, M.O. USA) at a dose of 400mg/kg in saline suspension from the stock concentration of 535g/ml. The rats were divided into 5 groups of 6 animals each. After seven (7) days, the rats were administered graded doses of the fruit extract. Group I was the control and it was given distilled water only. Groups II, III, IV and V were administered with geometrical doses (25mg/kg, 50mg/kg, 100 mg/kg and 200mg/kg) of the fruit extract intraperitoneally (i.p.) from a stock concentration of 200mg/ml. After 24hrs, 48hrs, and 72hrs, respectively of the effect of the extract on the hyperlipidaemic rats, (adapted from Williamson, *et al.,*1996), two rats from each group were humanely sacrificed and blood was collected from the vena cava 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 include sodium ion (Na^{+}), potassium ion (K^{+}), calcium ion (Ca^{2+}) and phosphates (PO_4^{3-}). They were estimated using standard methods (Chaney and Marbach, 1962; Lorentz, 1982; Seaton and Ali, 1984; Kaplan, 1989;

Tietz, 2006) .

Statistical analysis
Test of significance between control and treatments were carried out by Analysis of Variance (ANOVA) using Graph Pad Software (1998) and student t-test as applicable.

RESULTS

Effect of extract on body weight of rats
The effect of triton-X on mean body weight of albino rats is shown in Table I. The increase in body weight observed in the rats was not statistically significant (P>0.05) when compared with day zero in all the groups except in group 1 where the increase was significant (P<0.05).

Effect of extract on kidney function indices
The results of the various doses of aqueous fruit extract of *S. macrocarpum* on kidney function indices of hyperlipidaemia rats are shown in Tables II and III.
Serum creatinine dose-dependently increased and it was significant (P<0.05) throughout the period of study, whilst urea did not show any change (Table II).
The decrease in serum concentration of K^+ ion was dose-dependent and it was significant (P<0.05) only at 72hours whilst there was no significant change in Na^+ ion, Ca^{2+} ion and PO_4^{3-} ions (P>0.05) throughout the period of study (Table III).

DISCUSSION

The increase in mean body weight of the rats after triton-X administration on the rats in groups after II-IV orally for 7 days was not significant (P>0.05) except for group 1 where the weight increase was significant (P<0.05). This probably implies that triton-X at the dosage employed, 400mg/kg or the length of time given, had a slight effect on inducing hyperlipidaemia in the rats.

The administrations of increasing doses of *S. macrocarpum* fruit extract on hyperlipidaemic rats resulted in no change in sodium (P>0.05), indicating that there was probably a normal Na^+ ion excretion. It has been reported by Odutola (1992) that increased serum Na^+ ion concentration could be an indication of decreased sodium excretion or dehydration. Unlike sodium, the effect of extract on the hyperlipidaemic rats led to a decrease in serum concentration of K^+ ion and this was significant (P<0.05) at 72hrs. According to Odutola (1992), the serum potassium concentration is not a measure of total body potassium because the bulk of K^+ ion resides within the cells. Thus a reduction in K^+ ion in the present study will probably not affect the acid-base balance of the physiological system because the serum potassium only inhibits a small fraction of the total body potassium as occurred for diet-induced hypercholesterolaemic rats (Sodipo *et al.,* 2009b).

The use of the extract on the hyperlipidaemic rats did not lead to changes in Na^+, Ca^{2+} and PO_4^{3-} ions (P>0.05). Calcium ion, apart from its importance in the maintenance of the skeletal structure of the body is involved in coagulation, functioning of the heart, muscles and nerves and permeability of cell membrane (Roberts *et al.,* 2000). Assuming there was hypocalcaemia, this may be due to hypernatremia as the latter is often associated with hypocalcaemia (Fraser *et al.,* 1994; Sood, 2006). Thus, from the results of the experiment, there was no change in both Na^+ and Ca^{2+} ions in the extract-treated hyperlipidaemic rats, indicating that the relationship between Na^+ and Ca^+ ions in serum has not been tampered with.

The use of extract on hyperlipidaemic rats

led to no significant change in phosphate ions (P>0.05) indicating that the bone was not affected since their decreased levels may lead to bone damage (Fraser *et al.,* 1994; Abdulrahman, 2004; Sodipo, 2009). Phosphate is a threshold substance and its loss in the urine is dependent on both its level in the serum and the level of calcium, since if either element is in excess, the other will be excreted (Odutola, 1992). Thus, the fact that in the present study, the level of both calcium and phosphorous (inorganic phosphates), did not change significantly (P>0.05) shows there is a balance in the two ions.

The level of creatinine in the present study increased significantly (P<0.05) with increase in extract dose of the period of study. Elevated levels of creatinine are found in renal dysfunction. Decreased glomerular filtration rate may lead to elevated creatinine, probably suggesting the kidney is damaged. Also, reduced renal blood flow (which can result from shock, dehydration, congestive heart failure) can also lead to increased creatinine levels. Diabetes can also lead to increased creatinine levels or increased muscle activity (Sood, 2006). All these probably suggest kidney dysfunction or stimulation of muscle activity. 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; Sodipo *et al.,*2009b).

CONCLUSION

The aqueous fruit extract of *Solanum macrocarpum* probably led to impaired kidney function as there was an elevated serum creatinine level. The minimal change in phosphate ions indicate the bone is not affected since its decreased level may lead to bone damage. 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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TABLE I: Change in body weight of male albino rats after being administered Triton-X (400 mg/kg) orally for 7 days

Group	Mean Body Weight ± S.D. (g)	
	Days of Treatment	
	0	7
I	114.33 ± 11.76[a]	129.00 ± 9.22[b]
II	98.83 ± 11.55[a]	111.83 ± 11.18[a]
III	140.83 ± 37.57[a]	151.67 ± 36.82[a]
IV	137.33 ± 30.89[a]	147.00 ± 30.44[a]
V	175.33 ± 31.10[a]	194.83 ± 37.12[a]

Within rows, means with the same superscript are not statistically significant ($p > 0.05$) when compared with day 0 using student t-test

0 day = Before triton-X administration

7 days = After oral administration of triton-X

n = 6 rats

TABLE II: Effect of the aqueous fruit extract of *S. macrocarpum* on creatinine and urea of hyperlipidaemic rats administered orally with Triton -X for 7 days

Hours after extract administration	Extract dose (mg/kg)	Creatinine (mol)	Urea (mol)
		Mean ± S.D	
24	Control (distilled water)	45.00 ± 1.47[a]	4.65 ± 0.78[a]
	25.00	48.50 ± 2.12[b]	5.05 ± 0.07[a]
	50.00	49.50± 0.71[b]	5.40± 0.28[a]
	100.00	51.00± 1.41[b]	5.45± 0.07[a]
	200.00	60.50± 3.54[b]	6.15± 0.21[a]
48	Control (distilled water)	59.00± 1.41[a]	5.40± 0.42[a]
	25.00	61.00 ± 4.24[b]	5.55 ± 0.78[a]
	50.00	68.00 ± 2.88[b]	5.85 ± 0.21[a]
	100.00	69.00 ± 1.41[b]	6.00 ± 0.28[a]
	200.00	70.50 ± 3.54[a]	6.00 ± 0.57[a]
72	Control (distilled water)	58.50 ± 0.71[a]	5.05 ± 0.21[a]
	25.00	59.00 ± 1.41[b]	5.80 ± 0.57[a]
	50.00	63.50 ± 5.00[b]	5.80 ± 0.57[a]
	100.00	63.00 ± 2.83[b]	5.85 ± 0.50[a]
	200.00	71.00 ± 1.41[b]	6.05 ± 0.50[a]

Means with different superscripts are statistically significant ($p < 0.05$) among the groups

TABLE III: Effect of the aqueous fruit extract of *S. macrocarpum* on serum ectrolyte function indices of hyperlipidaemic rats administered orally with Triton -X for 7 days

Hours after extract administration	Extract dose (mg/kg)	Serum electrolytes (moles/L)			
		Na^+	K^+	Ca^{2+}	PO_4^{3-}
		Mean ± S.D.			
24	Control (distilled water)	142.00 ± .83[a]	2.05 ± 0.07[a]	2.05 ± 0.07[a]	0.55 ± 0.07[a]
	25.00	141.00± 1.41[a]	1.85 ± 0.21[a]	1.85 ± 0.21[a]	0.75 ± 0.07[a]
	50.00	148.00± 2.83[a]	1.85± 0.21[a]	1.85± 0.21[a]	0.75 ± 0.35[a]
	100.00	138.00± 2.82[a]	1.75± 0.07[a]	1.75± 0.07[a]	0.85 ± 0.35[a]
	200.00	146.00± 5.66[a]	1.75± 0.00[a]	1.75± 0.00[a]	0.95± 0.07[a]
48	Control (distilled water)	141.00± 1.47[a]	2.40± 0.14[a]	2.40 ± 0.14[a]	0.90 ± 0.14[a]
	25.00	142.00± 8.49[a]	2.35± 0.07[a]	2.35± 0.07[a]	1.05± 0.07[a]
	50.00	135.59± 0.71[a]	2.30± 0.07[a]	2.35± 0.07[a]	1.05± 0.21[a]
	100.00	134.00± 8.49[a]	2.30± 0.14[a]	2.30± 0.14[a]	1.05± 0.07[a]
	200.00	133.00± 4.24[a]	2.30± 0.14[a]	2.30± 0.14[a]	1.10± 0.14[a]
72	Control (distilled water)	142.00± 2.83[a]	7.05± 0.07[a]	2.35± 0.21[a]	0.85± 0.07[a]
	25.00	136.00± 0.00[a]	6.10 ± 0.14[b]	2.30± 0.14[a]	0.95± 0.07[a]
	50.00	136.00± 0.00[a]	5.95± 0.07[b]	2.15± 0.07[a]	0.95± 0.07[a]
	100.00	140.00± 0.00[a]	5.90± 0.14[b]	2.10± 0.14[a]	1.05± 0.07[a]
	200.00	137.00± 4.24[a]	5.20± 0.07[b]	2.05± 0.07[a]	1.05± 0.07[a]

Means with different superscripts along a row or column? are statistically significant ($p < 0.05$) among the groups.