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Effects of some edible oils on renal function in rats

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Abstract
This work was done to investigate the effects of palm oil, groundnut oil and coconut oil on kidney function. Biochemical analysis carried out includes the determinations of creatinine, urea, sodium, potassium, alanine aminotransferase (ALT) and aspartate aminotransferase (AST) and alkaline phosphatase (ALP) levels. Measurement of kidney weight, body weight, feed intake, faecal output as well as histological examination were also carried out. Consequently, 32 albino rats were divided into 4 groups of 8 rats each, the control rats were fed rats' chow only while others were given 90% rats' chow supplemented with 10% of palm oil, coconut oil or groundnut oil. They were given these diets along with water for six weeks *ad libitum*. Results showed that body and kidney weight were not significantly altered compared with control. Also urea and sodium levels were not significantly altered although potassium levels were significantly reduced compared with control. Creatinine levels were significantly increased in all the test rats. ALT levels were significantly increased in rats fed groundnut and palm oil based diet while AST levels were significantly increased only in those rats fed coconut oil – based diet. Histological examination shows the presence of chronic inflammatory cells. These results suggest that renal function was compromised when rats were given these oil-based diets.

Keywords: Kidney; Creatinine; Urea; Aminotransferases; Histological analysis

INTRODUCTION

Oils and fats that are used as food are mainly in the form of fatty acid triesters of glycerol (triacylglycerols). Triacylglycerols are important nutrients for several reasons; firstly, they provide a concentrated source of food energy (38kJ/g) more than twice the energy density of protein (17kJ/g) or carbohydrate (16kJ/g). Secondly, they increase the palatability of many foods, in addition, some triacylglycerols are dietary sources of those unsaturated fatty acids that the human body requires but cannot produce by metabolism of other materials (Gurr, 1988). Triacylglycerols are composed of saturated and unsaturated fatty acids. Fats and oils which contain more unsaturated fatty acids are particularly susceptible to oxidation. Intake of food containing oxidized lipid increases the concentration of secondary peroxidation products in tissues (Slater, 1972).

Fats and oils which contain high levels of saturated fatty acids increases blood cholesterol levels and hence the risk of cardiovascular disease incidence (Dupont, *et al.*, 1991). Large amounts of cholesterol partially inhibit endogenous cholesterol

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synthesis but result in net increase of serum cholesterol concentrations because of suppression of the synthesis of low density cholesterol (LDL) receptor. Ahmad *et al.* (2009) studied the effect of beef fat, fish fat and soyabean on the liver, kidney and heart of rat; no significant kidney weight was recorded. Saha *et al.* (2005) performed an experiment to determine the effects of different edible oils on growth performance, different organ weight and serum transaminases in rats; he observed a significant difference among the effects of different edible oils on growth performance. Gaiva *et al.* (2003); Al-Othman (2000) and Rashid *et al.* (1998), carried out various investigations to find out the effects of fish oil and soyabean oil on body weight gain.

Chronic kidney disease (CKD) is a worldwide public health problem and is now recognized as a common condition that is associated with an increased risk of cardiovascular disease incidence (Arora *et al.*, 2006). The cost of treating this condition is enormous, appropriate management should involve a multifactorial approach targeting the control of dyslipidaemia amongst others. Palm oil, groundnut oil and coconut oil are the most commonly used edible oils in most countries of the world especially in the tropics. Hence, the need to assess the effects of these oils on kidney function cannot be overemphasized. This work was done to determine the effects of these oils on kidney weight and other biochemical indices of renal function.

EXPERIMENTAL

Materials/Animals. The rats used for this study were obtained from Ambrose Alli University, Ekpoma, Edo State, Nigeria. The feed used (rats' chow) were products of Edo Feed and Flour Mills, Limited, Ewu, Edo State, Nigeria. Palm oil was obtained from Palm oil Research Company (PRESCO), Edo State. Groundnut oil was purchased from a local market in Suleja, Niger State, Nigeria, while coconut oil from local coconut oil processors in Edo State.

Treatment of animals: Thirty-two (32) albino rats (Wistar strain) were divided into 4 groups of 8 rats each. They were acclimatized for 2 weeks on rats' chow and water only. Group 1 (control) was given 100% rats' chow while the other groups were given 90% rats ' chow supplemented with either palm oil (group 2), coconut oil (group 3) and groundnut oil (group 4). The animals were given these diets for six weeks along with water *ad libitum*. Weekly measurements of weight were recorded. Feed intake and faecal output were estimated daily.

Collection of blood and kidney samples: The rats were subjected to an overnight fast, after which they were anaesthesized and blood collected by cardiac puncture into sterile containers with or without anticoagulant. The kidney was excised, blotted dried, weighed and placed in 10% formalin for histopathological analysis.

Methodology: Biochemical analysis were carried out to determine the concentrations of creatinine, urea, sodium, potassium and the activities of enzymes such as ALT, AST and ALP using diagnostic kits (Quimica Clinica Applicada, S.A). Creatinine was estimated using the modified Jaffe's method (Spierto, 1979). At alkaline pH values, creatinine reacts with picric acid to produce a coloured compound, creatinine alkaline picrate which is photometrically measured. Blood urea nitrogen (BUN) was determined by the modified method of Berthelot-Searcy (Fawcett and Scott, 1960). Urea is hydrolysed by urease to produce ammonium ion, which on addition of salicylate and hypochlorite produces a coloured indophenols derivative. Sodium and potassium levels were determined using the flame photometric method as described by Tietz (1995). ALT and AST activities were determined based on the colorimetric measurement of hydrazone formed with 2, 4 dinitophenylhydrazine (Reitman and Frankel, 1957).

Statistical Analysis. All data were expressed as mean ± SEM. One way analysis of variance was used to test for differences among all the groups. Duncan's multiple range test was used to test for significant differences among the means. A value of $p < 0.05$ was considered statistically significant.

RESULTS

Weight gain did not differ significantly between the test rats and the control. Feed intake was only significantly ($p<0.05$) increased in those rats administered palm oil based diets while faecal output was only significantly reduced in those rats administered coconut oil-based diets compared with control. These results were unaltered in others (Table 1). Kidney size was not significantly altered in all the test rats compared with control (Table 2).

Table 3 shows the effect of these oils on some biochemical indices. Creatinine levels were significantly ($p<0.05$) increased compared with control. Urea levels were not significantly affected. Sodium levels were also not significantly affected but potassium levels were significantly reduced compared with the control. While ALP levels were significantly increased in all the test rats, ALT levels were significantly increased in rats administered palm oil and groundnut oil – based diets while AST levels were significantly increased only in rats given coconut oil-based diet.

Figures 1, 2, 3 and 4 show the microscopic representation of the kidneys of rats administered palm oil, groundnut oil and coconut oil-based diets along with those of control rats. The kidneys of rats fed palm oil, groundnut and coconut oil-based diets showed increased blood flow (congestion) in the veins and thickening of the walls (hypertrophy) of the blood vessels. Mild accumulation of chronic inflammatory cells in the outer region (cortex) of the kidneys was also observed.

DISCUSSION

Work done to investigate the effects of palm, groundnut and coconut oil – based diet on body weight, kidney weight, feed intake, faecal output and some biochemical indices of renal function revealed that there were no significant ($p>0.05$) differences in body weight gain and kidney weight compared with control (Tables 1 and 2). Gaiva *et al.* (2003); Al-Othman (2000) and Rashid *et al.* (1998) on investigating the effects of fish oil and soyabean oil on body and organ weight recorded increased but variable and inconsistent body and organ weight.

Table 1: Effects of palm, groundnut and coconut oil-based diet on body weight gain, feed intake and faecal output.

Diet	Weight gain (g)	Feed Intake (g)	Faecal output (g)
Control	26.0±3.8	128.3±2.6	53.7±2.4
Palm oil	27.9±4.5	142.4±4.2*	58.0±6.5
Groundnut oil	26.7±4.1	130.5±3.6	53.7±3.2
Coconut oil	27.5±4.4	123.1±2.4	45.9±2.8

Results are represented as mean ± SEM (n=8).* significant at $p<0.05$ compared with control.

Table 2: Effects of Palm, groundnut and coconut oil-based diet on organ size

Diet	Kidney weight (g)	
	Right	Left
Control	0.57±0.01	0.57± 0.01
Palm oil	0.55±0.01	0.55±0.00
Groundnut oil	0.60±0.01	0.57±0.01
Coconut oil	0.56±0.01	0.51±0.01

Results are represented as mean ± SEM (n=8).

Table 3: Effects of Palm, groundnut and coconut oil-based diet on some biochemical indices

	Control	Palm oil	Groundnut oil	Coconut oil
Creatinine (µmol/L)	72.49±3.8	111.38±5.7*	116.69±6.2*	121.99±5.5*
Urea (mmol/L)	3.88±0.4	4.22±0.5	3.71±0.5	3.45±0.3
Sodium (mmol/L)	165.3±5.5	160.4±2.8	155.7±2.3	161.3±4.5
Potassium (mmol/L)	10.3±0.4	6.26±0.3*	5.9±0.1*	6.4±0.2*
ALT (µ/L)	18.2±1.2	29.5±3.1*	22.5±2.2*	15.3±1.1
AST (µ/L)	22.0±0.8	27.0±0.5	27.8±1.9	31.8±2.6*
ALP (µ/L)	15.22±2.2	24.16±0.1*	24.4±2.5*	24.7±1.8*

Results are represented as mean ± SEM (n=8).* significant at $p<0.05$ compared with control.

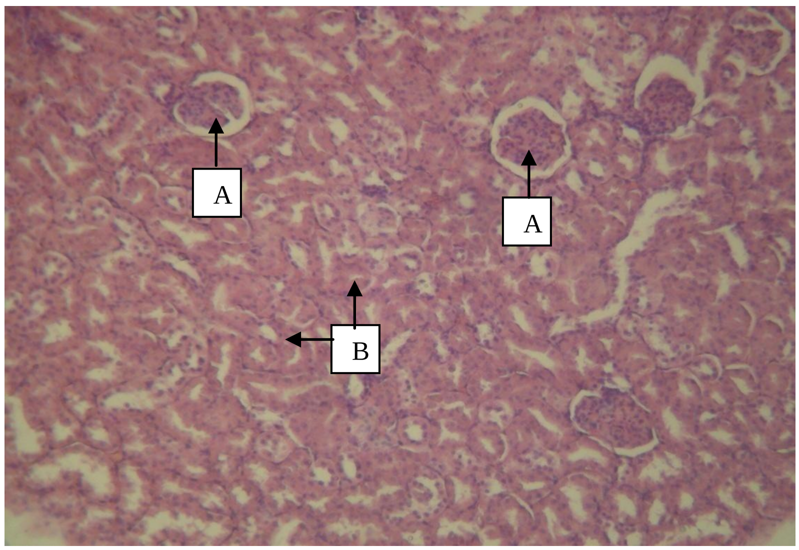

Fig. 1: Microscopic representation of kidney of rats given control diets showing normal kidney with glomeruli (A) and tubules (B). {X4 H & E}.

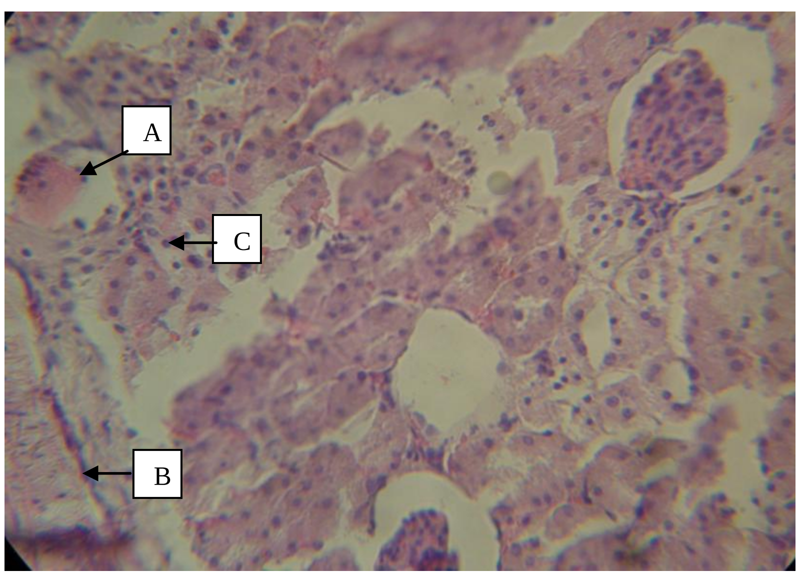

Fig. 2: Microscopic representation of the kidney of rats given palm oil – based diet showing mild congestion (A), vascular hypertrophy (B) and mild infiltrates of chronic inflammatory cells (C). {X 10 H & E}.

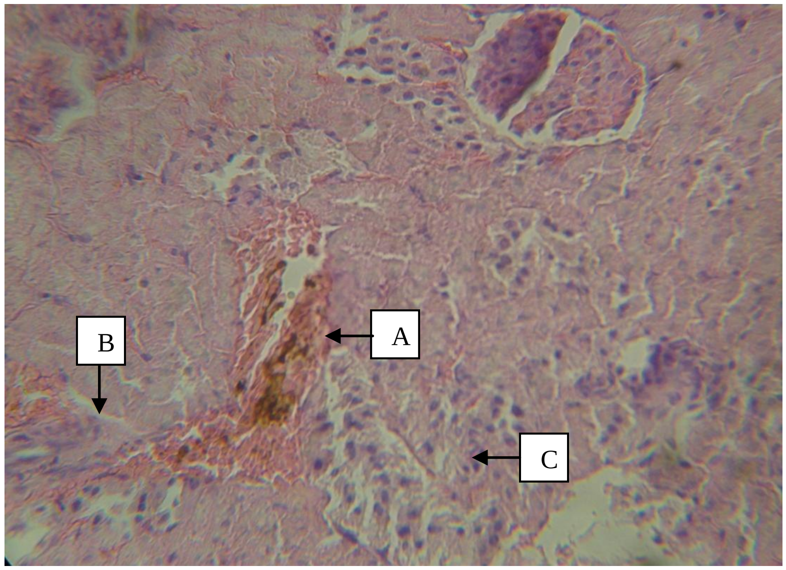

Fig.3: Microscopic representation of the kidney of rats given groundnut oil – based diet showing moderate cortical congestion (A), vascular hypertrophy (B) and mild infiltrates of chronic inflammatory cells (C) {X 10 H&E}.

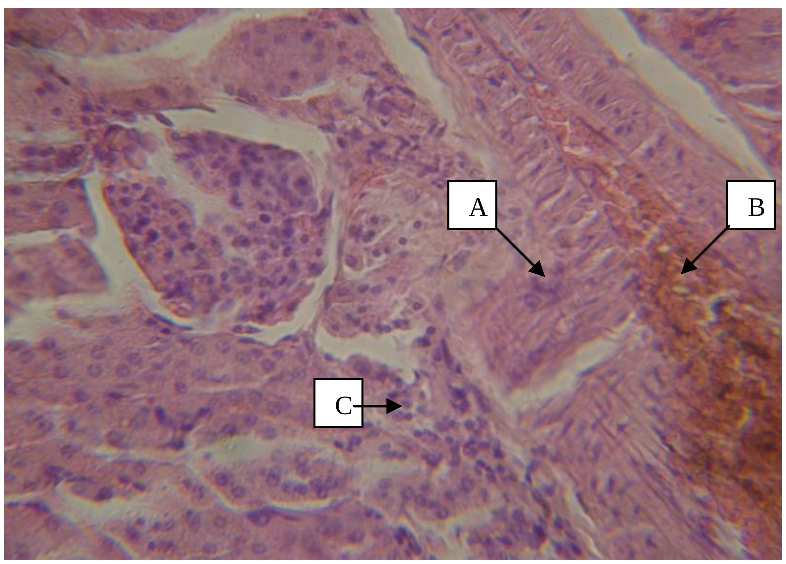

Fig. 4: Microscopic representation of the kidney of rats given coconut oil – based diet showing moderate vascular hypertrophy (A), congestion (B) and mild infiltrates of chronic inflammatory cells (C).{X 10 H & E}.

Ahmad *et al.* (2007) reported no increase in kidney weight when rats were given diets containing beef fat, fish fat and soyabean oil. Increase or decrease in either absolute or relative weight of an organ after administering a chemical or substance is an indication of the toxic effect of that substance (Orisakwe *et al., 2003*). There were no significant ($p>0.05$) increases in urea levels although creatinine levels were significantly increased.

High creatinine levels suggest possible kidney malfunction, this may occur as a result of reduction in glomerular filtration rate (Arora *et al*., 2006). Results of enzyme activity were variable, while coconut oil-based diet increased AST activities significantly compared with the control, palm oil and groundnut oil-based diet did not alter AST levels but increased ALT levels. ALT is found mainly in the liver but smaller amounts may be found in kidneys, heart, muscles and pancreas, high levels of ALT may be indicative of liver damage however slightly high levels may be caused by fatty deposits. AST is more indicative of kidney damage than ALT, however slightly high levels of AST may also be caused by fatty deposits in tissues (Chernecky *et al*., 2004; Pagana *et al*., 2006). Histopathological analysis shows mild infiltrates of chronic inflammatory cells in the kidney of all the test rats. Inflammation is a protective response made by the body; the presence of inflammatory cells may have necessitated the increase observed in the activities of AST and ALT.

Conclusion. The results of this study indicate that 10% palm oil-based, groundnut oil-based and coconut oil-based diets may produce toxic effects on the kidney of rats. This is a preliminary study; further work should be done to ascertain whether decreasing the amount of these edible oils would alter these effects.

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