THE EFFECT OF INTAGASTRICALLY ADMINISTERED SESAME (*SESAMUM INDICUM* L) OIL ON GROWTH RATE AND SOME BIOCHEMICAL PROFILE OF RATS FED A HIGH-FAT DIET.

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ABSTRACT

The effect(s) of sesame (*Sesamum Indicum* L) seed oil on the growth rate, performance and some biochemical parameters in adult albino (Wister) rats maintained on a high fat diet was examined. Adult rats maintained on a high fat diet were intragastrically fed 10mg/ml of sesame seed oil suspended in normal saline, daily for 60 days. Two other groups maintained on the high fat diet only (High fat diet control) and the normal diet (Normal diet control) were included. Water and diet were provided *ad libitum*. The rats were weighed weekly, while feed supply and left-overs were recorded daily. At 60 days, all animals were killed by decapitation. Blood and liver samples were taken for biochemical analyses.

Feeding high fat diet significantly ($P < 0.05$) increased the final body weight, liver and kidney weights of the rats compared to those on normal diet. Administration of sesame seed oil along with high fat diet further increased ($P < 0.05$) the final rat body weight while decrease ($P < 0.05$) was observed in the liver weight and a significant ($P < 0.05$) decrease in the kidney weight was observed compared to the high fat diet fed rats.

Biochemical profile shows significantly ($P < 0.01$) higher levels of plasma proteins and globulins in the normal diet-fed rats compared to the high fat-diet-fed rats. Administration of sesame seed oil along with high fat diet significantly ($P < 0.01$) increased the plasma glucose, total proteins, globulins and uric acid concentrations compared to the high fat diet fed rats. Significantly ($P < 0.01$)

higher glucose and uric acid levels and a significantly ($P < 0.01$) lower globulin levels were observed in the sesame seed oil group compared to the normal diet control group. The plasma albumin concentration did not differ significantly among the groups.

Key Words: Sesame Seed Oil, High fat diet, Albino rats, growth rate, performance, biochemical profiles.

INTRODUCTION

Vegetable oils are extensively consumed in the tropical countries where they serve as important sources of dietary fat. In addition, the oil free meals are exclusively used as rich protein sources in livestock feed. (Shamanthaka *et al.*, 1973). Among vegetable oils widely consumed in the tropics are corn oil, safflower oil, cotton seed oil, sunflower oil, groundnut oil, sesame seed oil and others. (Stroev, 1989; David *et al.*, 1975). Many of these oils have been reported to lower plasma cholesterol and lipid concentrations (Stroev, 1989; Ahrens *et al.*, 1959; Omage *et al.*, 1997).

Sesame seed has been reported to have a special significance as a rich source of sulphur containing amino acids, particularly methionine and lysine while the solvent extracted meal contains more than 60% proteins (Shamanthaka *et al.*, 1973; Johnson *et al.*, 1979). Sesame oil which is rich in unsaturated fatty acids (Elegbede *et al.*, 1992; Cornelius, 1980) was reported to have cholesterol and lipid lowering effects when fed to rats maintained on a high fat diet (Omage *et al.*, 1997). In most studies involving vegetable oils emphasis has always been placed on their ability to influence the cholesterol and lipid levels of animals (Stroev, 1989; Ahrens *et al.*, 1959). It is pertinent to mention that apart

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TABLE 1: COMPOSITION OF THE NORMAL DIET AND THE HIGH FAT DIET.

Ingredient	Diet 1	Diet 2
	Normal Diet	High Fat Diet
	%	%
Maize	56.87	54.87
Soyabean (full fat)	20.98	19.98
Blood meal	10.00	10.00
Cotton Seed Cake	5.00	5.00
Butter	-	6.00
Bone meal	1.50	1.50
Salt	0.50	0.50
Vit. Premix*	0.15	0.15
Calculated Analysis:		
CP	19.5	15.2
Metabolizable Energy ME (Kcal/kg)	2,744	2,906

*Roche VM502 contributed the following per kg. of diet:

Vit. A, 12,000 I.U., Vit. D₃ 1,200 I.U., Vit. E, 3.6 I.U., Vit K, 1.8mg; Vit B₂ 3.6mg; Nicotinate, 18mg;

Calcium-d-Pantothenate, 9.6mg; Biotin, 0.36mg; Vit. B₁₂, 0.12mg; Choline Chloride, 120mg; Chlorotetracycline, 4.8mg;

Manganese, 24mg; Iron, 48mg; Zinc, 96mg; Copper, 60mg; Iodine, 1.8mg; Cobalt, 48mg.

from the cholesterol and lipid profiles, vegetable oils could influence other biochemical parameters within the organism, and this may be equally as important. In due consideration of the foregoing observations, this study evaluated the changes in growth rate, performance, plasma glucose, proteins, albumin and uric acid of rats fed a high fat diet with and without sesame seed oil and normal diet.

MATERIALS AND METHODS

Experimental Design

Fifteen adult male Wister rats (100 - 200g body weight) free from infection, above 8 weeks of age were obtained from the Nigerian Institute for Trypanosomiasis Research, Vom, Nigeria.

The rats were divided into 3 groups of 5 rats each and housed in separate labelled cages. They were acclimatized for 2 weeks when they were fed the normal diet (Table 1). The rats in groups A and B were fed high-fat diet (Table 1) in groups while rats in group C

were continued on normal diet (Table 1). In addition, rats in group A received sesame seed oil suspended in normal saline daily at a dose of 10mg per 100g body weight. Water was provided *ad libitum* to all the rats. Rats in groups B and C served as the high fat diet and normal diet control groups respectively. The rats were weighed weekly. In addition feed supply and left overs were recorded each day in all the groups. The experiment lasted for a period of 60 days and no mortality was recorded in any of the groups.

Sesame seed oil was extracted from sesame (*Sesamum Indicum L*) seed as described by Omage *et al.*, 1997.

Sample Collection

On the 60th day post oil/diet administration, all the animals were weighed and killed by decapitation after an overnight fast. Blood was collected in vials containing EDTA as the anticoagulant while the liver and kidney were quickly removed, blotted and weighed. Plasma was prepared by centrifuging the blood at 2000g for 20 minutes.

GROWTH AND BIOCHEMICAL PROFILE OF RATS INJECTED SESAME SEED OIL
TABLE 2: EFFECT OF SESAME SEED OIL ON BODY, LIVER AND KIDNEY WEIGHTS
OF RATS FED A HIGH FAT DIET.

TREATMENT	Initial body weight (g)	Final body weight (g)	Liver weight (g)	Liver w/ unit body wt. (mg/g)	Kidney weight (g)	Kidney w/ unit body wt. (mg/g)
GROUP A						
High Fat Diet + Sesame Seed Oil (n=5)	184.16 ±11.10	266.06 ^c ±29.08	8.01 ^b ±0.64	30.10 ±2.40	1.62 ^a ±0.13	6.08 ±0.50
GROUP B						
High Fat Diet Control (n=5)	186.00 ±39.55	253.86 ^b ±25.04	9.89 ^c ±1.75	38.95 ±6.88	2.15 ^b ±0.36	8.47 ±1.42
GROUP C						
Normal Diet Control (n=5).	177.52 ±17.90	196.26 ^a ±13.67	6.35 ^a ±0.40	32.36 ±2.02	1.52 ^a ±0.22	7.75 ±1.13

Values are expressed as Mean SD.

a,b, = Values with different superscripts on each row are significantly different ($P < 0.05$).

TABLE 3: PERFORMANCE OF RATS ON THE DIFFERENT TREATMENTS

Treatments	Av. Initial wt. (g)	Av. Final wt. (g)	Av. Daily Feed Intake (g)	Av. Daily wt. Gain	Feed Gain Ratio	Mortality (%)	(SD) SEM
GROUP A							
High Fat Diet	184.16	266.05 ^a	5.95	0.98	6.07	0	0.22
+ Sesame Seed Oil	± 11.10	± 29.08	± 1.15	± 0.49			
GROUP B							
High Fat Diet	186.00	254.86 ^b	5.25	0.81	6.48	0	0.49
Control	± 39.55	± 25.04	± 1.05	± 1.09			
GROUP C							
Normal Diet	177.52	196.26 ^a	4.59	0.69	6.65	0	0.17
Control	± 17.90	± 13.67	± 0.77	± 0.39			

Values are expressed as Mean SD of n = 5.

a,b = Values with different superscripts on each row are significantly ($P < 0.01$) different.

GROWTH AND BIOCHEMICAL PROFILE OF RATS INJECTED SESAME SEED OIL
TABLE 4: EFFECT OF SESAME SEED OIL ON BLOOD AND PLASMA PARAMETERS OF
RATS FED A HIGH FAT DIET.

Treatments	Glucose Concentration (mg/100 ml)	Total Plasma proteins (g/L)	Albumin concentration (g/L)	Globulins concentration (g/L)	Uric acid concentration (mg/100ml) (mg/L)
GROUP A					
High Fat Diet + sesame seed oil (n = 5)	90.15 ^c ± 11.80	80.53 ^c ± 1.68	40.82 ± 2.27	39.71 ^b ± 1.35	93.92 ^b ± 3.43
GROUP B					
High Fat Diet Control (n = 5)	63.22 ^b ± 6.70	75.21 ^a ± 1.31	41.38 ± 1.60	33.83 ^a ± 2.66	43.71 ^a ± 3.22
GROUP C					
Normal Diet Control (n = 5)	55.61 ^a ± 6.90	88.16 ^b ± 1.33	39.72 ± 2.88	49.43 ^c ± 3.02	33.67 ^a ± 2.53

Values are expressed as Mean SD

a,b,c,d = Values with different superscripts on each row are significantly different (P < 0.01).

FIG.1: MEAN BODY WEIGHTS OF RATS AT WEEKLY INTERVALS FOLLOWING OIL ADMINISTRATION. THE RATS WERE GIVEN NORMAL DIET (•), HIGH FAT DIET (○), AND SESAME SEED OIL (×)

Biochemical Analysis

The plasma samples were assayed for total protein and albumin by the Method of Reinhold (1953), glucose by the Method of Asatoor and King (1954), uric acid as described by Stroev and Makarova (1989), and globulins calculated by the difference between total protein and albumin.

Statistical Analysis

The data collected in the experiment were presented as means standard deviations. The means were compared by using the analysis of variance and student's t-test at 95% and 99% level of significance as described by Chatfield (1983).

RESULTS

The High Fat Diet (HFD) caused significant ($P > 0.01$) increases in the final body weight of rats above that caused by the normal diet (Table 2). When sesame seed oil was fed simultaneously with the HFD, it caused further significant ($P < 0.01$) increases in the final body weights. Subsequent animal growth was affected ($P > 0.05$) as indicated by the initial body weights at the time of oil and diet administration and the final body weights upon termination of the experiment (Figure 1, Table 2). There was no difference ($P > 0.05$) in feed

intake, weight gain and feed/gain ratio in all the groups (Table 3). There was also, no influence of the oil treatment on mortality rate.

The liver weights of the high fat diet and sesame seed oil and the high fat diet control groups were significantly ($P < 0.05$) higher than the normal diet control group. A significant ($P < 0.05$) difference was also observed in the mean kidney weights (1.52g & 1.52g) of the high fat diet and sesame seed oil and normal diet control groups respectively compared to the high fat diet control group which was found to be 2.15g (Table 2).

A significant ($P < 0.01$) difference was evident in the glucose, proteins and globulins concentrations in the high fat diet and sesame seed oil group compared to the other groups while the two control groups showed a significantly ($P < 0.01$) lower uric acid concentrations compared to the high fat diet and sesame seed oil group (Table 4). Plasma albumin concentrations in all the groups are similar (Table 4).

DISCUSSION

The growth rate and performance of rats given high fat diet and sesame seed oil (HFDSSO) was comparable to those of the high fat diet (HFD) and Normal diet (ND) control groups throughout the experimental period, (Figure 1) indicating that there was no significant difference in energy intake and utilization among the three groups. These observation agreed with previous reports for sesame seed oil, soyabean oil, corn oil and palm oil (Elegbede *et al.*, 1992; Sylvester *et al.*, 1986 and Sundram *et al.*, 1989). The sesame seed oil used in this study was comparable to that used by Elegbede *et al.*, (1992) in terms of its fatty acid composition. However, the final rat body weights for the two group of high fat diet fed rats were significantly higher than those of the normal diet control group. This may be due to the high fat loading of the diet, which on metabolism, may have led to it's increased deposition in the adipose tissues. Weight gain by the rats in the two high fat diet groups followed a trend similar to that of feed intake, suggesting that the similar trend in feed

intake play a crucial role in the similar pattern of weight gain observed. The feed intake in the two high fat diet fed rats was higher, though not significantly ($P > 0.05$) than those of the normal diet control group and this may probably be due to the increased palatability of the fat enriched high fat diet (Tables 1 and 3).

Feeding high fat diet to rat increased their liver and kidney cholesterol and triglyceride contents (Umar *et al.*, 1994) and this may partly explain the higher liver and kidney weights in the high fat diet fed rats compared to the normal diet control group. The observed differences in the weights of the livers and kidneys in all the groups may also be due to the relative differences in the final rat body weights as indicated by similar organ weight per unit body weights of the animals (Table 2). High fat diet control animals with final body weights close to the oil treated group gave similar liver and kidney weights (Table 2). Data from the present study do not produce evidence for an alteration in specific organ development by the oil. These observation is consistent with the report of Elegbede *et al.*, (1992).

Sesame seed oil treatment significantly ($P < 0.01$) elevated the fasting blood glucose and uric acid concentrations compared to the HFD and ND control groups. In the HFD group, a slight non significant ($P > 0.05$) decrease in glucose concentration was observed compared to the ND group. Administration of sesame seed oil in addition to high fat diet feeding (HFDSSO) significantly ($P < 0.01$) increased the plasma glucose concentration compared to the HFD and ND groups. The reason for the observed increase in plasma glucose concentration by sesame seed oil is not immediately known. It is pertinent to note that blood glucose concentration is usually kept high after an overnight fast through gluconeogenesis by glycerol which comprises about 10 per cent neutral fat (Davidson *et al.*, 1975), where α -Glycerol phosphate serves as accessory link between carbohydrates and lipids and the conversion of glycerol-containing lipids to

carbohydrates and vice versa (Stroevm 1989), acetyl CoA which bridges the gaps between monosaccharides, amino acids and lipids and makes possible the interconversions of these monomers via their intimately inter-related metabolic routes (Stroev, 1989), Cortisol produced by the adrenal gland which increases the formation of liver glycogen from protein and fat (Davidson *et al.*, 1975) or the release of fatty acids by adipose tissue and the shift in the fuel used from glucose to fatty acids by muscle and the liver (Stryer, 1981). These parameters are all influenced by increased dietary lipids. However, whether or not the observed elevated plasma glucose by sesame seed oil is due to any of the factors above remains to be determined.

Uric acid is the ultimate oxidation product of the purine bases and it is derived from endogenous purine metabolism which reflects a steady state in which the rate of purine synthesis and catabolism, measured by the excretion of uric acid are approximately equal (Smith *et al.*, 1985). The significant elevation of the plasma uric acid levels observed in the HFD group compared to the ND group is due to the high fat content of the diet. High fat diets have been reported to increase plasma uric acid and decrease urinary uric acid excretion because keto acids (products of lipid metabolism) are known to reduce the renal excretion of uric acid (MacLachlan and Rodnan, 1967; Davidson *et al.*, 1975). The further significant ($P < 0.01$) increase in plasma uric acid levels observed when sesame seed oil was administered along high fat diet (HFDSSO) compared with the HFD group could probably be due to oil effect since increase in plasma uric acid occurs regardless of the degree of saturation of the fat (Davidson *et al.*, 1975).

High fat feeding significantly ($P < 0.01$) decreased the total plasma proteins in the HFDSSO and HFD groups compared to the ND group. Administration of sesame seed oil to high fat diet fed rats further increased the total protein compared to the HFD group. This effect may be related to the differences in the dietary protein in the normal diet and the

high fat diet (Table 1). In a similar study with garlic oil using a standard diet and a high fat diet which are isonitrogenous, a similar but non significant decreases were observed (Williams *et al.*, 1985). Protein turnover rates in visceral organs of rats was reported (Muramatsu *et al.*, 1963) to increase with increments in dietary protein concentration from 0 to 250 or 400g/kg diet, accompanied by no further increase at high concentrations while Hayase and Yoshida (1980) suggested, in contrast that in the rat liver protein degradation rate was decreased by increasing dietary protein concentration from 50 to 300g/kg. Laurent *et al.*, (1984) also observed in rats that whole-body and muscle protein synthesis was increased as dietary protein was raised from 20 to 200g/kg diet with no further increases at higher concentrations. The mechanism involved in the further elevation in total proteins observed upon administration of sesame seed oil is not clear. Sesame seed is a rich source of sulphur containing amino acids and the solvent extracted meal contains more than 60% proteins (Johnson *et al.*, 1979; Shamanthaka *et al.*, 1973). No differences in albumin concentration was observed in the three groups. The observed differences in the globulin concentrations is related to the differences in the total plasma protein concentrations in the three groups.

From the information on the hypocholesterolemic and hypolipidemic effects of sesame seed oil (Omage *et al.*, 1997) and the continued search for medication, nutrient or procedure that will reduce the level of any of the risk factors of coronary disease (Kritchevsky, 1991), this study reports other additional benefits of sesame seed oil in regulating growth rate, performance and other biochemical parameters associated with feeding on high fat diet.

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