

Full Length Research Paper

Effects of *Persea americana* leaf extracts on body weight and liver lipids in rats fed hyperlipidaemic diet

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The effects of aqueous and methanolic leaf extracts of *Persea americana* on body weight and liver lipids in rats were studied. Male albino rats were fed a modified diet containing 0.5% cholesterol and 0.25% cholic acid to provoke hyperlipidaemia. The hyperlipidaemic rats were given 10 mg/kg body weight of either aqueous or methanolic extract of *P. americana* leaf daily for 8 weeks. There were no significant differences ($p > 0.05$) in the overall body weight gain of the hyperlipidaemic rats compared to normal control. However, the administration of the aqueous and methanolic extracts provoked 14 and 25% reduction, respectively, in the body weight gain of the treated rats compared to the hyperlipidaemic control. Mean liver weights were markedly increased ($p < 0.05$) in rats fed hyperlipidaemic diet (groups B, C and D: 70, 69 and 57%, respectively) compared to normal control rats. The methanolic extract provoked a minimal (8%) decrease in mean liver weight compared to the hyperlipidaemic control rats. It can be hypothesized that *P. americana* leaf extracts increase catabolism of lipids accumulated in adipose tissue causing a decrease in body weight but does not influence liver lipid levels in rats.

Key words: *Persea Americana*, body weight gain, hyperlipidaemia, leaf extracts, albino rats.

INTRODUCTION

Lifestyle changes accompanying industrialization have a significant impact on the health of the people. The modernization of societies appears to result in a dietary pattern that is high in saturated fats and refined sugars and is low in fibre content. Analyses of available aggregate data sources indicate that a shift towards "western diets" high in saturated fat and sugar and low in fibre is occurring (Reddy and Yusuf, 1998; Popkin, 2002). In Nigeria, there appears to be a cultural transition towards a more westernized lifestyle. The traditional foods consisting mainly of roots, cereals, beans, tubers and vegetables are giving way to fatty foods, sweet snacks and drinks which have too much calories. These changes in dietary pattern among Nigerians, coupled with

changes in physical activity patterns, increased use of tobacco products and alcohol are possible causes of hyperlipidaemia and obesity which are becoming important factors in the pathogenesis of chronic degenerative diseases such as cardiovascular disease, diabetes and cancer.

It has been postulated that in many individuals excess weight gives rise to cardiovascular disease, type 2 diabetes mellitus, hypertension, stroke, dyslipidaemia, osteoarthritis, and some cancers (Eckel et al., 2006; Burton et al., 1985; Ezzati et al., 2005). It is also known that fatty liver disease is associated with hyperlipidaemia and obesity (Sharadi and Eldad, 2000). Plants were the major source of materials which the ancient man resorted to for combating various ailments and thus preserving his health (Akah and Ekekwe, 1995). At present, a number of botanicals are still being used in folk-medicine for treatment of different diseases.

Persea americana (avocado or alligator pear) is an almost evergreen tree belonging to the laurel family,

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Table 1. Mean weekly body weights of rats fed with extracts of *P. americana*.

Week	A	B	C	D
0	65.95 ± 3.46	65.88 ± 11.23	93.13 ± 9.62	87.37 ± 11.01
1	69.52 ± 7.80 ^a	77.95 ± 13.89 ^b	101.99 ± 12.30 ^b	95.64 ± 9.18 ^b
2	81.45 ± 6.93	85.12 ± 14.61	114.16 ± 14.24	108.10 ± 10.40
3	90.13 ± 8.64 ^a	94.20 ± 17.34 ^a	117.62 ± 15.12 ^b	111.41 ± 10.4 ^b
4	107.58 ± 9.59 ^a	97.19 ± 15.52 ^b	124.20 ± 16.19 ^b	112.89 ± 25.82 ^b
5	123.82 ± 9.46	115.24 ± 17.21	134.92 ± 19.99	124.45 ± 27.44
6	135.83 ± 6.84	125.27 ± 19.60	152.86 ± 24.72	141.53 ± 29.88
7	141.31 ± 7.37	135.60 ± 16.54	160.18 ± 24.65	150.55 ± 30.11
8	154.13 ± 9.50 ^a	152.59 ± 20.80 ^a	167.56 ± 25.74 ^b	152.35 ± 29.93 ^b

Values are expressed as means ± SD for six rats.

Values not sharing a common superscript letter differ significantly at $p < 0.05$.

Group A, rats fed standard chow; Group B, rats fed modified diet; Group C, rats fed modified diet + 10 mg/kg body weight of aqueous extract of *P. americana*; Group D, rats fed modified diet + 10 mg/kg body weight methanolic extract of *P. americana*.

Lauraceae. It is indigenous to Central and South America but is now cultivated in the United States, Asia, parts of Europe and tropical Africa. The leaves are alternate, dark green and glossy on the upper surface, whitish on the underside; variable in shape (lanceolate, elliptic, oval, ovate or obovate) 7.5 – 40 cm long (Morton, 1987). According to Morton (1987), avocado has many medicinal uses. The leaves are chewed as a remedy for pyorrhea. The aqueous extract of the leaves has a prolonged antihypertensive effect. The leaf decoction is taken as a remedy for diarrhea, sore throat and haemorrhage. It allegedly stimulates and regulates menstruation. Recently, the aqueous leaf extract of *P. Americana* was reported to possess hypoglycemic activity (Antia et al., 2005). The purpose of this study was to test whether the leaf extract of *P. americana* would influence body weight gain and liver lipid levels in a rat model.

MATERIALS AND METHODS

Preparation of plant extracts

Fresh leaves of *P. americana* were obtained from a cultivated plant in Lagos. The leaves were air-dried and pulverized in a Waring blender and the aqueous and methanolic extracts prepared by means of Soxhlet extraction. The extracts were evaporated to dryness in an oven at 40°C and stored in clean sterile vials until required.

Animal feeding

Albino rats were divided into four feeding groups (A, B, C and D) of six rats per group. Group A was fed standard rat chow and water. Groups B to D were fed a modified diet containing 20% groundnut oil, 0.5% cholesterol and 0.25% cholic acid to provoke hyperlipidaemia. In addition, groups C and D rats were orally treated with aqueous and methanolic extracts of *P. americana* respectively at a daily dose of 10 mg/kg body weight. Rats in group

B acted as hyperlipidaemic control and received water orally. The animals were observed daily and weighed weekly for 2 months.

At the end of the feeding period, the animals were sacrificed under pentobarbital anaesthesia (100 mg/kg body weight). The livers, hearts, brains, kidneys and lungs were quickly excised and perfused with chilled 1.15% (w/v) KCl solution in order to remove all traces of contaminating haemoglobin. The tissues were blotted dry, weighed and stored at -80°C pending analysis.

Determination of liver lipids

Liver lipids were extracted according to the method of Folch et al. (1957). Liver total cholesterol (T-CHOL), high-density lipoproteins (HDL-CHOL), low-density lipoproteins (LDL-CHOL), and triacylglycerols (TAG) were measured using appropriate kits supplied by RANDOX Laboratories Ltd., Crumlin, United Kingdom.

Statistical analysis

Data, expressed as mean ± S.D, were analyzed by analysis of variance (ANOVA). Statistical significance of the difference of the means was evaluated by Student's t-test. Differences were considered statistically significant if the p value was < 0.05 .

RESULTS

Table 1 shows the mean weekly body weights of rats in the four experimental groups. In the first week, body weight increase was significantly higher ($p < 0.05$) in the hyperlipidaemic rats compared to normal control. Also, there were significant differences ($p < 0.05$) in body weight increase in the 3rd, 4th and 8th weeks among the various groups. Body weight increase in the second week was least in hyperlipidaemic control rats. However, in the 3rd and 8th weeks body weight increase was significantly lower ($p < 0.05$) in the treated groups compared to the normal and hyperlipidaemic control rats.

However, there were no significant differences ($p > 0.05$) in the overall body weight gain and the overall weight

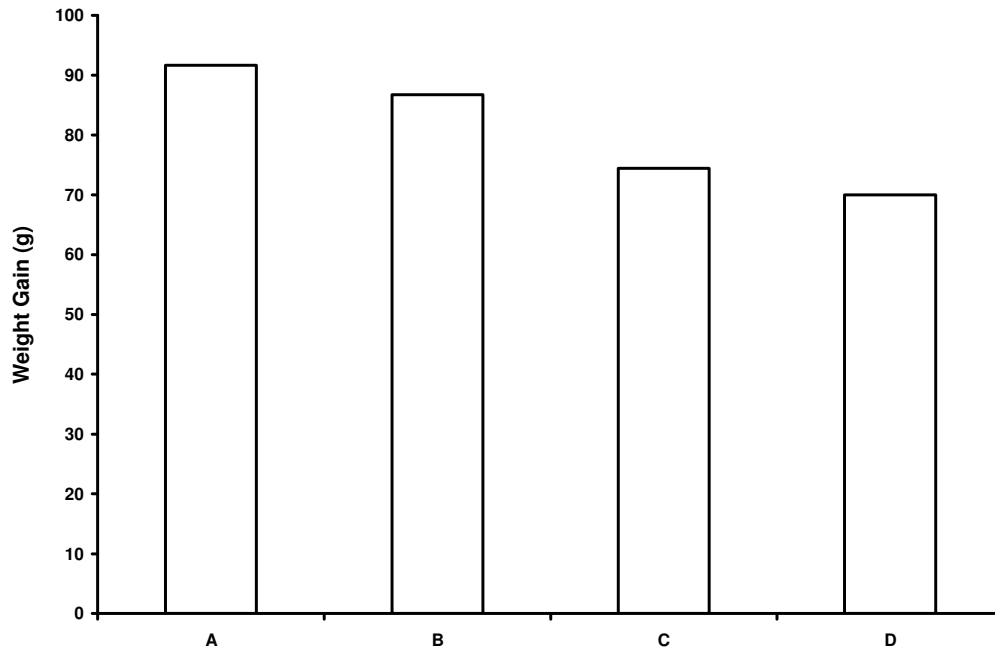


Figure 1. Mean overall body weight gain in rats fed with extracts of *P. americana*. Values are means \pm SD (n = 6). Group A =fed standard rat chow; Group B =fed modified diet; Group C =fed modified diet + 10 mg/kg body weight aqueous extract of *P. americana*; Group D = fed modified diet + 10 mg/kg body weight of methanolic extract of *P. americana*.

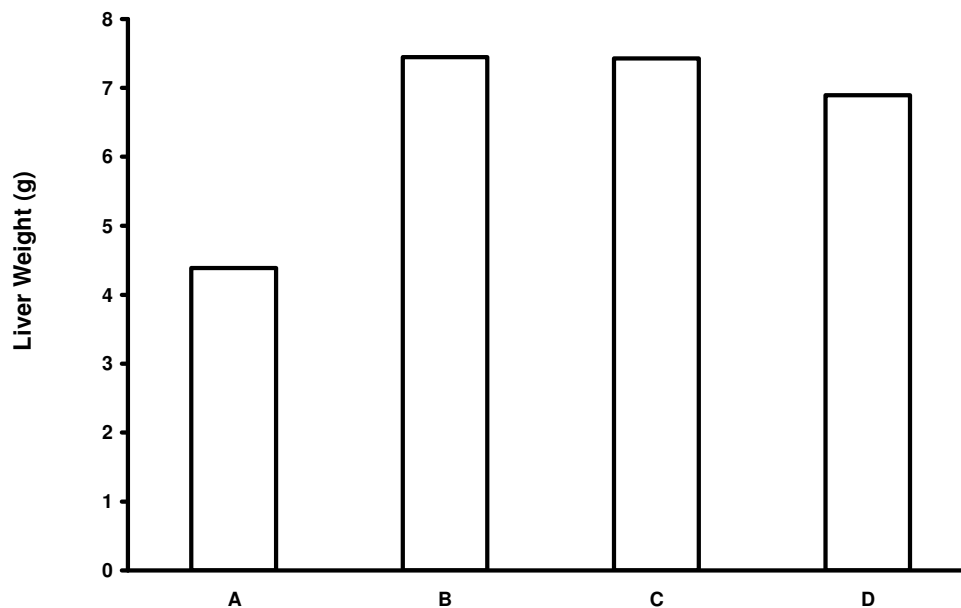


Figure 2. Mean liver weights in rats fed with extracts of *P. americana*. Values are means \pm SD (n = 6). Group A =fed standard rat chow; Group B =fed modified diet; Group C =fed modified diet + 10 mg/kg body weight aqueous extract of *P. americana*; Group D = fed modified diet + 10 mg/kg body weight of methanolic extract of *P. americana*.

gain per cent for groups A, B, C and D were 133.71, 131.62, 79.92 and 74.37, respectively. However rats treated with both aqueous and methanolic *P. americana* leaf extracts showed decrease in overall body weight

gain (14 and 25%, respectively) compared to the hyperlipidaemic control (Figure 1).

Figure 2 shows the mean liver weights of rats in all the groups. Liver weight was markedly increased ($p < 0.05$) in

Table 2. Mean weight of organs of rats fed with extracts of *P. americana*.

Organ	A	B	C	D
Kidney	0.93 ± 0.13	0.88 ± 0.09	0.83 ± 0.10	0.80 ± 0.14
Lungs	0.702 ± 0.07	0.72 ± 0.12	0.87 ± 0.11	0.90 ± 0.22
Heart	0.53 ± 0.14	0.53 ± 0.07	0.55 ± 0.07	0.55 ± 0.12
Brain	1.40 ± 0.12	1.42 ± 0.12	1.60 ± 0.08	1.57 ± 0.04

Values are expressed as means ± SD for six rats.

Group A, rats fed standard chow; Group B, rats fed modified diet; Group C, rats fed modified diet + 10 mg/kg body weight of aqueous extract of *P. americana*; Group D, rats fed modified diet + 10 mg/kg body weight methanolic extract of *P. americana*.

Table 3. Liver lipid profile (mg/dl) of rats fed with extracts of *P. americana*.

Lipid	A	B	C	D
T-CHOL	47.53 ± 8.56 ^a	599.53 ± 97.97 ^b	616.43 ± 56.81 ^b	610.30 ± 39.47 ^b
LDL-CHOL	35.15 ± 11.01 ^a	415.36 ± 136.62 ^b	415.54 ± 48.76 ^b	416.28 ± 8.10 ^b
HDL-CHOL	5.11 ± 2.11 ^a	11.67 ± 3.73 ^b	9.68 ± 5.71 ^b	12.41 ± 3.93 ^b
TAG	36.73 ± 10.05 ^a	862.50 ± 207.43 ^b	956.03 ± 280.68 ^b	908.02 ± 192.48 ^b

Values are expressed as means ± SD for six rats.

Values not sharing a common superscript letter differ significantly at $p < 0.05$

Group A, rats fed standard chow; Group B, rats fed modified diet; Group C, rats fed modified diet + 10 mg/kg body weight of aqueous extract of *P. americana*; Group D, rats fed modified diet + 10 mg/kg body weight methanolic extract of *P. americana*

rats fed the hyperlipidaemic diet (groups B, C and D: 70, 69 and 57%, respectively) compared to normal control rats. Other organs did not show any significant difference ($p > 0.05$) in weight although brain weight was higher in rats treated with *P. americana* leaf extracts compared to normal and hyperlipidaemic control (Table 2). The liver lipid profile of the rats in the four experimental groups is shown in Table 3. Liver T-CHOL, LDL-CHOL and TAG were significantly raised ($p < 0.05$) in rats fed hyperlipidaemic diet compared to normal control.

DISCUSSION

Throughout the period of experiment there was no significant difference in food consumption in all groups (data not shown). The body weights of rats in each group were determined weekly as a general index of overall health. Based on body weight, each group of rats tolerated the treatment diet when compared with rats fed standard chow. It is evident from our study that the administration of aqueous and methanolic leaf extracts of *P. americana* provoked a reduction in body weight gain compared to the hyperlipidaemic control. It could be that *P. americana* leaf extracts increase the catabolism of lipids accumulated in adipose tissue resulting in a decrease in mean body weight.

Liver weights were significantly increased by the intake of hyperlipidaemic diet as compared to normal control rats, and it was accompanied by significant increase in liver cholesterol level. This result is in agreement with previous report that liver weights were significantly enhanced by intake of hyperlipidaemic diet containing 1%

cholesterol, 0.5% cholic acid and 25% coconut oil (Zulet et al., 1999). It was observed that the excised livers of rats fed hyperlipidaemic diet were golden yellow in colour. This is similar to the findings that treatment with poloxamer-407 to induce hypercholesterolemia result in the development of golden yellow livers in C57BL/6 mice (Palmer et al., 1998; Johnston et al., 1999).

There was a 13-fold increase in hepatic cholesterol concentrations in the hyperlipidaemic rats compared to control. A 2-fold increase in hepatic cholesterol had previously been reported in rats relative to control when both were fed a high-fat atherogenic diet containing cholic acid (Shefer et al., 1992). Also, feeding diets supplemented with cholesterol and cholic acid markedly increased liver weights (two-fold), hepatic triglycerides (3.7 fold) and cholesterol (12 fold) concentrations in geese (Eder, 1999). Inclusion of saturated fatty acids in the diet has been shown to produce hypercholesterolemic effect in rats (Lutz et al., 1994; Zulet et al., 1999). The groundnut oil included in the hyperlipidaemic diet in this study contained 17% saturated fatty acids and this could account for the difference in increase in the accumulation of cholesterol in the liver in this study. It is possible that the normal catabolism of liver lipids was impaired in the rats fed hyperlipidaemic diet with consequent accumulation of lipids in the liver. The hepatic cholesterol concentrations in the treated rats and the hyperlipidaemic control were similar suggesting that both aqueous and methanolic leaf extracts of *P. americana* at a concentration of 10 mg/kg body weight used in this study could not exert antihyperlipidaemic effect in the liver.

In conclusion, it can be hypothesized that *P. americana* leaf extract increases catabolism of lipids accumulated in adipose tissue causing a decrease in mean body weight gain. However, it might be necessary to determine whether higher concentrations of *P. americana* leaf extract would reduce liver lipid levels in obesity and fatty liver conditions.

REFERENCES

- Akah PA, Ekekwe RK (1995). Ethnopharmacology of some Asteraceae family used in Nigerian traditional medicine. *Fitoterapia* 66:351-356.
- Antia BS, Okokon JE, Okon PA (2005). Hypoglycemic activity of aqueous leaf extract of *Persea americana* Mill. *Indian J. Pharmacol.* 37: 325-326.
- Burton BT, Foster WR, Hirsch J, Vanltallie TB (1985). Health implications of obesity: NIH consensus development conference. *Int. J. Obes. Relat. Metab. Disord.* 9: 155-169.
- Eckel RH, Kahn R, Robertson RM, Rizza RA (2006). Preventing cardiovascular disease and diabetes: A call to action from the American diabetes Association and American Heart Association. *Diabetes Care* 29: 1697-1699.
- Eder K (1999). The effect of a combined dietary treatment with cholesterol and cholic acid on the lipid metabolism of geese at low or high choline concentrations. *Arch. Tierernahr.* 52: 285-297.
- Ezzati M, Vander Hoorn S, Lawes CMM, Leach R, James WPT, Lopez AD, Rodgers A, Murray CJL (2005). Rethinking the “diseases of affluence” paradigm: Global patterns of nutritional risks in relation to economic development. *PLoS Med.* e133 doi:10.1371/journal.pmed.0020133.
- Folch J, Lees M, Sloane–Stanley GH (1957). A simple method for the isolation and purification of total lipids from animal tissues. *J. Biol. Chem.* 226: 497–590.
- Johnston TP, Baker JC, Jamal AS, Hall D, Emeson EE, Palmer WK (1999). Potential down regulation of HMG-CoA reductase after prolonged administration of P-407 in C57BL/6 mice. *J. Cardiovasc. Pharmacol.* 34: 831-842.
- Lutz M, Cortez J, Vinet R (1994). Dietary fats and cholesterol supplementation effects on aortic and lipid response in rats. *J. Nutr. Biochem.* 5:446-450.
- Morton J (1987). Avocado. In: *Fruits of warm climates*.ed. Julia F. Morton, Miami FL. 91–102.
- Palmer WK, Emeson EE, Johnston TP (1998). Poloxamer 407-induced atherogenesis in the C57BL/6 mouse. *Atherosclerosis* 136:115-123.
- Popkin BM (2002). An overview on the nutrition transition and its health implications: The Bellagio Meeting. *Public Health Nutr.* 5:93–103.
- Reddy KS, Yusuf S (1998). Emerging epidemic of cardiovascular disease in developing countries. *Circulation* 97:596–601.
- Sharadi Y, Eldad A (2000). Non-alcoholic fatty liver disease is associated with hyperlipidaemia and obesity. *Am. J. Med.* 109: 171
- Shefer S, Nguyen LB, Salen G, Ness GC, Chowdhary IR, Lerner S, Batta AK, Tint GS (1992). Differing effects of cholesterol and taurocholate on steady state HMG-CoA reductase and cholesterol 7 α -hydroxylase activities and mRNA levels in the rat. *J. Lipid Res.* 33:1193–1200.
- Zulet MA, Barber A, Garcin H, Higuere P, Martinez JA (1999). Alteration in carbohydrate and lipid metabolism induced by a diet rich in coconut oil and cholesterol in a rat model. *J. Am. Coll. Nutr.* 18:36–42.