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Alteration In Serum Lipid Profile Following Chronic Consumption Of Thermally – Oxidized Palm Oil And Groundnut Oil – Modified Diets In Rats.

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ABSTRACT

Thermally oxidized palm oil and groundnut oil are widely consumed in Nigeria today, and the world at large. Considering the modification of the normal constitutents of the oils by heat when overfried, this study seeks to study the effects of thermally oxidized groundnut oil (TGO) and thermally oxidized palm oil (TPO) on serum lipid profile which is an indicator of cardiovascular health. Eighteen male albino rats weighing 160 – 200 g were used for this study. The animals were randomly assigned into 3 groups (n = 6) thus; control, TGO and TPO treated groups. Control animals received normal rat chow and water *ad libitum.* Animals in TGO treated group received normal feed mixed with thermally oxidized groundnut oil in the ratio 85:15g respectively. Animals in TPO treated group also received a mixture of normal feed and thermally oxidized palm oil in the ratio 85:15g respectively. The feeding lasted for 28 days, after which the animals were sacrificed and blood samples collected for serum lipid profile analysis. Results showed that serum total cholesterol (TC), triglyceride (TG), high density lipoprotein (HDL-c) and very low density lipoprotein (VLDL-c) concentrations were significantly ($p<0.001$) reduced in TGO and TPO groups, compared with control. Also, HDL-c concentration was significantly ($p<0.05$) lower in TPO treated group compared with TGO treated group. Serum LDL-c concentration on the other hand was significantly ($p<0.001$) higher in TGO and TPO treated groups, compared with control. It was also significantly ($p<0.05$) higher in TPO treated group compared with TGO treated group. Considering the higher level of LDL-c and lower level of HDL-c in TPO treated group compared with TGO treated group, we therefore conclude that consumption of TPO poses a greater risk of developing cardiovascular disease than TGO, although both thermally oxidized oils pose a risk of developing cardiovascular disorders.

Keywords: Cholesterol, groundnut oil, lipid profile, peanut oil, thermoxidized palm oil.

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INTRODUCTION

Palm oil and groundnut oil are both consumed by most house holds in Nigeria and the world at large. Palm oil is an edible plant oil derived from the fruits of palm tree. It is extracted from the pulp of the fruit of the oil palm.[1] Palm oil is one of the most widely used cooking oils in Africa. It is composed of saturated and unsaturated fatty acids in almost equal proportions [1]. Fresh palm oil is also known to contain high amount of tocopherols and tocotrienols which have antioxidant effects [2]. In heating palm oil during its production, care is taken to ensure the nutrients (carotenes – vitamin A precusor, vitamin E and the antioxidants) are not lost to excessive heat.

Groundnut oil, also called peanut oil is a mild tasting vegetable oil derived from peanuts. It is widely used across Africa and in most nations of the world. Groundnut oil has a high smoke point relative to other cooking oils, hence it is the most prefered in frying [2].

In the course of frying foods with either palm oil or groundnut oil, the oils become thermally oxidized and lose their anti – oxidant properties. This makes the oxidized oils detrimental to health. Thermally oxidized oils have been shown to adversely affect health [3-8]. This study therefore seeks to ascertain the effect of chronic consumption of these thermoxidized forms of groundnut oil and palm oil on lipid profile, which gives an insight on whether or not cardiovascular disorder will likely result or not.

MATERIALS AND METHODS

Experimental animals and protocol:

Eighteen (18) male albino Wistar rats weighing 160 – 200 g were purchased from the Department of Pharmacology, College of Medical Sciences, University of Calabar, Nigeria. Each animal was placed in a separate metabolic cage, to allow measurement of food and water intake of individual animals. They were allowed to acclimatize for 7 days and exposed to normal temperature and 12/12 hours light/dark cycle. All animals had unrestricted access to rat feed and water. At the end of 7 days of acclimatization, the animals were randomly divided into 3 groups (n = 6) as follows;

- Group 1 – Control
- Group 2 – Thermally oxidized ground nut oil fed group (TGO)
- Group 3 – Thermally oxidized palm oil treated group (TPO)

Feed formulation

Ground nut oil and palm oil were both purchased from Marian market, in Calabar, Cross River State, Nigeria. Both oils were separately heated until they decolourized. After thermally oxidizing the oils, they were allowed to cool off before using them to formulate the diets for groups 2 and 3. Thermally oxidized ground nut oil – modified diet was formulated by mixing normal rat feed with thermoxidized ground nut oil in the ratio 85:15 grams respectively. This was given to group 2 animals (TGO treated group). Also, thermally oxidized palm oil – modified diet was formulated by mixing normal rat feed with thermoxidized palm oil in the ratio 85:15 grams respectively. This was given to group 3 animals (TPO treated group). The feeding was done for 28 days. Food intake, water intake and weight change were measured daily using the method described by Okon *et al* [9].

Sample collection

At the end of 28 days of feeding, the animals were sacrificed under chloroform anaesthesia. Blood samples were then collected via cardiac puncture using a 5 ml syringe and needle. Blood samples were introduced into plain labelled sample bottles and centrifuged at 3000 rpm for 10 minutes to separate and collect serum for lipid profile estimation.

Serum lipid profile estimation

Total cholesterol (TC) concentration was determined by the enzymatic colorimetric test kit method of Sieldel *et al*., [10]. Serum triglyceride (TG) concentration in the samples was measured by method of Negele *et al*., [11]. High density lipoprotein cholesterol (HDL-c) was determined by method of Siedel *et al*., [10] for total – cholesterol estimation, while VLDL-c concentration was obtained by dividing the serum TG concentration by 2.2, thus:

$$\text{VLDL-c (mg/dl)} = \frac{\text{Triglyceride (TG)}}{2.2}$$

Low density lipoprotein cholesterol (LDL-c) was measured by the Friedewald's[12] relationship. LDL-cholesterol was obtained by subtracting HDL-c and VLDL-c from TC as shown below;

$$\text{LDL-c} = \text{TC} - (\text{HDL-c} + \text{VLDL-c})$$

Statistical analysis

Results are presented as mean ± SEM. One way analysis of variance (ANOVA) was employed to analyse the data, followed by the least square difference procedure (LSD). A difference was said to be statistically significant at $p<0.05$. Statistical software, SPSS version 17.0 and Microsoft excel (2010 version) were used for data analysis.

RESULTS

Comparison of water intake in the different experimental groups

The mean water intake for control, TGO and TPO treated group was 23.82 ± 0.41, 18.27 ± 0.37 and 15.58 ± 0.38ml, respectively. Mean daily water intake was significantly ($p<0.001$) lower in TGO and TPO treated group, compared with control. Mean daily water intake was also significantly ($p<0.001$) reduced in TPO treated group, compared with TGO treated group (Figure 1).

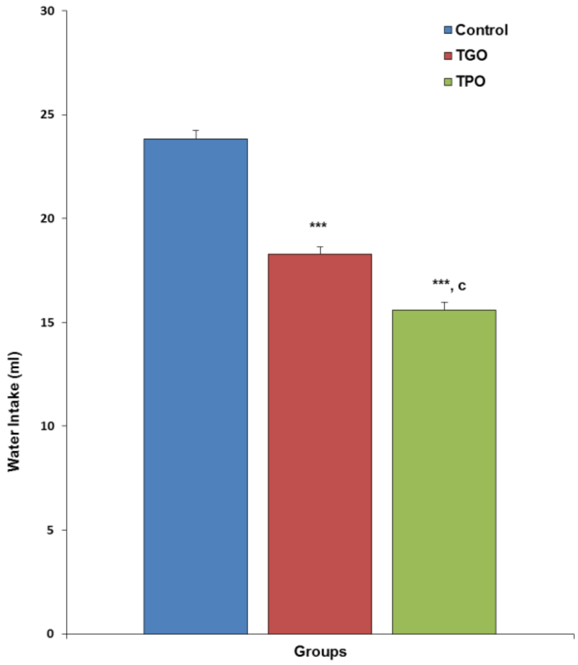

Figure 1: Comparison of mean water intake of the different experimental groups. Values are mean ± SEM, n = 6. ***p<0.001 vs Control; c = p<0.001 vs TGO.

Comparison of food intake in the different experimental groups

The mean food intake for control, TGO and TPO treated group was 20.37 ± 0.44, 19.46 ± 0.38 and 20.21 ± 0.31g, respectively. There was no significant difference in mean daily food intake in the different experimental groups (Figure 2).

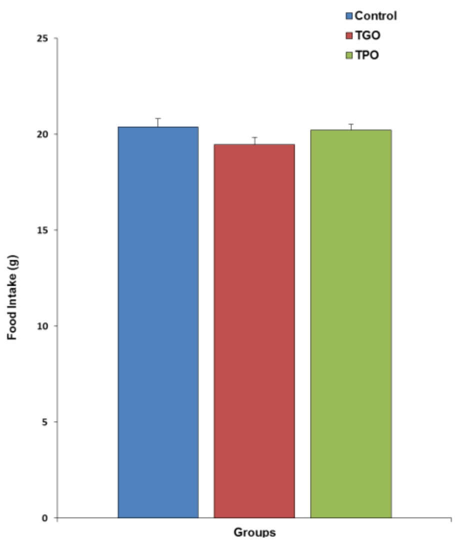

Figure 2: Comparison of mean food intake of the different experimental groups.
Values are mean ± SEM, n = 6.

Comparison of body weight change in the different experimental groups:

The mean body weight change was 40.0 ± 5.16, 35.0 ± 10.25 and 25.0 ± 4.28g for control, TGO and TPO treated group, respectively. Body weight change was significantly ($p<0.05$) lower in TPO treated group, compared with control, (Figure 3).

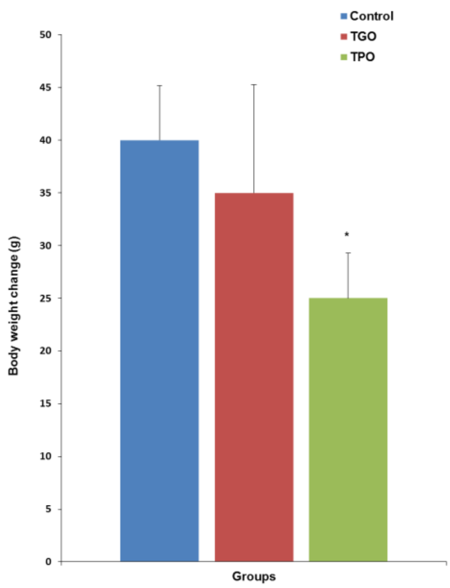

Figure 3: Comparison of body weight change of the different experimental groups.
Values are mean ± SEM, n = 6. *p<0.05 vs Control.

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Comparison of total cholesterol concentration in the different experimental groups:

Serum total cholesterol concentration was 0.6 ± 0.03, 0.36 ± 0.01 and 0.47 ± 0.01 mmol/L for control, TGO and TPO treated group, respectively. Serum total cholesterol concentration was significantly (p<0.001) lower in TGO and TPO treated groups, compared with control. It was also significantly (p<0.001) lower in TGO treated group, compared with TPO treated group, (Figure 4).

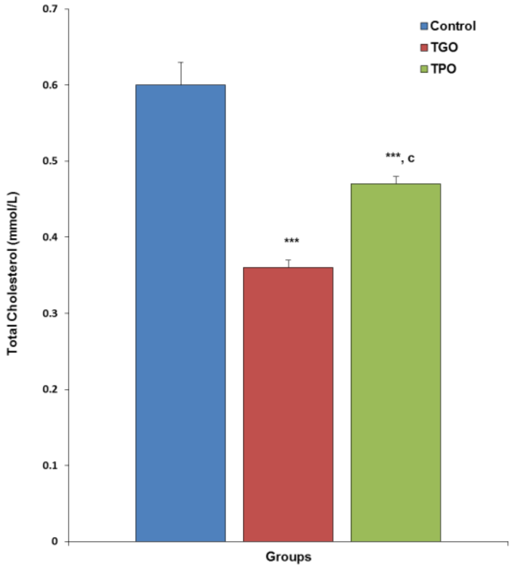

Figure 4: Comparison of total cholesterol concentration of the different experimental groups. Values are mean ± SEM, n = 6. ***p<0.001 vs Control; c = p<0.001 vs TGO.

Comparison of triglyceride concentration in the different experimental groups:

Serum triglyceride concentration was 0.28 ± 0.01, 0.16 ± 0.01 and 0.18 ± 0.01 mmol/L, for control, TGO and TPO treated group, respectively. Serum triglyceride concentration was significantly (p<0.001) lower in TGO and TPO treated groups, compared with control, (Figure 5).

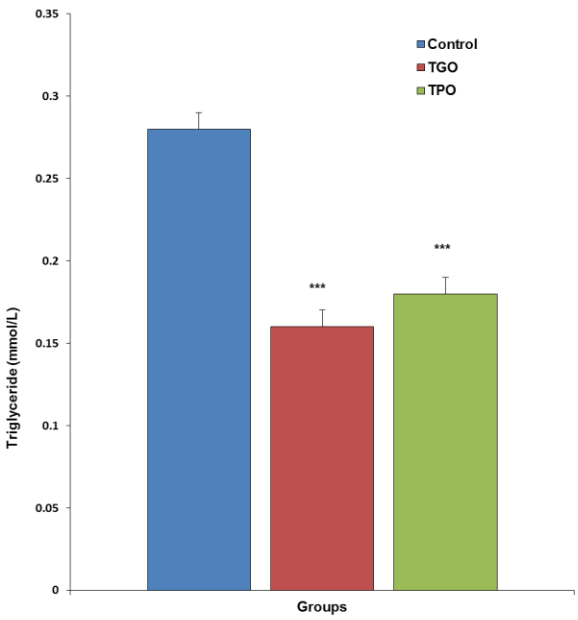

Figure 5: Comparison of triglyceride concentration of the different experimental groups. Values are mean ± SEM, n = 6. ***p<0.001 vs Control.

Comparison of HDL-c concentration in the different experimental groups:

Serum HDL-c concentration was 0.41 ± 0.03, 0.17 ± 0.01 and 0.11 ± 0.01 mmol/L for control, TGO and TPO treated group, respectively. Serum HDL-c concentration was significantly ($p<0.001$) lower in TGO and TPO treated groups, compared with control. Serum HDL-c concentration was significantly ($p<0.05$) lower in TPO group, compared with TGO treated group, (Figure 6).

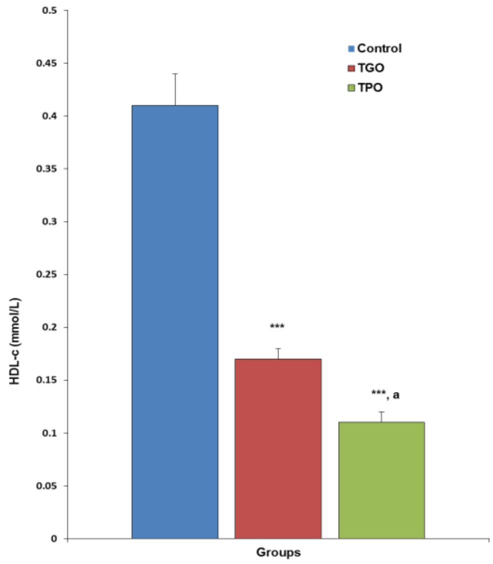

Figure 6: Comparison of HDL-c concentration of the different experimental groups. Values are mean ± SEM, n = 6. ***p<0.001 vs Control; a = p<0.05 vs TGO

Comparison of LDL-c concentration in the different experimental groups:

Serum LDL-c concentration was 0.07 ± 0.00, 0.12 ± 0.01 and 0.27 ± 0.01 mmol/L for control, TGO and TPO treated group, respectively. Serum LDL-c concentration was significantly ($p<0.001$) higher in TGO and TPO treated groups, compared with control. Serum LDL-c concentration was also significantly ($p<0.05$) higher in TPO group, compared with TGO treated group, (Figure 7).

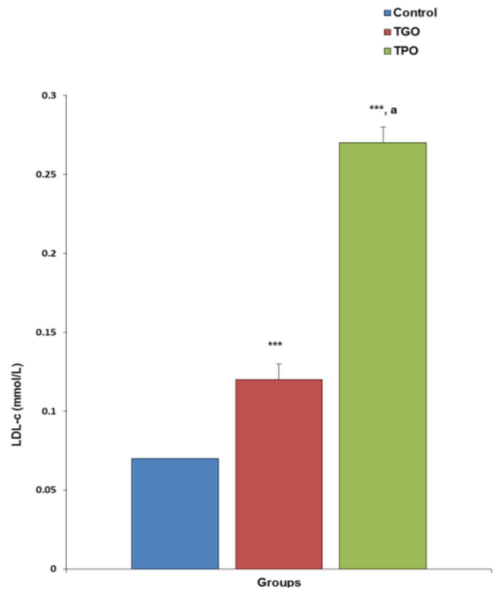

Figure 7: Comparison of LDL-c concentration of the different experimental groups. Values are mean ± SEM, n = 6. ***p<0.001 vs Control; a = p<0.05 vs TGO.

Comparison of VLDL-c concentration in the different experimental groups:

Serum VLDL-c concentration was 0.13 ± 0.00, 0.07 ± 0.00 and 0.08 ± 0.00 mmol/L for control, TGO and TPO treated group, respectively. Serum VLDL-c concentration was significantly ($p<0.001$) lower in TGO and TPO treated groups, compared with control, (Figure 8).

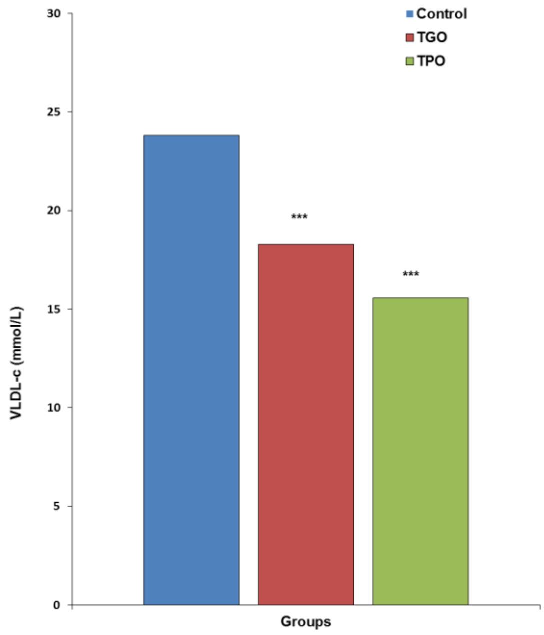

Figure 8: Comparison of VLDL-c concentration of the different experimental groups. Values are mean ± SEM, n = 6. ***p<0.001 vs Control.

DISCUSSION

The comparative effect of thermally oxidized palm oil and groundnut oil on serum lipid profile in albino Wistar rats was studied. This was based on the fact that previous studies have focussed a lot on red palm oil and thermally oxidized palm oil, while neglecting groundnut oil, another edible oil which is widely consumed especially in fried foods. The results of this study showed a decreased water intake in the TGO and TPO treated groups, compared with control. This suggests a possible suppression of the thirst centre. Food intake was not significantly affected by either TGO or TPO in this study. Mean body weight change was lower in TPO treated group, compared with control and TGO treated group. This is consistent with the report of Osim *et al.,*[16] who attributed the loss in body weight secondary to TPO consumption to peroxides and hydroxyesters present in thermally oxidized palm oil. These agents are known to be hazardous to tissues. The lower body weight change observed in TPO treated group may therefore be a consequence of some tissue damage and wasting.

Contrary to the works of Agarwal, (1985) [13] and Markuszewski who both earlier reported that thermally oxidized palm oil was hypercholesterolemic, the results of this present study has shown a reduction in serum total cholesterol concentration in the TPO and TGO treated groups. This study has also shown that the reduction in serum total cholesterol was more in TGO treated group, compared with TPO group. Triglyceride, HDL-c and VLDL-c concentrations were all reduced in the TGO and TPO treated groups, compared with control, while serum LDL-c concentration was significantly increased in TGO and TPO treated groups, being highest in TPO group compared with TGO group.

The likelihood of developing cardiovascular disorders has been shown to increase with increased levels of saturated fatty acids e.g palmitic acid, lauric and myristic acid which are known to raise the levels of total cholesterol or low density lipoprotein. The levels of serum HDL-c is known to negatively correlate with the risk of suffering cardiovascular disease [15], while the serum levels of LDL-c is known to positively correlate with the risk of suffering cardiovascular disease [15]. The results of this study suggest that TGO and TPO could increase the risk of developing heart disease.

CONCLUSION

We therefore conclude that although both thermally oxidized oils pose a risk of developing cardiovascular disorders, consumption of TPO poses a greater risk of developing cardiovascular disease than TGO considering the higher level of LDL-c and lower level of HDL-c in TPO treated group, compared with TGO treated group.

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