ISSN:1991-8178

Australian Journal of Basic and Applied Sciences

Journal home page: www.ajbasweb.com

Comparative Effects of Thermoxidized Palm Oil and Groundnut Oil Diets on some Haematological Parameters in Albino Wistar Rats

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ARTICLE INFO

Article history:
Received 12 November 2014
Received in revised form 26 December 2014
Accepted 29 January 2015
Available online 10 February 2015

Keywords:
Groundnut oil, haematocrit, haemoglobin, peanut oil, thermoxidized palm oil.

ABSTRACT

Background: Several studies have demonstrated the detrimental effects of consumption of thermally oxidized oils on various systems of the body. This study seeks to ascertain and compare the effects of consumption of thermally oxidized palm oil (TPO) and thermally oxidized groundnut oil (TGO) diets on some haematological parameters. **Objective:** Eighteen male albino Wistar rats weighing 200 – 220 g were used for this study. The animals were randomly assigned 1 of 3 groups (n = 6), thus control group, TPO fed group and TGO fed group. Thermally oxidized oil diets were formulated by separately adding TPO and TGO to normal rat feed in the ratio 85:15 for normal feed and thermally oxidized oil respectively. The animals in TPO and TGO groups were allowed to eat the modified diets ad libitum. The feeding regimen lasted for 4 weeks. At the end of 4 weeks of administration, the animals were sacrificed under chloroform anaesthesia and blood samples collected for analysis. **Results:** Haemoglobin concentration of TGO fed group was significantly ($p<0.05$) higher than that of the control group. Also, packed cell volume (PCV) of animals in the TPO fed group was significantly ($p<0.05$) lower than that of the control group, while ESR was not significantly different between the groups. Total WBC count of the TGO fed group was significantly ($p<0.001$) higher, compared to control and TPO fed group. Neutrophil count for control, TPO and TGO fed group was 51.6 ± 2.26%, 36.33 ± 1.05% and 40.67 ± 0.67%, respectively. Neutrophil count was significantly ($p<0.001$) lower in TPO and TGO fed groups, compared with control. Lymphocyte count was significantly ($p<0.001$) higher in TPO and TGO fed group, compared with control. **Conclusion:** This study has demonstrated that TPO and TGO consumption may be detrimental to the body's haematological system as it alters Hb concentration, PCV, WBC count, Neutrophil and lymphocyte counts. The observed changes were more in TPO fed group, than TGO fed group.

To Cite This Article: E.J. Ani, V.U. Nna, C.E. Obi, N.J. Udobong, Comparative Effects of Thermoxidized Palm Oil and Groundnut Oil Diets on some Haematological Parameters in Albino Wistar Rats. ***Aust. J. Basic & Appl. Sci.,*** *9(5): 181-184, 2015*

INTRODUCTION

Palm oil which is obtained from *Elaesis guineensis* has a wide variety of applications. It serves as cooking oil, and also serves as a constituent of many processed foods, soaps, and other personal care products (Gapor *et al.*,1982; Cottrell, 1991). Palm oil has been shown to contain about 50% saturated fatty acid, yet it does not promote atherosclerosis and arterial thrombosis (Gapor *et al.*,1982; Cottrell, 1991). Groundnut oil, also called peanut oil, on the other hand is obtained from groundnut (peanut). It is a vegetable oil which contains only a small proportion of non-glyceride constituents. Groundnut oil is an excellent food oil, with a good flavour. Generally, vegetable oils primarily consist of triglyceride, but several other compounds are present (Ani *et al.*, 2014).

Dietary oils rich in polyunsaturated fatty acids serve as the principal and inexpensive source of essential fatty acids and vitamins (Gapor *et al.*,1982; Cottrell, 1991). These oils are however susceptible to oxidative changes during use like frying because their polyunsaturated fatty acid constituents readily undergo oxidation resulting in the formation of peroxides, aldehydes, ketones, aldehydroesters and ozonides (Osim *et al.*, 1994; Isong *et al.*, 1997; Owu *et al.*, 1998; Ebong *et al.*, 1999). Thermally oxidized oils therefore, may be dangerous to health. Oxidized palm oil when chronically consumed, causes growth retardation, thrombosis, fatty livers, essential fatty acid deficiency, a deficiency of nucleic acid and micronutrient malnutrition, leading to deactivation of key metabolic enzymes as previously reported (Hill *et al.*, 1982; Izaki *et al.*, 1984; Isong *et al.*, 1992; Odutuga *et al.*, 1997; Mesembe *et al.*, 2005). The

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free radicals that are generated as a result of consumption of thermally oxidized oils may be involved in the aetiology of diseases such as cancer, diabetes, arthritis and cataract (Pryor, 1991; Lunec, 1992). Following previously reported detrimental effects of consumption of thermally oxidized oils, this study is therefore aimed at investigating their effects on specific blood indices.

MATERIALS AND METHODS

Experimental Animals and Protocol:

Eighteen (18) male albino Wistar rats weighing 200 – 220 g were purchased from the animal house of the Department of Physiology, University of Calabar, Calabar, Cross River State, Nigeria. The animals were randomly divided into three groups (n = 6) and allowed to acclimatize for 7 days. They were also exposed to normal temperature and 12/12 hours light/dark cycle. All animals had access to rat feed and water *ad libitum.* The groups were; control group, thermally oxidized ground nut oil fed group (TGO) and thermally oxidized palm oil fed group (TPO).

Formulation of Feed:

Palm oil and groundnut oil were both purchased from Watt 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 TGO and TPO fed groups. Thermally oxidized groundnut oil – modified diet was formulated by mixing normal rat feed with thermoxidized groundnut oil in the ratio 85:15 grams. This was given to TGO fed group. In the same vein, thermally oxidized palm oil – modified diet was formulated by mixing normal rat feed with thermoxidized palm oil in the ratio 85:15 grams (Osim *et al.*, 1994), and given to TPO diet fed group. The feeding was done for 28 days.

Collection of Sample:

At the end of the feeding period, the rats were anaesthetized with chloroform after an overnight fast. Blood was collected into heparinized screw cap bottles for estimation of the various haematological parameters. Haemoglobin concentration, packed cell volume (PCV), erythrocyte sedimentation rate (ESR), white blood cell (WBC) count, differential WBC counts and percentage lysis of red blood cells (RBC) were determined using standard methods.

Statistical Analysis:

Data are presented as mean ± SEM. The One – way analysis of variance (ANOVA) was used to analyse the data. Values of $p<0.05$ were considered significant. Computer software SPSS and excel analyser were used for the analysis.

Results:

Table one shows that the haemoglobin concentration of TGO fed group (12.16 ± 0.38 g/dL) was significantly ($p<0.05$) higher than that of the control (11.15 ± 0.29 g/dL). Also, the PCV of animals in the TPO fed group (42.00 ± 0.52%) was significantly ($p<0.05$) lower than that of the control group (44.50 ± 1.02%), while ESR was not significantly different between the groups (Table 1).

Table 1: Comparison of RBC count, Hb concentration, PCV and ESR in the different groups.

Groups	Hb (g/dL)	PCV (%)	ESR (mm/hr)
Control	11.15 ± 0.29	44.50 ± 1.02	1.67 ± 0.21
TPO	11.92 ± 0.20	42.00 ± 0.52[c]	2.33 ± 0.21
TGO	12.16 ± 0.38[c]	43.67 ± 0.56	1.67 ± 0.21

c = $p<0.05$ vs Control, n = 6.

The WBC count of the TGO fed group (75.17 ± 4.12 $x10^3$cell/µL) was significantly ($p<0.001$) higher when compared with that of the control group (66.33 ± 1.48 $x10^3$cell/µL), and the group fed with TPO (53.33 ± 1.67 $x10^3$cell/µL). Neutrophils count for control, TPO and TGO fed group was 51.6 ± 2.26%, 36.33 ± 1.05**%** and 40.67 ± 0.67%, respectively. Neutrophils count was significantly ($p<0.001$) lower in TPO and TGO fed groups, compared with control.

Lymphocytes count was 31.67 ± 1.71%, 45.50 ± 1.54% and 42.00 ± 0.73%, for control, TPO and TGO fed group, respectively. Lymphocytes count was significantly ($p<0.001$) higher in TPO and TGO fed group, compared with control. There was no significant change in the levels of eosinophils, basophils and monocytes.

Table 2: Comparison of total WBC and differential counts in the different groups.

Groups	WBC ($x10^3$ cell/µL)	Neutrophils (%)	Lymphocytes (%)	Eosinophils (%)	Basophils (%)	Monocytes (%)
Control	66.33 ± 1.48	51.67 ± 2.26	31.67 ± 1.71	6.50 ± 0.43	1.33 ± 0.33	8.83 ± 0.65
TPO	53.33 ± 1.67[a]	36.33 ± 1.05[a]	45.50 ± 1.54[a]	9.17 ± 1.76	1.17 ± 0.31	7.83 ± 0.70

TGO	75.17 ± 4.12[a,b]	40.67 ± 0.67[a]	42.00 ± 0.73[a]	8.00 ±0.63	1.00 ± 0.37	8.33 ± 0.71

a = p<0.001 vs Control; b = p<0.001 vs TPO, n = 6.

Figure 1 shows the osmotic fragility of RBC to varying concentrations of NaCl solution in the different experimental groups. The results obtained showed that there was no haemolysis in the control group for concentrations of 1.0 – 0.8% NaCl. Haemolysis began at NaCl concentration of 0.7%, while complete haemolysis was observed at concentration of 0.2 and 0.1% NaCl. In the TPO fed group, haemolysis began at a concentration of 1.0% NaCl, and was complete at a concentration of 0.2 and 0.1% NaCl. Unlike the TPO fed group, the onset of haemolysis in the TGO fed group was seen at NaCl concentrations of 1.0% and completely haemolysis was seen at 0.1% NaCl concentration (Figure 1).

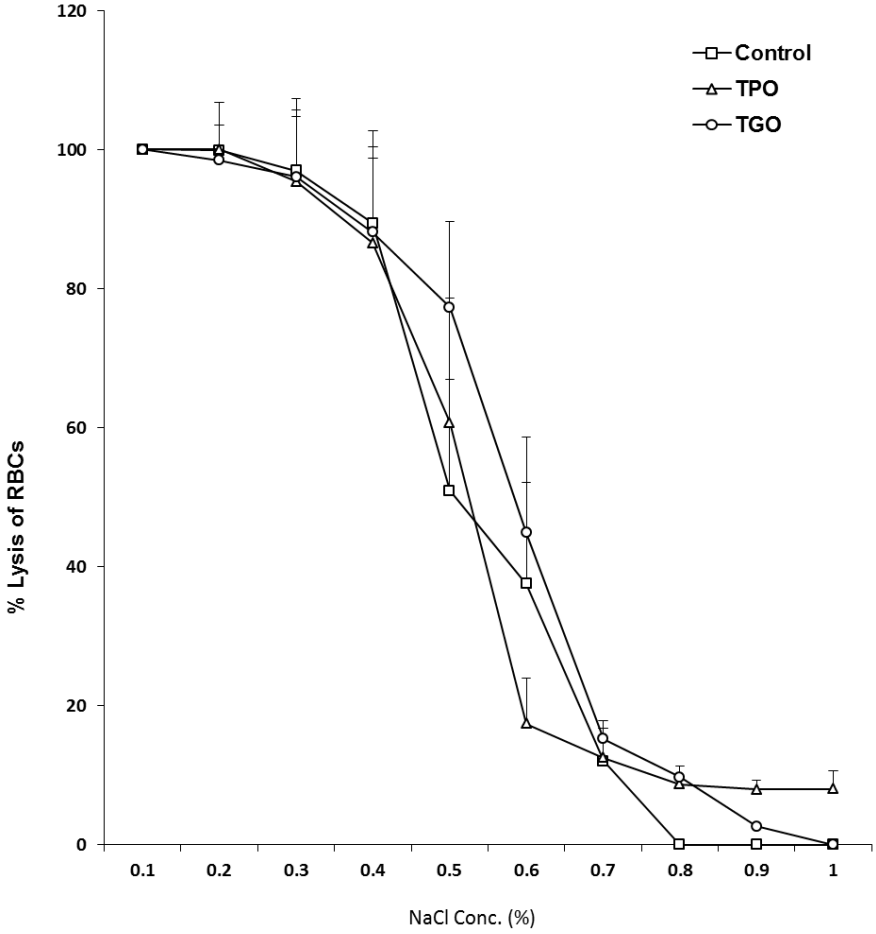

Fig. 1: Comparison of osmotic fragility of red blood cells to graded concentrations of NaCl solution in the different experimental groups. Values are mean ± SEM, n = 6.

Discussion:

Inclusion of thermoxidized oil in the diets of rats is seen to alter the white blood cell as a whole, its components, the PCV and Hb of blood and the ESR as shown in this study.

Several studies have demonstrated the effects of thermally oxidized oils on some systems of the body. The present study assesses the effects of TPO and TGO on some haematological parameters. Mesembe *et al.,* (2005) had earlier reported that thermally oxidized palm oil diet resulted in anaemia. In our study however, thermally oxidized palm oil diet significantly ($p<0.05$) reduced PCV, compared with TGO fed group and control, but haemoglobin concentration was significantly ($p<0.05$) higher in TGO fed group, compared with control. Thermoxidized palm oil and TGO diets did not significantly affect ESR in this study. Although ESR was higher in TGO fed group, compared with control, the difference was not statistically significant. The observed changes however may not be of clinical significance as they still fall within clinically healthy values. The inconsistency observed between this study and that reported by Mesembe *et al.,* (2005) may be attributed to the duration of exposure to TPO. Our study employed 4 weeks, while the other study employed 14 weeks. Also observed in this study was that the haemoglobin

values of both rats fed with thermoxidized palm oil and thermoxidized groundnut oil increased when compared with the control meaning that there was an increased oxygen carrying – capacity of the blood. This increase in Hb concentration may be as a result of increase uptake of iron by the intestinal mucosa resulting in increased bioavailability of iron in the system.

White blood cells play a very important role in the body's immune system as they daily search for, invade and destroy disease causing bacteria, viruses and fungi. The body is in normal agreement when there is an increase in white blood cells; but a highly significant increase as is shown in this study may be an indication of inflammation, infection, stress to major organs or certain diseases. Total WBC count was significantly ($p<0.001$) lower in TPO fed group, but significantly ($p<0.001$) higher in TGO fed group, compared with control. Total WBC count was also significantly ($p<0.001$) higher in TGO fed group, compared with TPO fed group. Eosinophils, basophils and monocytes counts were not significantly affected by either TPO or TGO. The overall decrease in total WBC count in the TPO fed group may be attributed to increased oxygen free radicals and hydroxyl esters contained in oxidized oils that cause injury to cells, tissues and organs (O'Sara, 1996). This may be responsible for the observed decrease in neutrophils count in the TPO and TGO fed groups, since they are first mobilized in large numbers to fight injury. Also, lymphocytes are mobilized in large numbers during chronic conditions. This probably explains the significantly increased lymphocyte count observed in TPO and TGO fed rats.

Conclusion:

This study has demonstrated that TPO and TGO consumption may be detrimental to the body's haematological system as it alters Hb concentration, PCV, WBC count, Neutrophil and lymphocyte count. Thermally oxidized palm oil was found to be more detrimental than thermally oxidized groundnut oil.

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