COMPARATIVE EFFECTS OF GROUNDNUT OIL AND PALM OIL ON LIPID PROFILE OF ADULT WISTAR RATS

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ABSTRACT

BACKGROUND: The consumption of groundnut oil and palm oil have become common in our daily diets. These oils are edible vegetable oils widely consumed globally and are composed of saturated and unsaturated fatty acids. While these oils are often promoted for their perceived health benefits, emerging research suggests potential implications for lipid profiles. They are said to be pro-atherogenic and can be responsible for cardiovascular complications.

AIM: This study was aimed to assess the comparative effects of groundnut oil and palm oil on lipid profile of Wistar Rats.

MATERIALS AND METHODS: Fifteen (15) Adults Wistar rats weighing between 90-100g were procured for this study. They were divided into three (3) groups of five (5) rats each. All the animals were given rat chow and normal saline *ad libitum*. The Control group (Group 1) was given rat chow and normal saline only. The Sample groups; Group 2 was administered with 100mg/kg of groundnut oil while Group 3 was given 100mg/kg of palm oil for 21 days. The weight of the animals before and after the administration were recorded.

RESULTS: Increase in body weight was seen across all the groups (both control and sample). The average body weights of

the control group, Group 2 and Group 3 were 110, 115 and 119 grams respectively which indicates that the sample groups were significantly different when compared with the control group ($P<0.05$). That of sample group 2 indicates a statistically significant difference in relation to sample group 3 ($P<0.05$). The Control group (Group 1) had the lowest cholesterol level (70.01±0.03 mg/dl) while the rats administered groundnut oil (Group 2) had the highest cholesterol level (100.07±0.17 mg/dl). The cholesterol level of the rats administered with palm oil (Group 3) was (85.50±0.07 mg/dl). The Control group had the highest value for HDL (110.78±0.06 mg/dl), followed by Group 3 (89.66±0.02 mg/dl) while Group 2 had the least HDL level (80.50±0.06 mg/dl). The triglyceride and LDL levels were highest in Group 3 (100.92±0.02 mg/dl and 90.78±0.04 mg/dl respectively), followed by Group 2 (80.87±0.07 mg/dl and 80.70±0.06 mg/dl respectively). Group 1 had the lowest triglyceride and LDL levels (70.80±0.00 mg/dl and 72.48±0.48 mg/dl respectively).

CONCLUSION: Groundnut oil was seen to increase the lipid profile more than the palm oil. Excessive intake of these vegetable oils should be avoided to prevent elevated lipid profile which may predispose an individual to cardiovascular diseases.

Keywords: *Palm oil, Groundnut oil, Body weight, Lipid profile, cardiovascular diseases.*

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INTRODUCTION

Palm oil, extracted from *Elaeis guineensis* oil palm fruit, is the most widely consumed vegetable oil accounting for about 35% of global vegetable oil consumption [1]. Apart from the phytonutrients called minors (vitamin E, carotenoids), it is composed of 50% unsaturated fatty acids and 50% saturated fatty acids, of which 44% is palmitic acid [2], making it an oil which is known to be pro-atherogenic and which would be responsible for cardiovascular complications [3,4,5,6]. Groundnut oil, also known as peanut oil, is a popular oil derived from the seeds of the groundnut plant (*Arachis hypogaea*). It is widely consumed worldwide due to its excellent flavor, high smoke point, and various health benefits. The production of groundnut oil involves several stages, including harvesting, cleaning, shelling, pressing, refining, and packaging.

Globally, there is a constant rise in cardiovascular disease cases. About 60% of all deaths in 2005 were related to these diseases, 80% of which occurred in developing countries [7,8]. Several studies attribute the increased risk of cardiovascular disease to high serum cholesterol and its fractions [9]. This cholesterol is derived mostly from edible fats and oils including groundnut oil and palm oil, which is the most cited. Cholesterol is a waxy, fat-like substance made in the liver, and found in the blood and in all cells of the body. Cholesterol is important for good health and is needed for making cell walls, tissues, hormones, vitamin D, and bile acid. Low-density lipoprotein (LDL), also referred to as ‘bad cholesterol’ is a type of lipoprotein in the blood that carries cholesterol to cells

throughout the body. While cholesterol itself is vital for bodily functions, high levels of LDL cholesterol can contribute to plaque buildup in arteries, increasing the risk of heart disease and stroke. High-density lipoprotein (HDL), often called 'good cholesterol' is a type of lipoprotein that helps remove excess cholesterol from the body. Indeed, Tholstrup *et al*. (2011) reported that palm oil significantly increased Low Density Lipoprotein (LDL) cholesterol when compared with groundnut oil. However, this oil is common in African and Asian food habits, mainly in rural areas where it is used in raw form [11,12,13,14]. A study was conducted with 2240 healthy subjects aged 18 years and above to verify the effect of palm oil consumption on anthropometric parameters (weight and height). It was found that the regular and normal consumption of palm oil by this population did not increase the weight of the subjects consuming it [15]. In addition, several studies have also shown the health benefits of palm oil consumption [16]. In Côte d'Ivoire, changes in lipid profile in farm chickens fed with groundnut oil and palm oil which had a cholesterol-lowering effect was studied. The study indicated that consumption of these oils decreased serum levels of triglycerides and LDL cholesterol but increased HDL cholesterol [17]. Another study carried out on 120 subjects suffering from ischemic heart disease reported no disturbance of lipid and lipoprotein parameters with these subjects who consumed palm oil after four weeks [17]. Several studies on the benefits of palm oil have been carried out for the most part in hypertensive, obese, diabetic, cancerous subjects or suffering from ischemic cardiopathies [17], but not with healthy subjects. Knowing that some apparently healthy subjects have an apprehension about palm oil, it became imperative to study the impact of palm oil and groundnut oil consumption on healthy Wistar rats in order to see whether or not there are lipid and lipoprotein anomalies related to their consumption.

The consumption of groundnut oil and palm oil, have become common in conventional diets. While these oils are often promoted for their perceived health benefits, emerging research suggests potential implications for lipid profiles. Several studies have indicated a relationship between groundnut oil consumption and adverse lipid profiles, including elevated levels of low-density lipoprotein cholesterol (LDL-C) and triglycerides (TAG), and decreased high-density lipoprotein cholesterol (HDL-C). Again, a recent meta-analysis study by Mancini *et al*. (2015) found a significant association between palm oil intake and increased LDL-C levels. Some studies reported adverse effects of groundnut oil consumption on TG levels. Studies have shown in a Chinese population, that the consumption of certain fats and oils were associated with an increased risk of type 2 diabetes [18]. Many clinicians usually discouraged patients with type 2 diabetes from consuming fats and oils or at least limit their consumption. Certain vegetable oils have shown to have positive effect on diabetes management. Indeed, fish oil supplementation have proven to improve insulin sensitivity in rat study [19]. Olive oil also is a vegetable oil that has been scientifically proven to have least dyslipidaemic and atherogenic effect [20]. However, conflicting evidence exists, with some studies suggesting neutral or even beneficial effects on lipid profiles. Understanding the nuanced effects of

groundnut oils on lipid metabolism is crucial for informing dietary recommendations, mitigating cardiovascular risk factors and improving public health outcomes. Further research employing rigorous methodologies is warranted to elucidate these effects comprehensively. This study aims to assess the effects of groundnut oil and palm oil on the body weight and lipid profile of Wistar Rats.

MATERIALS AND METHODS

Experimental Animals

This study was conducted at the laboratories of the Department of Medical Laboratory Science and that of the Department of Anatomy, Presco Campus of Ebonyi State University, Abakaliki, Ebonyi State, Nigeria. Fifteen (15) Adult Wistar rats weighing between 90-100g were procured from the Veterinary Department, University of Nigeria, Nsukka, Enugu state, Nigeria. The rats were housed in the laboratory steel cages for one week for acclimatization under normal laboratory conditions before the commencement of the study. They were allowed to have access to rat chow and water *ad libitum*. All the animals received good care according to the criteria of the Investigations and Ethics Committee of the Community Laws governing the use of experimental animals. An ethical approval with the number EBSU/1704/02/001 was obtained from the Ethics Committee of the Department of Anatomy, Faculty of Basic Medical Sciences, Ebonyi State University, Abakaliki, Ebonyi State, Nigeria. Palm oil and groundnut oil used for this research were purchased from St Margret Umahi International market, Abakaliki, Ebonyi State, Nigeria.

Experimental design

Fifteen (15) adults Wistar Rats were randomly assigned into three groups of five rats each. The Control group (Group 1) received feed and water only, Group 2 received 100mg/kg of groundnut oil, while Group 3 animals were given 100mg/kg of palm oil daily. The experiment was carried out within the period of 21 days.

Sample collection

Procedures for ocular puncture

The blood samples were collected through ocular puncture with the animals under chloroform anaesthesia. This method allows the use of heparinized capillary which was broken into two and inserted into one of the eyes of the rats. The choice of the heparinized tube is to prevent clotting of the blood in the capillary during blood collection. Blood samples were collected into lithium heparin bottles after which samples were centrifuged at 2000 revolution per minute for 5 minutes and the plasma was isolated into plain bottles and stored refrigerated until analyses were carried out at Divine Chemicals and Analytical Laboratory Nsukka, Enugu State, Nigeria.

Determination of Lipid Profile

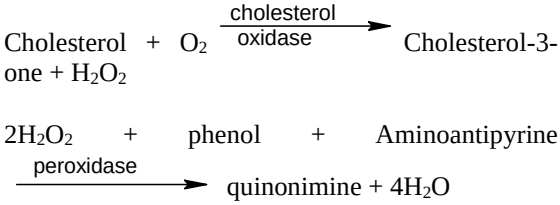
Determination of serum cholesterol (CHOL)

This was done using CHOD-PAP method.

Principle

The cholesterol was determined after enzymatic hydrolysis and oxidation. The indicator quinonimine was formed from hydrogen peroxide and 4-aminoantipyrine in the presence of phenol and peroxidase.

$$\text{Cholesterol ester} + H_2O \xrightarrow[\text{esterase}]{\text{cholesterol}} \text{Cholesterol} + \text{Fatty acids}$$



Procedure

Ten microliters (10µl) of distilled water were added into test tube for water blank, 10 µl of the standard reagent was added into test tube and 10 µl of the sample was added into each test tube. Then, 1000 µl of reagent R1 was added into each test tube and mixed. It was then incubated for 10 minutes at 37 ^{0}C. The absorbance of all the cuvettes was read and recorded at 546 nm.

Determination of serum triglycerides (TAG)

This was done according to the method of Tietz (1976).

Procedure

Five microliters (5µl) of distilled water were added into test tube, 5 µl of the standard reagent was added into another test tube and 5 µl of the sample was added into another test tube. Then, 500 µl reagent R1 was added into each test tube and mixed. This was incubated for 5 minutes at 37 ^{0}C. The absorbance of all the cuvettes was read and recorded at 546 nm.

TAG (mmol/l) = (change in Abs sample/ change in Abs standard) x standard conc

Determination of the serum high density lipoproteins (HDL)

High density lipoproteins (HDL) - cholesterol concentration was determined by the method of Albers *et al* (1978) using Randox kit.

Procedure

The 100 µl of the serum and standard was pipetted inside the centrifuge tube which was immediately accompanied with the addition of 500 µl of the diluted precipitation reagent (R1) to the centrifuge tube. The contents were mixed and allowed to stand for 10 minutes at 25 ^{0}C, then centrifuged for 15 minutes at 3500 rpm. The cholesterol concentration of the supernatant was determined after centrifugation. Into three test tubes labeled test sample supernatant, standard and blank were added 50 µl of sample supernatant, 50 µl of standard and 50 µl distilled water respectively. Then, 500 µl each CHOL reagent solution was added in the test tubes and mix, incubate for 10 min at 25 ^{0}C. Read the absorbance at 500 nm after 60 minutes.

HDL (mg/dl) = (change in Abs sample/ change in Abs standard) x conc of standard

Determination of the serum low density lipoproteins (LDL)

LDL-Cholesterol can be determined as the difference between total cholesterol and the cholesterol content of the supernatant after precipitation of the LDL fraction by polyvinyl sulphate (pvs) in the presence of polyethyleneglycol monomethyl ether.

LDL = total cholesterol – HDL/5 – tg

Statistical Analysis:

Data obtained were analyzed using Statistical Package for Social Sciences (SPSS) version 20, windows 10. The results were expressed as Mean ± Standard Error of Mean (SEM). Data obtained from this study were further analyzed using one-way Analysis of Variance (ANOVA) and

Post Hoc Tests which was used to compare means.

RESULTS

Effects of Groundnut oil and Palm oil on the body weight and Lipid Profile of Wistar Rats

The average body weights of the control group, Group 2 and Group 3 were 110, 115 and 119 respectively. The Control group (Group 1) had the lowest cholesterol level (70.01±0.03 mg/dl) while the rats administered groundnut oil (Group 2) had the highest cholesterol level (100.07±0.17 mg/dl). The cholesterol level of the rats administered with palm oil (Group 3) was (85.50±0.07 mg/dl). The Control group had the highest value for HDL (110.78±0.06 mg/dl), followed by Group 3 (89.66±0.02 mg/dl) while Group 2 had the least HDL level (80.50±0.06 mg/dl).

The triglyceride and LDL levels were highest in Group 3 (100.92±0.02 mg/dl and 90.78±0.04 mg/dl respectively), followed by Group 2 (80.87±0.07 mg/dl and 80.70±0.06 mg/dl respectively). Group 1 had the lowest triglyceride and LDL levels (70.80±0.00 mg/dl and 72.48±0.48 mg/dl respectively).

Table 1: Effect of Groundnut and Palm oils on the body weight

Groups	Weight (g)
1	110
2	115
3	119

Table 2: Effects of Groundnut oil on lipid profile of Wistar Rats

Lipids	Amount (mg/dl)
Cholesterol	2.07±0.17
HDL	0.50±0.06
TAG	0.87±0.07
LDL	0.70±0.06

Table 3: Effects of Palm oil on the Lipid profile of Wistar Rats

Lipids	**Amount (mg/dl)**
Cholesterol	1.50±0.07
HDL	0.66±0.02
TAG	0.92±0.02
LDL	0.78±0.04

Table 4: Effects of Groundnut oil and Palm oil on Lipid Profile of Wistar Rats

	Cholesterol mg/dl	**HDL mg/dl**	**TAG mg/dl**	**LDL mg/dl**
Group 1	70.01±0.03	110.78±0.06	70.80±0.00	72.48±0.48
Group 2	100.07±0.17[a]	80.50±0.06[a]	80.87±0.07[a]	80.70±0.06[a]
Group 3	85.50±0.07[b, c]	89.66±0.02[b, c]	100.92±0.02[b, c]	90.87±0.04[b, c]

Values are expressed as Mean ± SEM, n = 15.

a = shows that Group 1 is significantly different from Group 2 at $p<0.05$;

b = shows that Group 1 is significantly different from Group 3 at $p<0.05$;

c = shows that Group 2 is significantly different from Group 3 at $p<0.05$;

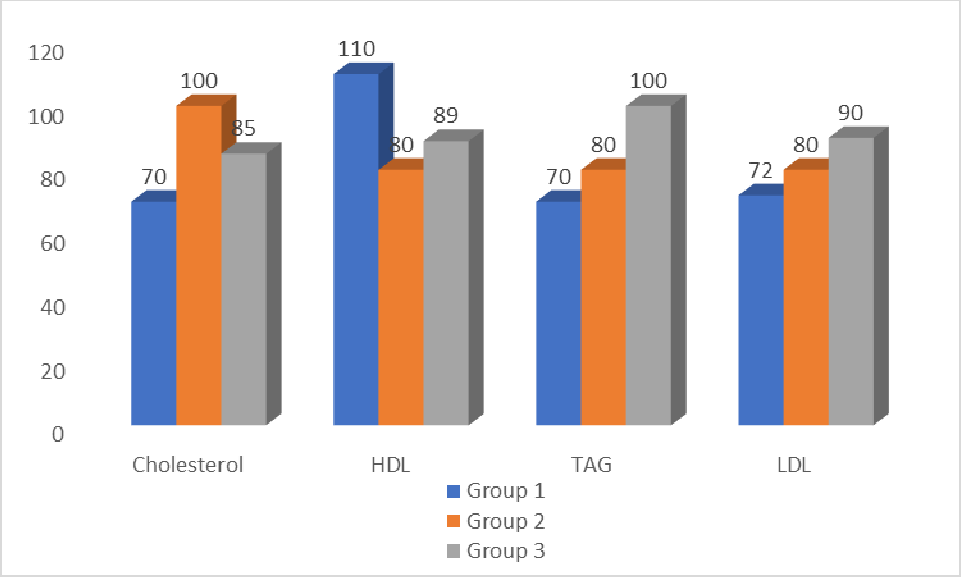


Fig. 1: Effects of Groundnut oil and Palm oil on Lipid Profile of Wistar Rats

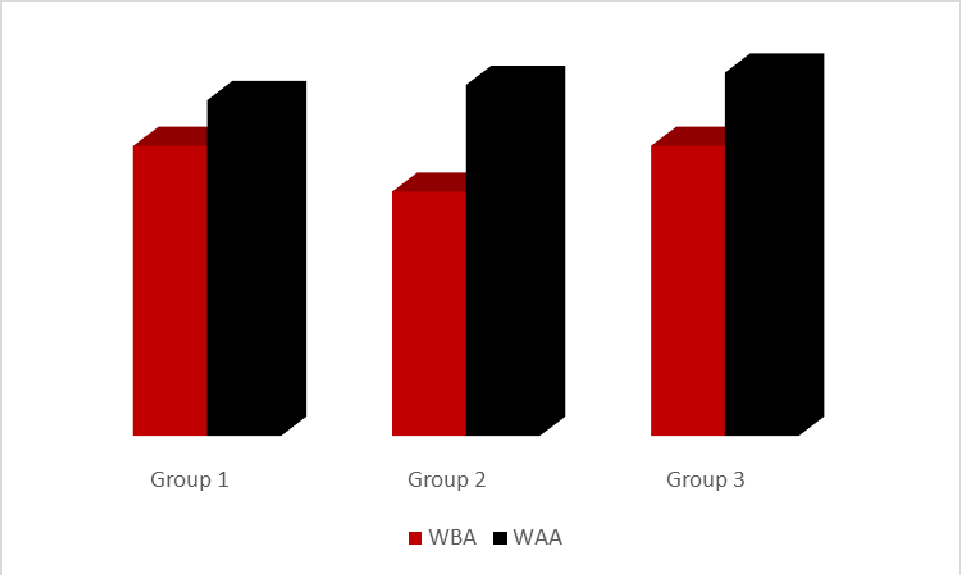


Fig. 2: Effects of Groundnut oil and Palm oil on the Body Weight of Wistar Rats

Key:
WBA= Weight before administration
WAA=Weight after administration

DISCUSSION

The nutritional and health benefits of both groundnut and palm oils as edible vegetable oils have been well documented [23,2]. In this study, increase in body weight was seen across all the groups (both control and sample). The body weights of the sample groups were significantly different when compared with the control group ($P<0.05$). That of sample group 2 indicates a statistically significant difference in relation to sample group 3 ($P<0.05$). These changes indicates that these oils may influence increased body weight. This maybe as a result of lipid cholesterol and calories present in these oils. The body can easily store excess calories from oil as fat, further contributing to weight gain. The highest body weight increase was seen with the palm oil-administered sample group.

The cholesterol level is highest in sample group 2 administered with groundnut oil followed by sample group 3. This indicates that groundnut oil has more cholesterol content when compared with palm oil; and this may be as a result of different reasons which include method of processing resulting in presence of high saturated and trans fats in the groundnut oil and also activation of the enzyme HMG- CoA (3-hydroxy-3-methyl glutaryl- coA) activity which is a key enzyme in cholesterol biosynthesis and an increase in VLDL, LDL. HMG- CoA synthesizes in vivo cholesterol [24]. These oils have abundance of saturated fats which can increase cholesterol level. This high cholesterol level results in increase in too many lipids (fats) in the blood leading to hyperlipidemia (hypercholesterolemia) which may lead to atherosclerosis and eventual heart diseases. Similarly, triglyceride is higher in palm oil-administered sample group when compared to that of the sample group administered with groundnut oil. Increased triglyceride level, especially with the combination of other factors like low HDL and high LDL cholesterol, can increase the risk of heart disease [25].

The HDL (good cholesterol) is lower in sample group 2 administered with groundnut oil than that of sample group 3 administered with palm oil. This indicates that groundnut oil has higher lipid content more than palm oil. The increased HDL levels are associated with a lower risk of cardiovascular disease. A reduction in the level of HDL cholesterol could be due to the stimulation of Lecithin cholesterol acyl transferase (LCAT) which induces the esterification and sequestration of cholesterol in HDL molecules, or by the stimulation of cholesterol ester transfer protein (CETP) which assures the transfer of cholesterol esters from HDL to chylomicrons, VLDL and LDL, thereby increasing the plasma level of the latter [26,27].

The LDL (bad cholesterol) is found to be higher in sample group administered with palm oil than the sample group administered with groundnut oil. This shows that palm oil has more ‘bad cholesterol’ and therefore has more tendency of causing several heart complications. The high level of LDL (hypertriglyceridemia) seen in palm oil indicates that the palm oil consumed has high saturated fats. Diets rich in fatty acids increase the atherogenic index by inducing oxidative stress (enzymatic and non-enzymatic) in rats, thus, increases the oxidation of low-density lipoprotein

(LDL) which plays a key role in the genesis of atherosclerosis.

Palm oil has been used in food preparation for over 5,000 years. This oil is consumed in its fresh state and/or at various levels of oxidation. Feeding experiments in various animal species and humans have highlighted controversial evidences on the beneficial and harmful effects of fresh palm oil to health. On one hand, these benefits include reduction in the risk of arterial thrombosis and atherosclerosis, inhibition of cholesterol biosynthesis, platelet aggregation and reduction in blood pressure [28]. The World Health Organization in its report (2005) states that there is convincing evidence that palmitic oil consumption contributes to an increased risk of developing cardiovascular diseases [29]. Past research confined to epidemiological observations, intervention trials and studies on experimental animals and humans have provided vital information on the obvious facts of the dietetic fats on blood pressure (BP). Therefore, the excessive or chronic intake of dietary oils rich in saturated fatty acids could increase the risk of metabolic and cardiovascular diseases [2].

CONCLUSION

Palm oil and groundnut oil are dietary oils with the requisite constituents to increase fats in the blood. This increase in the fat content results to increase in cholesterol level thereby resulting to risks of developing cardiovascular health implications. Consumption of diets rich in fats therefore should be avoided or reduced. Excessive intake of vegetable oils, especially palm oil and groundnut oil should be avoided to prevent elevated lipid profile.

Conflict Of Interest

Authors declared they have no competing interest.

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