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Comparative Effect Of Fresh Palm Oil And Thermally Oxidized Palm Oil On Cardiovascular Risks

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ABSTRACT

Background: Palm oil is generally part of human delicacies world over; either in fresh form or thermo-oxidized. This, however, is not without consequences. The current study investigates cardiovascular risks associated with consumption of fresh palm oil compared to consumption ofthermally oxidized palm oil. Method: Twenty-one (21) albino wistar rats weighing 180-250g were randomly grouped into three, with each group having seven (7) rats each (n= 7). Group 1 (control - received normal rat feed and clean water only), Group 2 (receivedfresh palm oil, and Group 3 (receivedthermally oxidized palm oil. At the end of the feeding duration, the animals were sacrificed under ketamine anesthesia (intramuscular dose of 0.1ml/100mg) and blood extracted from them by cardiac puncture for biochemical analysis. Results: The result of the study revealed that there was a significant decrease ($P < 0.05$) in the Triglyceride (TG), Very Low Density Lypoprotein (VLDL) and High Density Lipoprotein (HDL) concentrationsin the group treated with thermally oxidized palm oil when compared with the control group and the group treated withfresh palm oil. On the other hand, there was a significant increase ($P < 0.05$) in the concentration of total cholesterol (TC) and Low Density Lipoprotein (LDL). Conclusion: Consumption of thermally oxidized palm oil diets has deleterious effects on lipid profile. Therefore, cooking with and/or consumption of palm oil subjected to heat treatment for several long periods of time should be discouraged in homes as this might have deleterious effects on cardiovascular health. Also, repeatedly heated palm oil appears to increase lipid peroxidation exposing the body to free radicals. This may be because the repeated heating may have destroyed its vitamin E constituents which include α-tocopherol (21%), α-tocotrienol (26%), γ-tocotrienol (40%) and δ-tocotrienol (13%) which act as biological antioxidants and also check oxidative stress and atherosclerosis.

Keywords: Low density lipoprotein, high density lipoprotein, fresh palm oil, thermally oxidized palm oil, lipid profile, cardiovascular risk

INTRODUCTION

Palm oil is extracted from the fruits of Elaesisguineensis (the palm oil tree). It is among the most frequently consumed oils in the world today, with Malaysia and Indonesia topping the chart of global leading producers [1]. In Africa, the origin of oil palm is traceable to the tropical rain forest zones of West Africa.

It contains varieties of very useful phytonutrients majorly β-carotene which is a precursor of vitamin A and vitamin E. Its vitamin E constituents include α-tocopherol (21%), α-tocotrienol (26%), γ-tocotrienol (40%) and δ-tocotrienol (13%) [2]. These componentsvitamins act as biological antioxidants and also check oxidative stress and atherosclerosis. B-Carotene gives the palm oil its seemingly reddish black radiance. The amount of carotene contained in a 100gweight of palm oil is seventeen times its amount in carrots (that is, about 7000 retinol equivalent of carotene per 100_g weight) [1]. The Tocotrienol in RPO is about 40-60 times more potent than tocopherols in terms of their antioxidative properties [3]. Fresh palm oil also contains chlorophyll, a major photosensitizer pigment which is present in most green plants [4,5].

As part of its benefits to the body systems, palm oil significantly reduces the risk of suffering an attack of stroke. Red palm oil has a 50% risk reduction of stress with anti-inflammatory and cholesterol lowering property (National Institute of Health, (NIH), 2003). It prevents or reverses the buildup of plaques (atherosclerosis) in blood vessels of the brain which reduces the risk of ischaemic stroke. Tocotrienol and carotenes contained in red palm oil have also been found to improve the state of the heart, dissolve vascular plaques, decrease peripheral resistance of blood flows and reduce the risk of hypertension and heart attack [5].

Also, tocotrienol has shown a neuroprotective effect on the brain and, is a potent antioxidant which helps to neutralize free radicals in the body. By this action, tocotrienol helps to mop up and inhibits harmful free radicals from causing oxidative injury to vital body organs, preventing cancers of the breast, pancreas, liver, spleen, stomach, colon, and prostate. Apart from inhibiting cancer growth, tocotrienol also initiates apoptosis; a process that leads to a programmed cell death of mutated cancerous cells in the body. Free radicals are chemicals that can cause a host of health issues, like skin aging, cancer, and chronic inflammations [6].

Palm oil also enables the absorption of vitamin A in the intestines. Lack of vitamin A has been often reported to cause night blindness. Also, the Alpha and Beta carotenes present in red palm oil are important precursors of vitamin A. Wale, 2015 also reported that some studies have linked palm oil to

a decrease in the incidence of cataracts and macular degeneration which are leading global cause of blindness. Tocotrienols and carotenes present in palm oil accumulate in the epidermis of the skin and shield it from harmful ultra violet rays. This is why palm oil has been linked with reduced risk of skin cancers [7].

Some of the benefits of palm oil as reported by NIH (2003) include, reduction in the risk of stroke and arterial thrombosis, inhibition of cholesterol biosynthesis and platelets aggregation, reduction in blood pressure and decrease of TC/HDL levels, a useful index for possible cardiovascular problems in individuals.

Conversely, some researchers have also recorded damaging effects of oxidized form of palm oil to the physiological and biochemical functions of the body. Mesembe reported that thermal oxidation of oils has destructive effects on cells of the body due to peroxidation. The reduction in the dietetic level of oxidized oil or level of oxidation has also been reported to reduce health risk [8].

Lipid profile is a panel of blood tests that serves as an initial screening tool for abnormalities in lipids, such as cholesterol and triglycerides. This test serves as a diagnostic tool for certain genetic, cardiovascular and pancreatic disorders. Lipid profile basically includes, low density lipoprotein (LDL), very low density lipoprotein, high density lipoprotein (HDL), triglycerides (TG), and total cholesterol (TC) [9]. Lipid profile was defined by NCEP, 2004 as TG: ≥ 1.69 mmol/l, borderline high TC: 5.17- 6.19 mmol/l, high TC: ≥ 6.20 mmol/l, high LDL-c ≥ 4.91mmol/l, low HDL-c < 1.03mmol/l in men and <1.28mmol/l in women. Abdominal obesity was defined at WHR > 0.95 in males and WHR > 0.8 in females. The higher the level of LDL-c, the greater the risk of having atherosclerotic heart disease, and the higher the level of HDL-c, the lower the risk of coronary heart disease [10].

Present study investigates cardiovascular risks associated with consumption of palm oil in fresh form compared to consumption of palm oil in thermally oxidized form.

MATERIALS AND METHODS

Experimental Animals

Fifteen (21) male albino rats of wistar strain weighing between 180g and 250g were used for the experiment. They were bred during the experimental period. The animal house met the standard of international animal practice law for experimental procedures as it was neat and well ventilated and animal beddings were changed daily. The animals had access to their feed and water freely.

Experimental Design

Thirty (21) albino rats of wistar strain weighing 180-250g were randomly divided into three (3) groups of sevenrats each (n=7). The rats were kept in their separate cages according to their different groups. The groups are:

Group 1(control group): this group received feed and water only

Group 2: received fresh palm oil diet

Group 3; received thermally oxidized palm oil diet

All experimental groups equally received feed and water. The experiment lasted for a period of 12 weeks.

Sources of palm oil

Ten (10) litres of fresh palm oil was purchased from wilmar palm oil estate in Akamkpa Local Government Area of Cross River State.

One half of the fresh palm oil was obtained in black plastic container and preserved in dark cool corner of the room to shield it away from sunlight and heat. Since the level of palm oil in most Nigerian dishes is 10 to 15% [8], 10% level was chosen. Thus, 10grams of fresh palm oil was mixed with 90grams of rat chow to make 10% (^{w}/W) protected palm oil diet (first test diet).

The other half of fresh palm oil was heated at a temperature between 180^{o}C and 200^{o}C in a stainless pot intermittently for five rounds, with each round lasting for 20 minutes and intervals of five hours in between rounds. Also, 10grams of cooled thermally oxidized palm oil was mixed with 90grams of rat chow to make 10% (^{w}/W) thermo-oxidized palm oil diet (second test diet). The rat chow was obtained from Top Feed Nigeria Limited, Calabar.

Collection of blood sample

Blood sample was collected by cardiac puncture. The animals were first suffocated by ketamine anaesthesia (0.1ml/100kg body weight) intramuscularly. Thereafter, they were dissected from the peritoneal region to the mediasternal region to expose the heart. Blood was collected directly from the heart into plain non heparinized sample bottles using the syringes. The bottles were labeled accordingly before being taken to the lab for analysis.

Serum lipid profile estimation

The lipid profile factors analyzed in this research are: total cholesterol (TC), triglyceride (TG), high density lipoprotein (HDL), low density lipoprotein (LDL) and very low density lipoprotein (VLDL).

Estimation of total cholesterol (TC): Serum total cholesterol was estimated using the enzymatic colorimetric test kit method of Sieldel et al. 1985)

Estimation of triglyceride concentration (TG): Triglyceride concentration (TG) was determined by method of Negele et al (1983). The GPO-PAD method was used in determining the triglyceride concentration in this research. 10ml of serum was pipette into a test tube. 10ml of distilled water was added and 100ml of working reagent (glycerol kinase) was pipette into it, and then mixed and incubated for 5 minutes at a temperature of 37^0C after which the mixture was read spectrophotometrically at a mark length of 630mm.

Triglyceride concentration was then calculated as;

$$\text{TG conc. (Mg/dl)} = \frac{\text{Absorbance of sample}}{\text{Absorbance of standard}}$$

$$= \frac{10u \times 200}{100\ u} = 200\text{mg/dl}$$

Estimation of high density lipoprotein (HDL): HDL was estimated using the method of Siedel et al, 1985 the same process as that of total cholesterol.

Estimation of VLDL concentration was obtained by dividing the serum TG by 5. This factor of 5 is based on the fact that in fasting subjects with triglycerides concentration of 100mg/dl. The VLDL to total plasma triglyceride ratio is fixed at 1:5.

VLDL-c (mg/dl) = triglycerides (TG)/5

Estimation of low density lipoprotein concentration (LDL):

LDL concentration was obtained using the friedwald's (1972) relationship.

LDL concentration is obtained from the difference between the serum TC and sum of HDL-C and VLDL.

LDL = TC – (HDL + VLDL

RESULTS

Group	Mean total cholesterol (mmol/L)	Mean triglyceride (mmol/L)	Mean HDL-c (mmol/L)	Mean VLDL-c (mmol/L)	Mean LDL-c (mmol/L)
Control	1.42+0.01	0.72+0.01	0.36+0.00	0.33+0.01	0.73+0.00
Fresh Palm Oil (PO)	1.48+0.01	1.10+0.02	0.45+0.00	0.50+0.01	0.36+0.01
Thermally-oxidized	1.78+0.02	0.91+0.02	0.26+0.00	0.42+0.01	0.82+0.02

Palm Oil (TPO)					

DISCUSION

The results show that thermo-oxidized palm oil increases total cholesterol(TC) significantly when compared with fresh palm oil, suggesting that feeding with repeatedly heated palm oil increases the concentration of serum TC. There was also an increase in serum concentration of LDL, TG and decrease in serum concentration of HDL and VLDL cholesterol in the group fed with thermo-oxidized palm oil when compared with the group fed with fresh palm oil. Previous studies have shown that the higher the level of LDLconcentration, the greater the risk of having atherosclerotic heart disease, and the higher the level of HDL concentration, the lower the risk of coronary heart disease [10] .

Also, repeatedly heated palm oil appears to increase lipid peroxidation exposing the body to free radicals. This may be because the repeated heating may have destroyed its vitamin E constituents which include α-tocopherol (21%), α-tocotrienol (26%), γ-tocotrienol (40%) and δ-tocotrienol (13%) which act as biological antioxidants and also check oxidative stress and atherosclerosis.

As part of its benefits to the body systems, palm oil significantly lessens the risk of suffering an attack of stroke. Red palm oil has a 50% risk reduction of stress with anti-inflammatory and cholesterol lowering property [11].

It prevents or reverses the buildup of plaques (atherosclerosis) in blood vessels of the brain which reduces the risk of ischaemic stroke. Tocotrienol and carotenes contained in red palm oil have also been found to improve the state of the heart, dissolve vascular plaques, decrease peripheral resistance of blood flows and reduce the risk of hypertension and heart attack [5]. But in thermo-oxidized form, it is discouraged because of its deleterious effects on cardiovascular health and its tendency to increase lipid peroxidation exposing the body to free radicals [12].

CONCLUSION

Palm oil,as part of human diets, is best taken fresh rather than in thermally oxidized form. This is because the fresh form has more nutritional value, and reduces the risks of cardiovascular diseases. Also, repeatedly heated palm oil appears to increase lipid peroxidation exposing the body to free radicals.

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