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COMPARATIVE STUDY OF THE EFFECTS OF OMEGA-3 FATTY ACID AND SATURATED FAT ON BLOOD VESSELS (AORTA) USING ALBINO WISTAR RAT MODEL

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ABSTRACT

Background: Palm oil, an edible vegetable oil extracted from the mesocarp of fruits of oil palms, primarily the African oil palm *Elaeis guineensis* is a major ingredient in Nigerian meals. Unrefined palm oil is rich in carotenes, saturated fats and tocotrienols (vitamin E) which have rather protective effects on blood vessels. However, the overall health impacts of palm oil, particularly in relation to cardiovascular disease, are still controversial. This study was designed to assess the effects of omega-3 fatty acid and saturated fats (palm oil) on blood vessels using albino wistar rat model. **Methods:** Fifteen albino wistar rats with average weight of 187.5g were divided into three groups of five rats each and allowed to acclimatize while being fed with standard laboratory animal chow and water *ad libitum* for 2 weeks. For the next six weeks, Group I received 80g of feed mixed with omega-3 fatty acid source (cod liver oil). Group II was fed 80g of feed mixed with saturated fatty acid (palm oil) while Group III, the control group, continued with basal diet only. Total body weights were measured daily throughout the six weeks of experiments. **Results:** Histological results revealed intact lumen in the two test groups similar to that obtained for the control group. **Conclusion:** Palm oil consumption has beneficial effects on blood vessels as it is low in cholesterol, raises HDL levels and reduces platelet aggregability. However, there is need to obtain a balance of different fatty acids found in other edible oils and food sources.

KEYWORDS: Palm oil, omega-3 fatty acid, blood vessels.

INTRODUCTION

Palm oil, one of the few highly saturated vegetable fats, is derived from the mesocarp of the fruits of the oil palms, primarily the African oil palm *Elaeis guineensis*[1] and to a lesser extent from the American oil palm *Elaeis oleifera* and the Maripa palm *Attalea maripa*. Palm oil is naturally reddish in colour because of a high beta-carotene content. It also contains the nutrients alpha-carotene, lycopene, tocotrienols (part of the vitamin E family), tocopherols, phytosterols and glycolipids.[2] The palm mesocarp oil is 41% saturated and contains very little cholesterol. Palm oil is a major food additive among Nigerians and an important source of calories in low income communities.[3]

Studies have indicated the importance of red palm oil, pointing out that the natural carotenes together with tocotrienols (vitamin E) have protective effects on blood vessels. Maes[2] and Andreu-Sevilla and coworkers[4] have shown that free radicals from polyunsaturated fatty acids trigger oxidative processes which result in the release of oxygen with dangerous and harmful bonds that affect tissues and organs at temperature of 37^0C. The polyunsaturated fatty acids then quickly turn rancid in the body causing oxidative stress which in turn leads to conditions such as cardiovascular disease and arthritis. Antioxidants neutralize the effects of these aggressive oxidizing substances. Such antioxidants like vitamin E and carotenes are found in large amounts in red palm oil.[5]

Without protection from carotenoids, vitamin E and other protective substances, cholesterol in the body will oxidize and foam cells produced in the process will adhere to the aorta, damaging the blood vessels and thus contribute to artherosclerosis and other coronary heart disease.[6] However, palm oil has been implicated in this process, as a causative agent of coronary heart disease, whereas Omega-3 fatty acid has been upheld as good fatty acid.[7] This is quite disturbing, considering the large population that consumes palm oil on a daily basis in Nigeria. This study, therefore, was designed to compare the effects of omega-3 fatty acid and saturated fatty acid (palm oil) on blood vessels (aorta) of albino wistar rats.

MATERIALS AND METHODS

Animals

Fifteen apparently healthy albino wistar rats, with weight range of 175g-200g were used for the study. The animals were housed in wire guaze cages in a well lit and adequately ventilated room, under standard environmental conditions (12h light and 12h dark cycle). They were allowed to acclimatize while being fed with standard laboratory animal chow and water *ad libitum* for two weeks. Ethical approval to use the animals for the study was obtained from the College of Medical Sciences Animal Research Ethical Committee.

Experimental groups

The fifteen rats were divided into three groups of five rats each and for the next six week, Group I rats were fed with omega-3 fatty acid source, 80g of feed mixed with cod liver oil. Group II rats received saturated fatty acid diet, 80g mix of feed and palm oil while the rats in Group III, which served as the control group, continued to be fed basal diet only. Total body weights of the rats were measured daily throughout the six weeks of the experiments.

Tissue collection and preparation

At the end of the experiments, the rats were anaesthetized with chloroform inhalation and then sacrificed. The aorta was removed and fixed in neutral buffered formalin for morphological examination and post fixed in Osmium tetra oxide for 24 hours and processed immediately via dehydration of tissue in ascending concentrations of alcohol, cleared in xylene and infiltrated with paraffin wax before placing in processing cassettes. Formalin reduces osmium tetra oxide in the tissues thereby making them appear black. The tissues were treated with ethanol to remove the black pigment. Sections were cut and mounted on slides and incubated for 2 minutes with Erhlich haematoxylin, followed by washing in tap water and incubating in eosin for 1 minute. Finally, slides were differentiated in 95% ethanol, washed in absolute ethanol and xylene and then covered with coverslip with DPX (Dibutyl polysterene xylene).

Fats stain

Slides pretreated with Osmium tetra oxide were also treated with Sudan black for demonstration of lipid cells (foam cells) indicative of artherosclerotic deposition.

RESULTS AND OBSERVATION

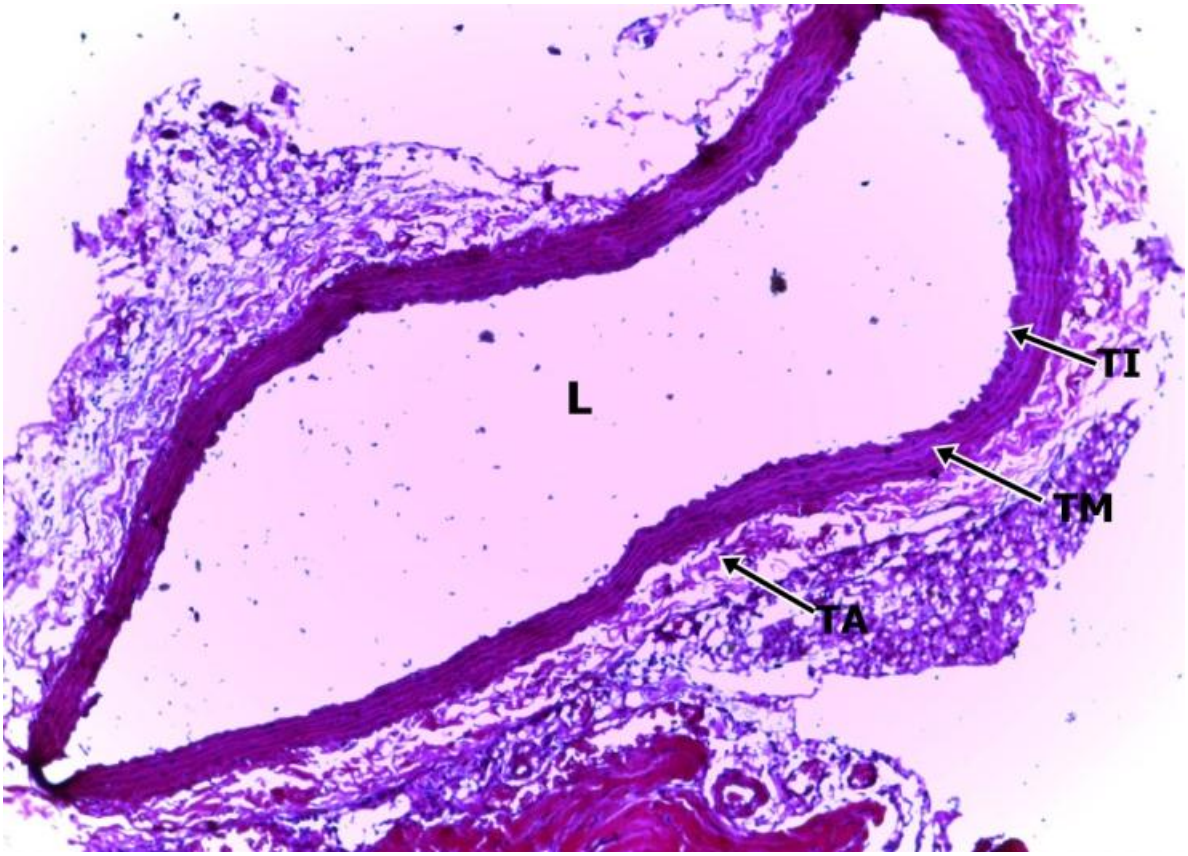

Plate 1A: Aorta stained with Sudan black (magnification X100)
GROUP I – Omega-3 fatty acid group (Cod liver oil)

Legend: L: Lumen, TI: Inner tunica intima, TM: Intermediate tunica media, TA: Outer tunica adventitia

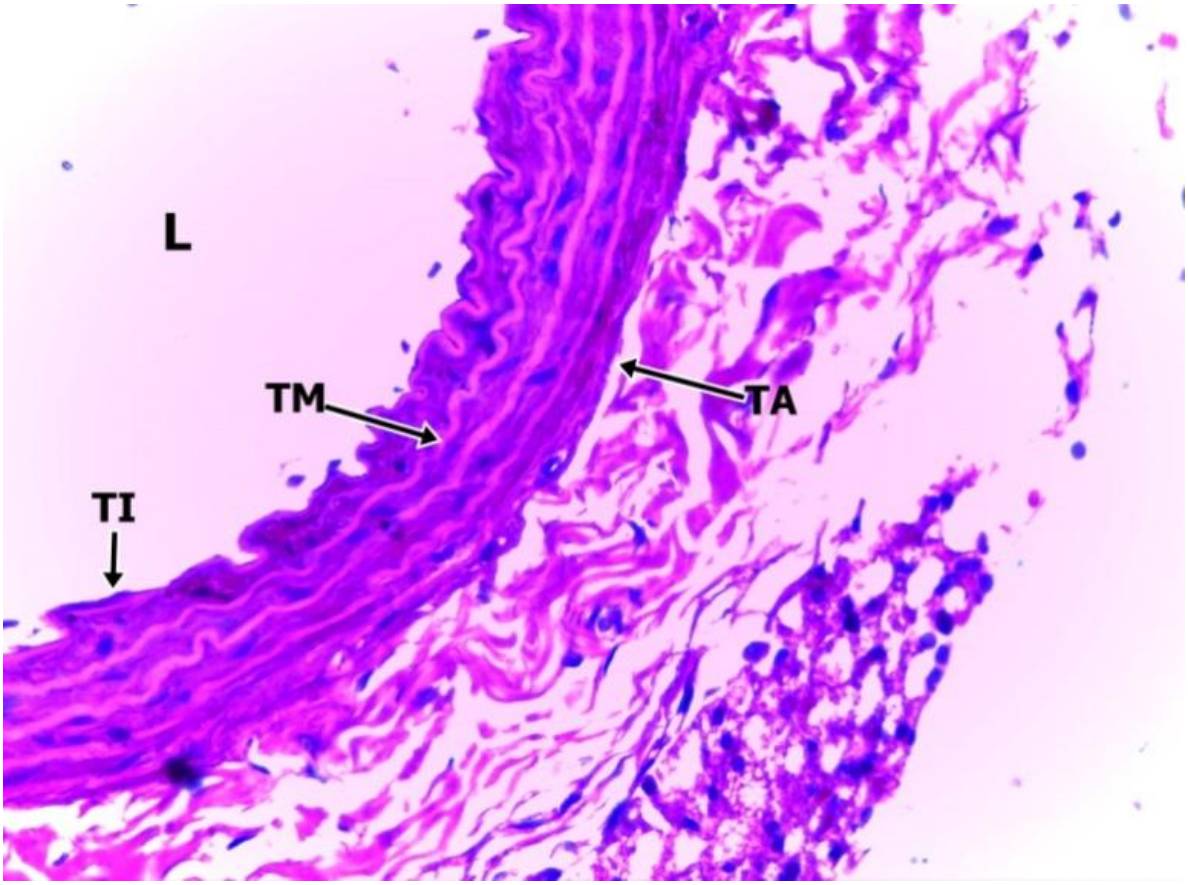

Plate 1B: Aorta stained with Haematoxylin and Eosin (magnification X400)
GROUP I - Cod liver oil group

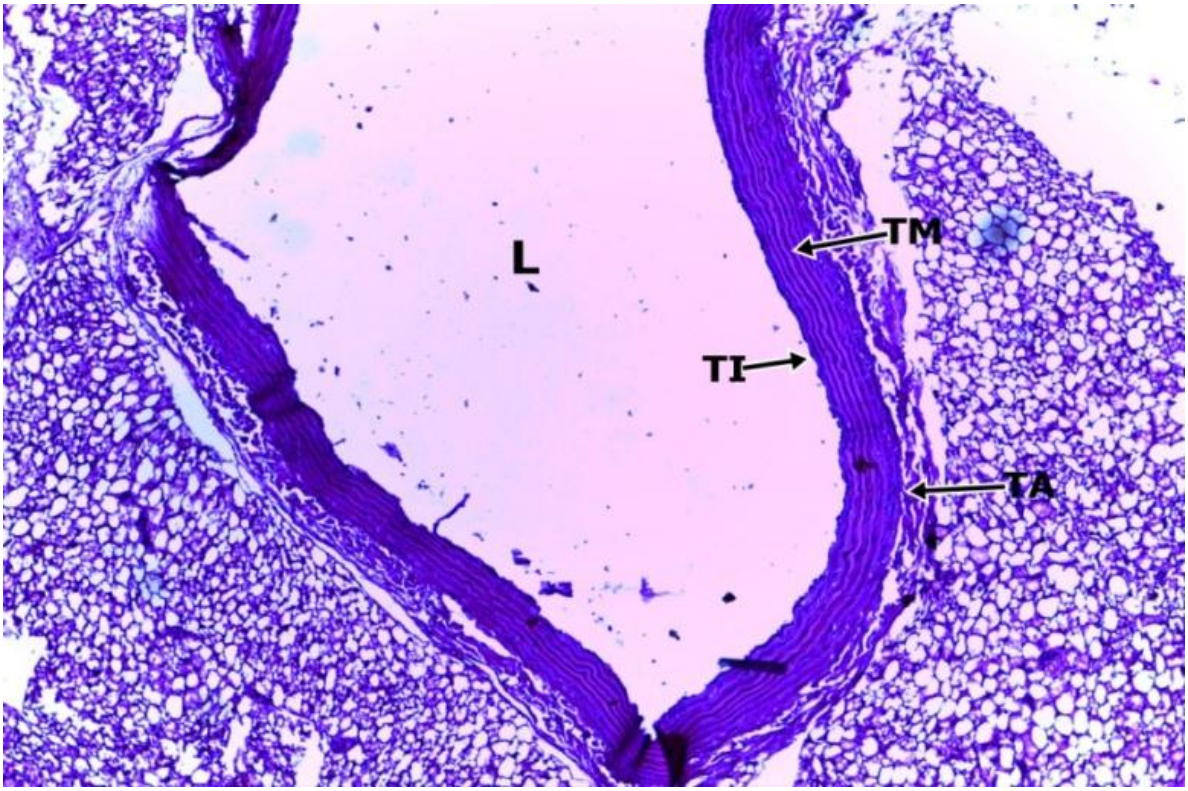

Plate 2A: Aorta stained with Sudan black (magnification X100)
GROUP II: Fresh palm oil group

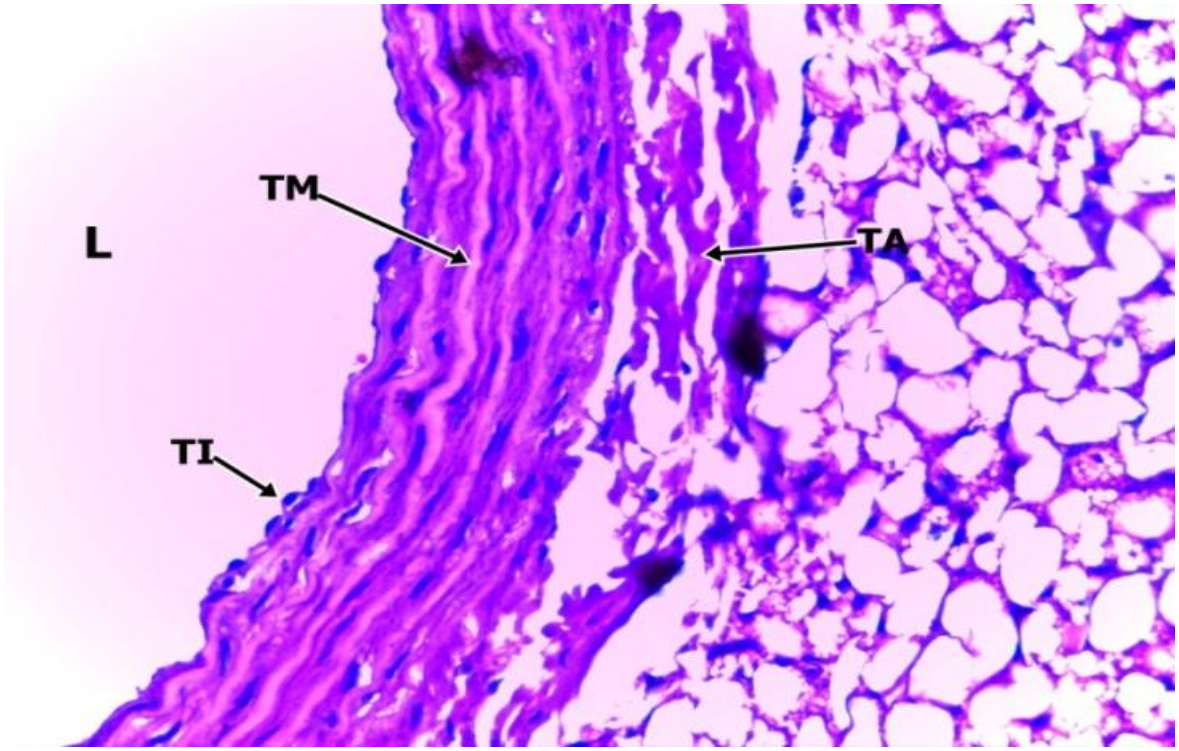

Plate 2B: Aorta stained with Haematoxylin and Eosin (magnification X400)
GROUP II: Fresh palm oil group

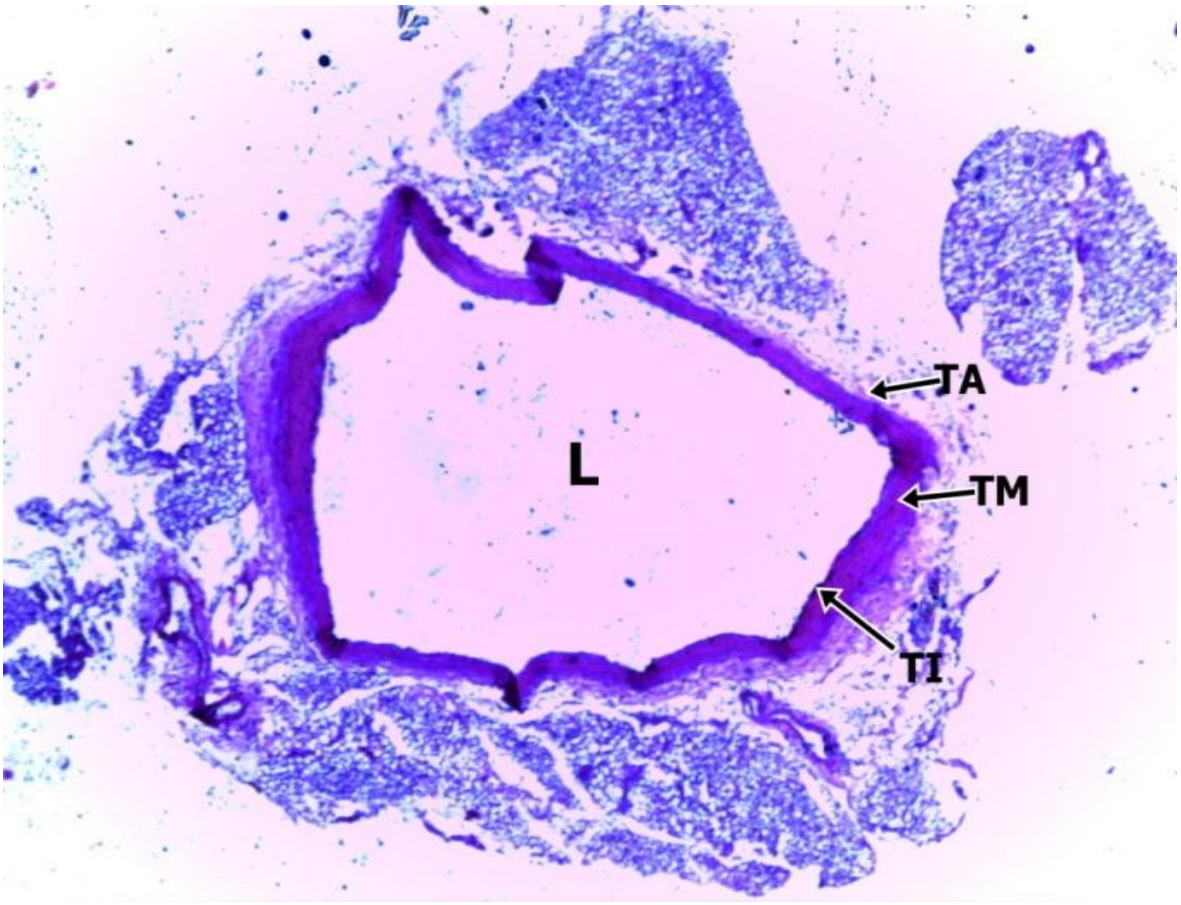

Plate 3A: Aorta stained with Sudan black (magnification X100)
GROUP III: Control group

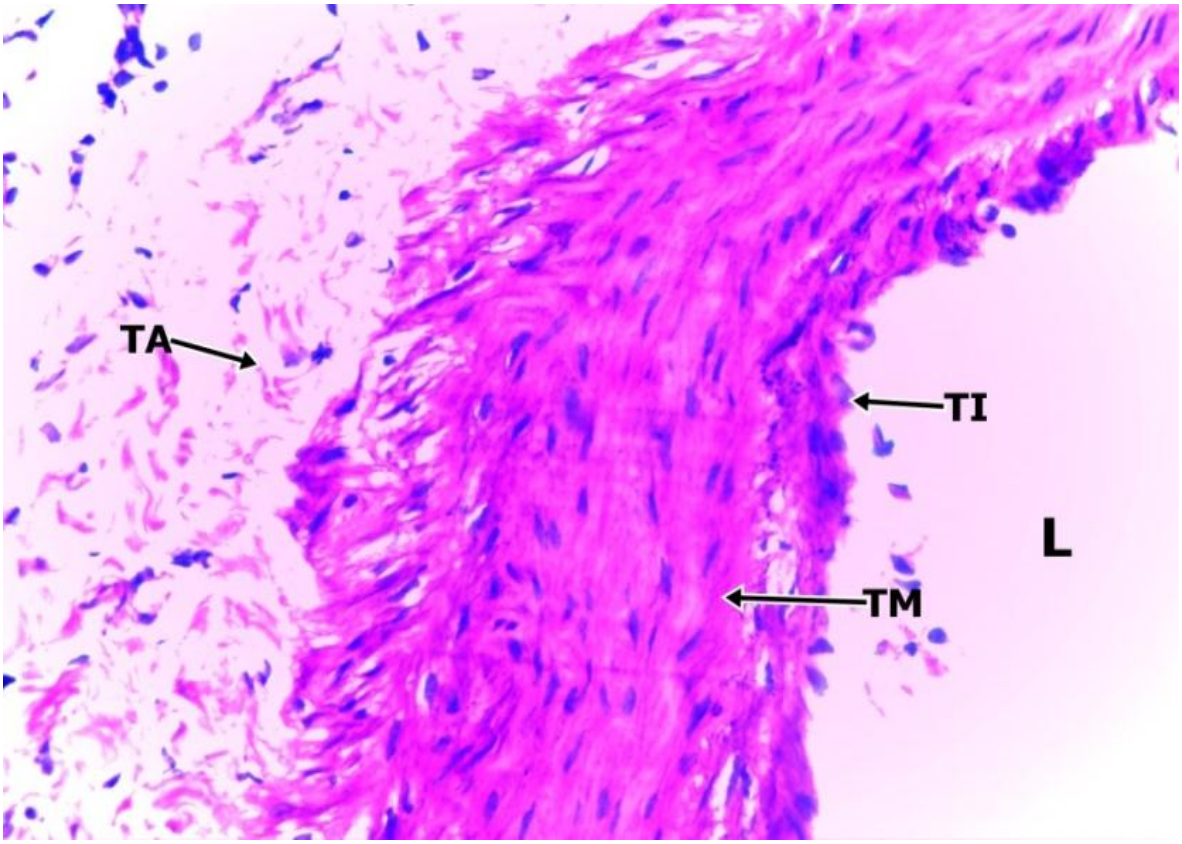

Plate 3B: Aorta stained with Haematoxylin and Eosin (magnification X400)
GROUP III: Control group

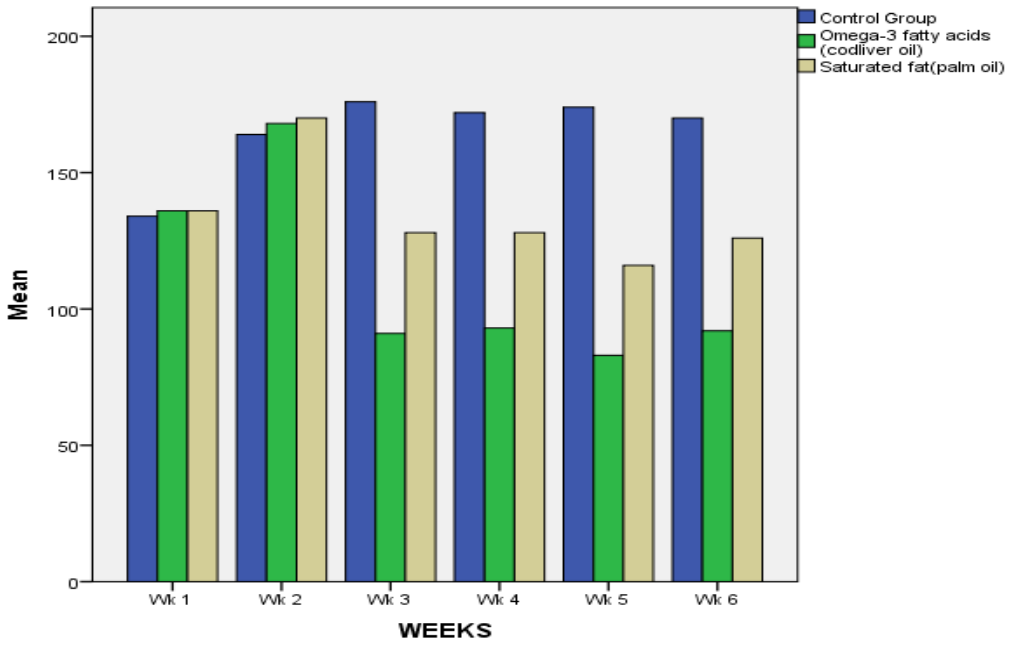

Fig. 1: Weight comparison between the control and experimental groups

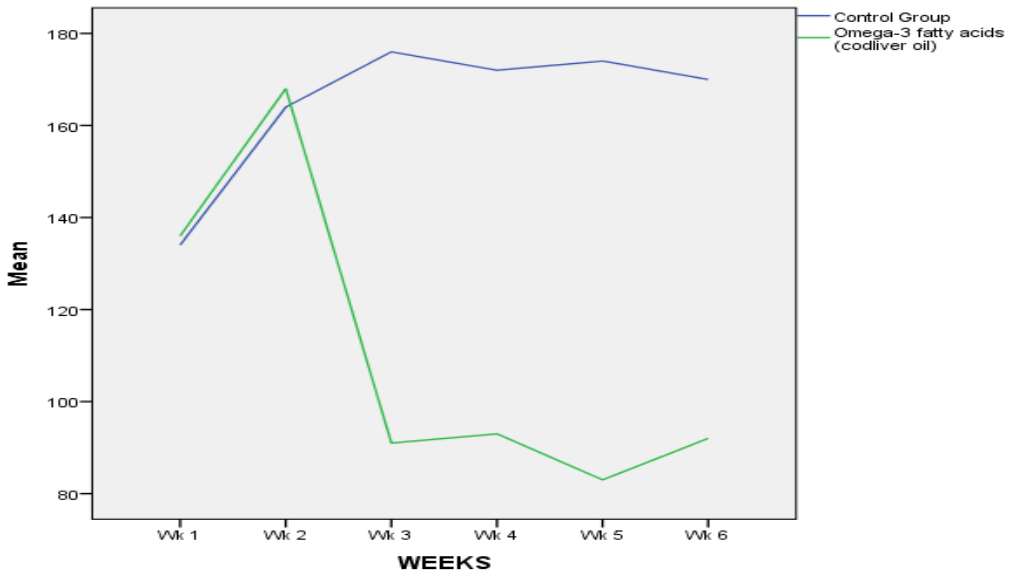

Fig. 2: Weight changes of albino wistar rats fed with omega-3 fatty acids

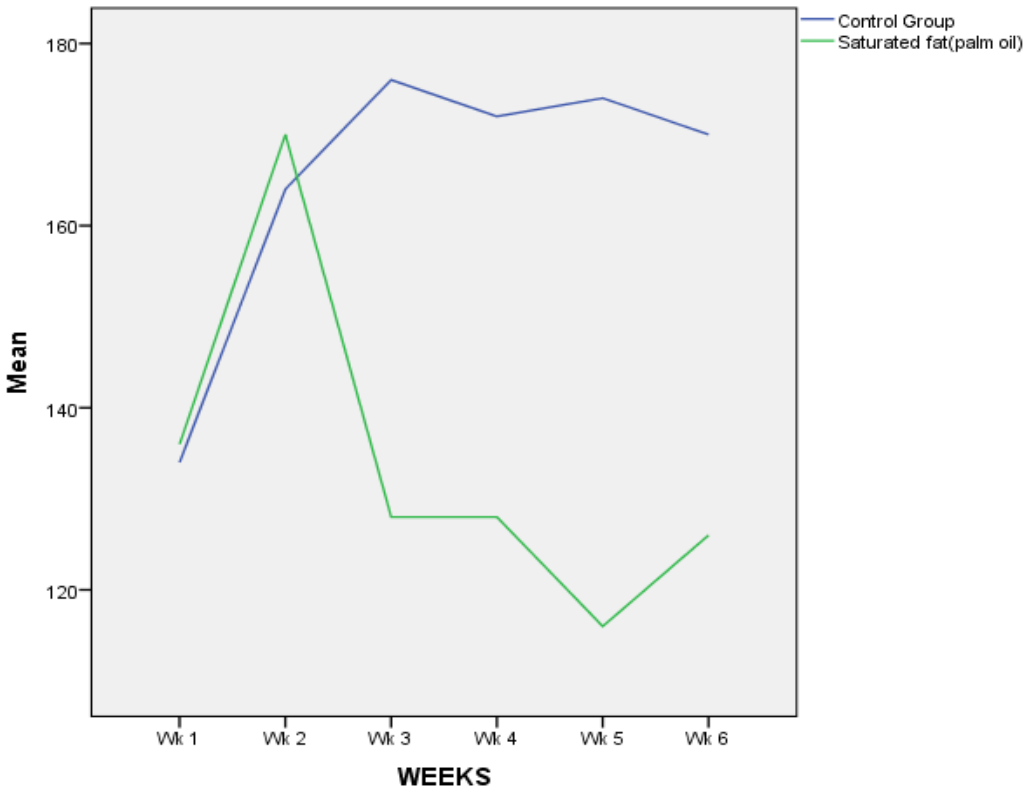

Fig. 3: Weight changes of albino wistar rats fed with saturated fat

DISCUSSION

Omega-3 fatty acid lowers blood pressure and heart rate thus improving blood vessel function. This helps to lower triglycerides and ease inflammation and by so doing reduces the risk of stroke, heart attack and death.[8] This finding is in agreement with the results of this study as shown in Plate 1 which indicates that blood vessels of the albino wistar rats that were fed omega-3 fatty acid source (cod liver oil) for six weeks had an intact lumen with distinct layers consisting of inner tunica intima, intermediate tunica media and outer tunica adventitia. The lining endothelium was also intact.

The World Health Organization stated in its technical report that there was increasing evidence that palm oil consumption increased risk of developing cardiovascular diseases.[9] Several other studies have also linked palm oil to higher risks of cardiovascular diseases including a 2005 study conducted in Costa Rica[10] and a 2011 analysis of 23 countries which showed that for each kilogram of palm oil added to the diet annually, there

was an increase in ischemic heart disease deaths (68 deaths per 10,000 increase) though the increase was much smaller in high-income countries.[11] The findings of our study disagree with these reports as shown in Plates 2A and 2B, where the blood vessels of the albino wistar rats were found to have intact lumen with distinct layers and elastic fibres, with complete absence of foam cells which indicate atherosclerosis.

Our work is rather in agreement with several studies[12-14] which have proved red palm oil to be beneficial. According to McNamara,[13] palm oil is an accepted replacement for hydrogenated vegetable oils which are a significant source of trans fats. It has also been indicated that palm oil reduces blood cholesterol when compared to sources of saturated fats like coconut oil, dairy and animal fats. Carotenes and vitamin E in red palm oil ensures that good HDL in the body is increased while reducing bad LDL.[2] This ensures that there is no oxidation of LDL, which is an essential step in obstruction of the aorta and hence, helps to prevent cardiovascular diseases. It has also been revealed, through epidemiological studies, that C_{12} Lauric and C_{14} Myristic saturated fatty acids, raise bad LDL cholesterol level.[15] These fatty acids however, are completely absent in palm oil.

The global pandemic of obesity represents a major public health challenge. More and more bulging waist lines, which is indicative of dangerous belly fats surrounding the organs, are observed.[16] A higher omega-3 fatty acid level is said to reduce belly fat by decreasing fats cell size and may represent a great way to manage body mass index (BMI).[8,17] The present study showed a sharp rise in the weight of the Group II rats in comparison with the control, as indicated in Figures 1 and 2. The weight was observed to drop as the weeks of experiments progressed. This indicated that the Omega-3 fatty acid constantly introduced into the animals' diet, reduced their weight by decreasing fat cell size, thus reducing the overall weight of the animals. Therefore, combining omega-3 fatty acid supplementation with both diet and exercise can provide a more significant result.

The animals that were fed with red palm oil showed the same weight response as indicated in figures 1 and 3. The weight computed directly with the control and was observed to drop as the weeks of experiment progressed. A similar trend was observed in another study that revealed that red palm oil helps in fat loss, because the vitamin A in palm oil is converted to retinoid which affects hormone levels, especially hormones that control appetite, thus lowering the risk of obesity. [18]

CONCLUSION

The results of the feeding experiments of albino wistar rats in this study showed that palm oil is not artherogenic. Therefore, on the basis of palm oil chemistry and evidence from this work, incorporation of palm oil in African diets is nutritionally sound and possibly protective from cardiovascular disease.

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