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MINIREVIEWS

Palm oil and the heart: A review

Osaretin J Odia, Sandra Ofori, Omosivie Maduka

Osaretin J Odia, Sandra Ofori, Department of Medicine, University of Port Harcourt, Port Harcourt 500001, Nigeria
Omosivie Maduka, Department of Preventive and Social Medicine, University of Port Harcourt, Port Harcourt 500001, Nigeria
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Correspondence to: Dr. Sandra Ofori, FWACP, MSc, Department of Medicine, University of Port Harcourt, Rivers State, Port Harcourt 500001, Nigeria. sandytom77@yahoo.com
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Abstract

Palm oil consumption and its effects on serum lipid levels and cardiovascular disease in humans is still a subject of debate. Advocacy groups with varying agenda fuel the controversy. This update intends to identify evidence-based evaluations of the influence of palm oil on serum lipid profile and cardiovascular disease. Furthermore, it suggests a direction for future research. The sources of information were based on a PubMed, Google Scholar, African Journal online and Medline search using key words including: palm oil, palmitic acid, saturated fatty acids and heart disease. Published animal and human experiments on the association of palm oil and its constituents on the serum lipid profile and cardiovascular disease were also explored for relevant information. These papers are reviewed and the available evidence is discussed. Most of the information in mainstream literature is targeted at consumers and food companies with a view to discourage the consumption of palm oil. The main argument against the use of palm oil as an edible oil is the fact that it contains palmitic acid, which is a saturated fatty acid and by extrapolation should give rise to elevated total cholesterol and low-density lipoprotein cholesterol levels. However, there are many scientific studies, both in animals and humans that clearly show that palm oil consumption does not give rise to elevated serum cholesterol levels and that palm oil is not atherogenic. Apart from palmitic acid, palm oil consists of oleic and linoleic acids which are monounsaturated and polyunsaturated respectively. Palm oil also consists of vitamins A and E, which are powerful antioxidants. Palm oil has been scientifically shown to protect the heart and blood vessels from plaques and ischemic injuries. Palm oil consumed as a dietary fat as a part of a healthy balanced diet does not have incremental risk for cardiovascular disease. Little or no additional benefit will be obtained by replacing it with other oils rich in mono or polyunsaturated fatty acids.

Key words: Palm oil; Serum lipid profile; Heart disease; Palmitic acid; Antioxidants

Core tip: With the increase in the prevalence of cardiovascular diseases (CVD) worldwide including developing countries, increasing attention is paid to underlying risk factors. Low-density lipoprotein (LDL) cholesterol is related to CVD in a linear and continous manner and one of the strongest risk factors for CVD. Dietary saturated fat increases LDL. Palm oil contains saturated fat and has thus been touted to be "bad for the heart". However it also contains unsaturated fats and beneficial antioxidants. This review sought to clarify the role of this important source of nutrients (to a

large part of the worlds' population) in CVD.

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INTRODUCTION

In recent times, there has been a running debate mainly in mainstream literature regarding the effects of palm oil consumption on the heart especially in the development of coronary artery disease. Advocacy groups and consumer protection groups drive most of the controversy with conflicting interests and agenda[1]. For thousands of years palm oil has been a major source of cooking oil in many communities in Asia and Africa[2-5].

In 2012, the World Heart Organization listed ischaemic cardiovascular disease (CVD) as the leading cause of death worldwide[6]. The relationship between serum cholesterol and CVD risk is linear and dose dependent with a 20%-25% reduction in the risk of death from CVD and non-fatal MI as low-density lipoprotein (LDL) cholesterol decreases by 1.0 mmol/L[7]. Palm oil consists of various fatty acids and this has been of major concern in discussing the value of palm oil vis-a-vis its relationship to cardiovascular disease[4,8]. The concern about palm oil is mainly because it contains palmitic acid, which is a saturated fatty acid and by extrapolation, using the Keys-Anderson equation which proposes that dietary intake of saturated fat increases serum cholesterol, will give rise to hypercholesterolemia when used as dietary oil[8]. However the main dietary saturated fatty acids (palmitic, stearic, lauric, and myristic acids) have varying effects on serum cholesterol. Saturated fatty acids with 12 and 14 carbon atoms (lauric and myristic acids) increase all the cholesterol fractions more than palmitic acid, and palmitic acid increases all the cholesterol fractions more than stearic acid[9]. On the other hand, oleic and linoleic acids which are unsaturated fatty acids do not have an adverse effect on serum cholesterol[9]. Palm oil has almost equal parts saturated and unsaturated fatty acids. Myristic acid (1%), stearic acid (5%) and palmitic acid (44%) make up the saturated fatty acid component in addition to monounsaturated oleic acid (39%), and polyunsaturated linoleic acid (11%)[10]. Furthermore, palm oil also contains vitamin E, carotenoids and antioxidants that do, at least in theory, protect the heart and also prevent cancer[4,5,11]. This review critically evaluates the scientific literature on palm oil in order to clearly show whether or not the consumption of palm oil indeed adversely alters the serum lipid profile and increases the prevalence of heart disease.

CHEMICAL COMPOSITION OF PALM OIL

The oil palm tree belongs to the genus Elaeis. The palm fruit has a fleshy mesocarp from which palm oil is derived and a seed from which palm kernel oil is derived[10]. These are two different types of oil and this paper is concerned with the former only.

The genus Elaeis has two species: E. guineensis and E. oleifera. The former is found mainly in West Africa, particularly in Nigeria and was propagated to Malaysia, Brazil, and Indonesia by the Portuguese in the 19th century for commercial purposes. E. oleifera originated from South America and is a dwarfish plant[5].

The major constituents of palm oil are triacylglycerols (TG). The glycerol molecule is esterified with three fatty acids. During the process of palm oil extraction from the fleshy mesocarp of the fruit, triacylglycerols attract other fat-soluble cellular components. These include phosphatives, sterols, pigments, tocopherols, tocotrienols, monoglycerols, diglycerol and free fatty acids (FFAs). The fatty acids are aliphatic acids like myristic, palmitic, stearic, linoleic acid. Palm oil also contains vitamins, antioxidants and other phytonutrients[10].

EFFECT OF PALM OIL CONSUMPTION ON SERUM LIPID PROFILE AND THE HEART

Animal studies

Onyeali *et al*[3] studied the influence of a palm oil-laced diet on the plasma lipid profile of Wister albino rats. The experimental animals were given a diet supplemented with 20% palm oil for 12 wk and compared to controls that were fed standard rat feed. They estimated the serum level of total cholesterol (TC), LDL, TG and high-density lipoprotein (HDL) at intervals of 0, 4, 8, and 12 wk. They demonstrated that although in the short term (4 wk) LDL and TC levels increased, sustained intake of the palm oil diet resulted in a significant reduction of the serum TG, TC and LDL levels compared to the control diet by 12 wk. The palm oil diet had no significant effect on HDL. The authors attributed most of these beneficial effects to the high content of antioxidants and vitamin A and E in the palm oil used. Tocotrienol and tocopherol make up 70% and 30% of the vitamin E present in red palm oil respectively[10]. The tocotrienols have been suggested to inhibit HMG CoA reductase enzyme activity and thus regulate serum cholesterol levels[12]. The findings from their study were in keeping with an earlier experiment in which Sulli *et al*[13] demonstrated that the supplementation of diet with α Tocopherol and β carotene (components of palm oil) reduced plasma cholesterol in hypercholesterolemic rabbits after 8 wk. Oluba *et al*[4] in Benin City Nigeria supplemented the diets of male albino Wister rats with palm oil and studied the effect of this on peroxidation of lipids and

activity of gluthathione peroxidase in their livers[4]. They showed clearly that as compared to the rats that were fed 5% cholesterol-diets without palm oil, those that had palm oil supplementation had a significantly reduced rate of lipid peroxidation in the liver. In addition, the activity of glutathione peroxidase increased significantly in the livers of the rats who fed on the supplemented diets. They extrapolated that in atheromatous plaques, oxidative damage induced by lipids could therefore be prevented by diets containing palm oil.

In the heart, ischemic episodes induces cell damage that can be made worse by sudden reperfusion due to the release of oxygen free radicals. Palm oil has been demonstrated to attenuate this effect in animal experiments. During reperfusion in rats that were fed diets supplemented by palm oil compared to control rats that had no supplementation, Tosaki *et al*[14] demonstrated a reduction in the level of oxidatively-modified proteins as well as an attenuation of the increase in free oxygen radicals in the heart. In a similar more recent study, Narang *et al*[15] used an isolated heart model of rats to demonstrate the effect of palm olein in the diet on ischemia reperfusion injury (IRI). Three groups of Wister rats were used. Two groups received different doses of palm olein (5% and 10% respectively). The third was the control group fed a normal diet. Thirty days later, each group was divided in two and each half was made to undergo global ischaemia for twenty minutes followed by reperfusion for 40 min. Following this, the investigators demonstrated that in the rats that were given the 5% olein-supplemented diet, there was an increase in the level of antioxidants in the myocardium but the levels of thiobabituric acid and reactive substance (TBARS) did not change. This was significant when compared to the rats fed the control diet that had significant oxidative injury with no concurrent increase in anti-oxidant activity. They however failed to observe a dose-dependent effect. Their study provided further evidence of the benefit of a palm oil supplemented diet in protecting the heart from oxidative stress and tissue injury following ischaemia-reperfusion. Furthermore, Kruger *et al*[16] clearly demonstrated a reduction in ischemia reperfusion injury in rats that were fed cholesterol rich diets when supplemented with palm oil. Many other studies have confirmed this[17-19].

Although they provide some evidence for the benefits of palm oil, they do not provide evidence of the effects of using palm oil that has been heated repeatedly on serum lipid profile and oxidant-antioxidant balance. It is well known that in parts of the world where palm oil is utilized for domestic cooking, it is reheated several times especially when used as frying oil. Adam *et al*[20] studied the influence of palm oil that had been heated repeatedly (five times) on serum lipid and homocysteine levels as well as peroxidation of lipids in rats. They found that the rats that were fed the heated palm oil had significantly increased lipid peroxidation, total cholesterol and TBARS compared to controls ($P < 0.05$).

These studies are inherently limited by the fact that they were conducted in rat models, which are not generalisable to humans as rats predominantly carry their cholesterol in HDL form[10]. Moreover the natural rat-diet is not fatty acid based further limiting the extrapolation of these results to humans.

Human studies

Palm oil especially as part of an overall low-fat diet has been shown to effectively maintain total cholesterol and lipoprotein cholesterol values. Kesteloot *et al*[21] measured serum lipids and apoproteins in 542 adults living in Nigeria. The subjects used palm oil exclusively as their source of cooking oil. The researchers reported that the subjects had lower cholesterol levels compared to values obtained from black and white Americans at the time.

Peanut oil and olive oil have 52%-60% and 65%-80% of their fatty acid composition as oleic acid respectively. Oleic acid has been demonstrated in several studies to have beneficial effects on serum lipids and cardiovascular disease[22]. These oils are thus recommended as healthier options. However, palm oil has 40% oleic acid. In addition the palmitic acid it contains, has been shown to have similar effects on the serum lipid profile as oleic acid.

Zhang *et al*[23] assessed the effect of palm oil used in Chinese diets in comparison to soya bean oil, peanut oil and lard. They showed that diets containing palm oil significantly reduced the levels of cholesterol in the serum of subjects who had normal serum cholesterol levels at baseline compared to lard but comparable to the effect of the mostly polyunsaturated soybean oil. Even among those who were hypercholesterolemic, palm oil significantly reduced the TC/HDL ratio more than peanut oil as the latter reduces HDL. It is important to note however that the Chinese diet contains less animal protein and cholesterol compared to typical "western" diets. This may have influenced their results, limiting their generalisability.

Ng *et al*[24] demonstrated that the main saturated fat in palm oil, palmitic acid was comparable to oleic acid in terms of its effect on cholesterol and lipoprotein levels in serum, as well as eicosanoids. Oleic acid is the major component of olive oil that is recognized as "heart-healthy" oil[24]. They achieved this by challenging 33 subjects (whose ages ranged between 22 and 41 years) that had normal serum levels of cholesterol with a diet rich in coconut oil for four weeks. Following this, they were given diets rich in palm olein or olive oil with a subsequent crossover after 6 wk. During this time, the only oil the subjects were allowed to use was the test oil group to which they were assigned. The coconut oil containing lauric and myristic fatty acids elevated all the lipoprotein and lipid parameters in

serum significantly. During the crossover periods, the olive oil and palm olein diets did not differ significantly in their effects on all measured lipid parameters. They concluded that in healthy humans with normal serum cholesterol levels, olive oil could be substituted with palm oil without significant changes in lipid profile. Similarly Sundram conducted a cross over study that was double blinded and demonstrated that palm olein and oleic acid were similar in their ability to lower cholesterol levels in serum[25]. An Indian study by Chafoorunissa *et al*[26] reported that groundnut oil and palm olein also have similar effects on cholesterol levels. They both maintain comparatively normal serum cholesterol levels.

In a systematic review and meta-analysis of 51 human dietary intervention trials, the authors compared trials in which palm oil was substituted for diets rich in polyunsaturated fatty acids (PUFAs), stearic acid and monounsaturated fatty acids (MUFAs)[27]. Although serum lipid profile (TC, HDL and LDL cholesterol, apolipoprotein A-I and apolipoprotein B) was beneficially altered with diets containing palm oil compared to myristic and lauric acid, the same was not the case when compared to PUFAs and MUFAs. In young people and those subjects that had overall lower energy intake from fat, this latter finding was not significant. The diets rich in palm oil did not significantly change the TC/HDL or LDL/HDL cholesterol ratios. On the other hand, the palm oil rich diets significantly increased the levels of apolipoprotein A-I and HDL cholesterol and reduced the levels of TC/HDL, triacylglycerols and apolipoprotein B when compared to trans fatty acid-rich diets. They concluded that with regards to usual dietary sources of fat, palm oil was not much different except when it was substituted for trans fat where it proved beneficial. Considering that majority of global fat consumption is in the form of solid fats and the process of converting liquid oils to solid fats involves hydrogenation, which produces trans fats, palm oil has a distinct advantage; it does not require hydrogenation to turn it to solid fats. In this way solid fats made from palm oil are free from trans fats[28].

Dietary fats influence on coronary heart disease risk has traditionally been estimated from their effects on total and LDL cholesterol. Following large epidemiologic studies in the 50's and 60's saturated fats gained a bad reputation in terms of being significantly associated with cardiovascular disease especially coronary heart disease (CHD) and cardiovascular mortality[8,9,22]. Furthermore several meta-analysis and systematic reviews of randomised controlled trials and cohort studies recommended that polyunsaturated fatty acids should substitute saturated fatty acids. This was based on the supposition that this reduces the risk of CHD events and fatal CHD despite the fact that they demonstrated no direct link between saturated fatty acids and CHD death[29-31]. This informed various guideline recommendations to reduce total dietary energy intake from saturated fats in a bid to decrease the prevalence of coronary heart disease[32-34]. A recent meta-analysis has countered this theory as the authors found that a significant relationship did not exist between saturated fat intake and cardiovascular disease (coronary heart disease and stroke)[35]. In patients with established CHD, secondary prevention by means of a reduced fat or modified fat diet (in which saturated fat is substituted by mono- or poly unsaturated fat) is also recommended[34]. However, another recent meta-analysis by Schwingshackl and Hoffmann has shown that this had no significant effect on all-cause mortality and cardiovascular mortality, combined cardiovascular events and myocardial infarction[36]. Furthermore multivariate meta-regression in their study did not reveal significant relationships between changes in saturated fatty acids, monounsaturated and polyunsaturated fatty acids and risk of all-cause or cardiovascular mortality, myocardial infarction and cardiovascular events. It remains important to note however that this meta-analysis included studies that differed in various ways including the protocols of the studies resulting in some heterogeneity. In addition there was publication bias and the quality of evidence was graded as moderate.

CONCLUSION

Taking all the above into consideration, it is known that saturated fat adversely affects lipid profile and raised serum total and low-density lipoprotein cholesterol is associated with cardiovascular risk. However not all saturated fats have this adverse effect. Palmitic acid the main saturated fat in palm oil has a similar effect on lipid profile as the monounsaturated fat oleic acid that is currently recommended. In addition palm oil also contains oleic and linoleic acids, and vitamin E tocotrienols that are powerful antioxidants and inhibit cholesterol synthesis as well[37].

Therefore, in conclusion it is the opinion of the authors that palm oil consumed as a dietary fat as part of a healthy balanced diet does not have incremental risk for cardiovascular disease. Little or no additional benefit will be obtained by replacing it with other oils rich in mono or polyunsaturated fatty acids. We recognize that more longitudinal population-based studies are needed to fully characterize the impact of the consumption of diets, which utilize palm oil compared to other accepted "heart healthy" oils like olive oil on the future risk of heart disease using lipid parameters as intermediate markers of risk.

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