Red palm oil: nutritional, physiological and therapeutic roles in improving human wellbeing and quality of life

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ABSTRACT

The link between dietary fats and cardiovascular disease has created a growing interest in dietary red palm oil research. Also, the link between nutrition and health, oxidative stress and the severity or progression of disease has stimulated further interest in the potential role of red palm oil (a natural antioxidant product) to improve oxidative status by reducing oxidative stress in patients with cardiovascular disease, cancer and other chronic diseases. In spite of its level of saturated fatty acid content (50%), red palm oil has not been found to promote atherosclerosis and/or arterial thrombosis. This is probably due to the ratio of its saturated fatty acid to unsaturated fatty acid content and its high concentration of antioxidants such as β-carotene, tocotrienols, tocopherols and vitamin E. It has also been reported that the consumption of red palm oil reduces the level of endogenous cholesterol, and this seems to be due to the presence of the tocotrienols and the peculiar isomeric position of its fatty acids. The benefits of red palm oil to health include a reduction in the risk of arterial thrombosis and/or atherosclerosis, inhibition of endogenous cholesterol biosynthesis, platelet aggregation, a reduction in oxidative stress and a reduction in blood pressure. It has also been shown that dietary red palm oil, taken in moderation in animals and humans, promotes the efficient utilisation of nutrients, activates hepatic drug metabolising enzymes, facilitates the haemoglobinisation of red blood cells and improves immune function. This review provides a comprehensive overview of the nutritional, physiological and biochemical roles of red palm oil in improving wellbeing and quality of life.

KEY WORDS: Antioxidants.
Cardiovascular diseases.
Chemopreventive agent.
Dietary supplements.
Red palm oil.

Introduction

Red palm oil is an edible natural oil produced from the fruit of the *Elaeis guineensis* tree, which is known to have been part of the human diet for over 5000 years and is seen as a nutritious food and a valuable medicine.[1,2] It derives its colour from carotenes such as β-carotene and lycopene, the same nutrients that give tomatoes, carrots and other fruits and vegetables their rich red and orange colours.

It is the second most widely produced edible oil, with over 28 million tonnes produced globally in 2004. It also serves as an important component of soaps, washing powders and personal care products and has also been reported to be useful in treating wounds.[3]

For many years, the inhabitants of West African countries have recognised and used red palm oil as a cooking oil. It is reported that European merchants trading with West African countries purchased red palm oil for use in Europe. Historical reports indicate that in the Asante Confederacy, state-owned slaves built large plantations of palm oil trees, while in the Kingdom of Dahomey, King Ghezo passed a law in 1856 forbidding his citizens from cutting down palm oil trees. It was appreciated by the pharaohs of ancient Egypt as a sacred food.

It is also known that red palm oil was regarded as a highly valuable product by British traders for use as an industrial lubricant during Britain's industrial revolution, and also in the manufacture of basic soap products. By 1870, palm oil constituted the primary export product of West African countries such as Ghana and Nigeria.

It is believed to have originated from tropical Africa; however, it has now spread to most parts of the world. In many countries it is cheaper than other edible oils and has the additional benefit of being an important source of vitamin A in vitamin A-deficient or marginally deficient communities.[2,3]

The link between dietary fats and cardiovascular diseases has stimulated growing interest in dietary red palm oil research. The link between nutrition and health in oxidative stress has created further interest in red palm oil and its potential ability to improve oxidative status by reducing it in patients with cardiovascular disease, cancer and other chronic diseases. However, it is important to note that too high an intake of red palm oil could induce liver toxicity and liver damage characterised by increased alanine transaminase (ALT) and asparate transaminase (AST) activities. Interestingly, consumption of moderate amounts

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of red palm oil has been reported to reduce oxidative stress.[4–6]

The aim of this review is to provide a comprehensive overview of current scientific information on the nutritional, physiological and biochemical roles of red palm oil in improving wellbeing and quality of life.

Nutritional, physiological and therapeutic roles

Role in supplementation

Red palm oil is used as the basic source of dietary fat in various countries due to its nutritional and biochemical importance. In some countries it is believed that red palm oil is an essential component in the diet of pregnant and nursing women for maintaining good health for both mother and child. Several studies have reported on the potential role of red palm oil in the treatment and prevention of malnutrition and vitamin deficiency, and indicate that governments of some developing countries are currently incorporating red palm oil in the diets or snacks of children and pregnant women to eradicate conditions such as vitamin A deficiency.[2,4–6,7]

Red palm oil also supplies fatty acids that are essential for growth and development and provides vitamins, antioxidants and other phytonutrients necessary to promote good health and quality of life.[5,8] Other reports indicate that red palm oil can adequately supply the fat and vitamin A precursors needed in the human diet. It is also regarded as the richest dietary source of provitamin A carotenes, containing 15 times more provitamin A carotenes than carrots and 300 times more than tomatoes, thus making it a potential resource in the treatment of vitamin A deficiency. It is believed that one teaspoon of red palm oil per day could supply the recommended daily allowance (RDA) of vitamin A for children. Reports by Canfield[9] and Balasundram *et al*.[10] show that the addition of red palm oil to the diet can double or triple the amount of vitamin A in a mother's milk.

Vitamin A deficiency is considered to be a public health problem in many developing countries.[11] There is a general consensus that food-based approaches are viable and sustainable options for addressing vitamin A deficiency in populations. One example is the fortification of food, which, if properly monitored, could make a significant contribution towards improving the vitamin A status of a population. It has also been shown that when incorporating red palm oil in different products, 15–20% of the RDA of β-carotene per portion of product consumed is provided.[12]

Red palm oil is unique when compared with other dietary fats in that it contains the highest known concentrations of natural antioxidants, particularly provitamin A carotenes and vitamin E. It is known that vitamins A and E contribute to the maintenance of good health and disease prevention, and further that red palm oil vitamin E contains 70–80% tocotrienols.[4,5,13,14] It also contains more nutrients than any other dietary oil. In addition to β-carotene, α-carotene and lycopene, it contains at least 20 other carotenes plus vitamin E, vitamin K, ubiquinone 10, squalene, phytosterols, flavonoids, phenolic acids and glycolipids. Vitamin E, tocotrienols, carotenes and other antioxidants make red palm oil a unique source of antioxidants.[2,4,15–17]

Owing to its nutrients and antioxidants, red palm oil is viewed as a natural dietary supplement. It is good for cooking and baking and consists of 50% saturated fatty acids, 40% monounsaturated fatty acids and 10% polyunsaturated fatty acids. The high saturated and monounsaturated fatty acid content makes red palm oil heat-resistant and stable, and the high saturated fat and antioxidant content make it resistant to oxidation and free-radical formation.[2,6,7,16,18–20]

Studies have confirmed the nutritional value of red palm oil due to high monounsaturation at the 2-position of triacylglycerols, making it an even healthier oil than olive oil. It is also known that the contribution of dietary fats to blood lipid and cholesterol modulation is a consequence of the digestion, absorption and metabolism of the fats. Lipolytic hydrolysis of red palm oil glycerides containing mainly oleic acid at the 2-position and palmitic and stearic acids at the 1 and 3 positions, permits the ready absorption of 2-monoacrylglycerols, while the saturated fatty acids are poorly absorbed. It has been observed that dietary red palm oil, when included as part of a balanced diet, generally reduces blood cholesterol, low-density lipoprotein (LDL)-cholesterol and triglycerides, while increasing high-density lipoprotein (HDL) cholesterol. Improved lipoprotein (a) and apo-A1 levels have been observed in the serum of persons who include red palm oil in their diet.[21,22]

The effects of red palm oil on major plasma carotenoids, tocopherols, retinol and serum lipids in Chinese diets were evaluated by Zhang *et al*.[23] In carrying out the study, the investigators selected a red palm oil group (20 male subjects aged 18–32 years) and a soybean oil group (22 male subjects, same age group). The results showed that plasma α-carotene, β-carotene and lycopene concentrations of the red palm oil (RPO) group increased significantly over a 21-day period, and at the end of the study (42 days) the α-tocopherol concentrations were found to be significantly increased. It was further observed that the serum concentrations of total cholesterol, triglyceride, HDL-cholesterol, apolipoprotein A1 and apolipoprotein B of all subjects showed no significant changes in the RPO group. The results of this study suggest that RPO is a good source of carotenoids and vitamin E and also that it can significantly increase the plasma concentrations of α-carotene, β-carotene, lycopene and α-tocopherol.

Canfield *et al*.[9] noted that despite the introduction of vitamin supplementation programmes, vitamin A deficiency in children remains a public health concern in developing countries. A study conducted in Honduras to investigate the effectiveness of short-term dietary RPO supplementation of mothers as a strategy for improving their vitamin A status reported that supplementation in the maternal diet increased provitamin A carotenoids in breast milk and in the serum of the mother and infant.

Zangre *et al*.[24] carried out a study to demonstrate the feasibility and effectiveness of introducing RPO in non-consuming areas in Burkina Faso. Red palm oil was obtained from the south-west region and was then promoted and sold at project sites by community workers who had been trained in persuasive communication and social marketing techniques. Blood samples were later collected from the target population who bought and consumed the RPO. The analysis of serum and dietary data collected at baseline showed that approximately 65% of the target population had low serum retinol as dietary vitamin A. However, following consumption of RPO, it was reported that the percentage of mothers and children at risk of vitamin A deficiency had been reduced significantly. Thus, the study indicated that the promotion of RPO was effective in improving vitamin A intake by the target population.

In a South African study, van Stuijvenberg *et al*.[13] determined the effect of a biscuit containing RPO as a source of β-carotene on the vitamin A status of primary school children as compared to the effect of a biscuit containing β-carotene from a synthetic source. The authors concluded that a biscuit containing RPO as a source of β-carotene is as effective as one containing synthetic β-carotene in improving the vitamin A status of primary school children. However, the additional qualities of red palm oil (i.e., no trans fatty acids, a rich source of antioxidants) make RPO an excellent alternative resource for addressing vitamin A deficiency. Red palm oil is also an excellent resource in addressing vitamin E deficiency considering its high vitamin E content.

Sivan *et al*.[25] administered RPO, groundnut oil fortified with retinol palmitate and unfortified groundnut oil to six groups of preschool children in India (four experimental and two control groups) in randomly assigned local porridge for a period of seven months. The study was designed to monitor the difference in the efficacy of the mode of supplementation and the optimum dose for improving vitamin A status. Results showed that the RPO groups had higher retinol and β-carotene levels when compared to the other groups.

Effects on the heart

Other studies have shown that RPO supplementation protects against heart disease/reperfusion injury.[5,26,27] To verify this, Esterhuyse *et al*.[26] fed rats with standard rat chow plus cholesterol and/or RPO supplementation for six weeks. The investigators determined functional recovery, myocardial phospholipid and cAMP/cGMP levels in isolated rat hearts subjected to 25 min of normothermic total ischaemia. Their findings showed that dietary RPO in the presence of cholesterol improved aortic output recovery when compared to cholesterol only ($P<0.05$) and that improved functional recovery in hearts supplemented with RPO versus controls was preceded by elevation in the cGMP levels early in ischaemia. Based on these findings, they concluded that dietary RPO supplementation improves reperfusion aortic output through mechanisms that may include activation of the NO-cGMP and inhibition of the cAMP pathway.

In another animal study, Esterhuyse *et al*.[20] showed that dietary RPO may improve myocardial ischaemic tolerance by increasing bioavailability of nitric oxide (NO) and improving NO-cGMP signalling in the heart, suggesting a cardioprotective role for RPO to the ischaemic and reperfused heart. These findings call for further studies in animal and human subjects to elucidate the mechanisms involved in the cardioprotective activity of RPO.

Bester *et al*.[28] developed an oxidative risk-induced diet (ORD) rich in polyunsaturated fatty acids (PUFAs) and low in saturated fatty acids (SFAs) and a high saturated fat diet (HFD) rich in SFAs and low in PUFAs. The diets were either supplemented with RPO (experimental group) or not supplemented with RPO (control group) and the researchers investigated whether or not RPO could offer protection against oxidative stress, ischaemia and reperfusion injury. Their findings showed that RPO offered protection against reperfusion injury/oxidative stress in ORD- and in HFD-fed rats, as indicated by increased aortic output recovery and improved oxidative status following RPO supplementation for 14 weeks.

The signalling mechanisms responsible for the effects of RPO in the presence of cholesterol, however, remained to be elucidated. Therefore, Kruger *et al*.[29] examined the effects of RPO with a high-cholesterol diet on mitogen-activated protein kinase (MAPK) phosphorylation and apoptosis. Rats were fed control diets that contained either 2% cholesterol or 25% cholesterol and 7 g RPO (CRPO) for five weeks. The hearts of the rats were excised and mounted on an isolated working heart perfusion apparatus. Cardiac function was measured and then the hearts were freeze-clamped and used to assess MAPK phosphorylation and to evaluate apoptosis. It was observed that cholesterol supplementation caused poor aortic output recovery when compared to the control group. In the presence of RPO, however, output increased significantly. It was further observed that the cholesterol group's poor aortic output was associated with a significant increase in p38-MAPK phosphorylation, whereas the CRPO-supplemented group showed a significant reduction in p38-MAPK phosphorylation when compared to the cholesterol-supplemented group. The investigators also noted that the significant reduction in p38-MAPK was also associated with reduced apoptosis, as indicated by significant reductions in caspase-3 and poly (ADP-ribose) polymerase cleavage. The study by Kruger *et al*.[29] provides a possible mechanism and alternative role for RPO as a non-pharmacological strategy to protect the heart against ischaemia reperfusion-induced injury in the presence of cholesterol, which is one of the risk factors associated with cardiovascular and ischaemic heart disease.

It has been shown that RPO supplementation improves reperfusion function; however, the exact protective cellular mechanisms have yet to be established.[20,26,28,29] To determine a potential mechanism for cardiac functional improvement, Engelbrecht *et al*.[30] investigated the regulation of MAPK and PKB/Akt in the presence and absence of dietary RPO supplementation in ischaemia/reperfusion-induced injury. The investigators used Wistar rats and fed them either a standard control diet or a control diet supplemented with RPO for six weeks. The investigators reported that dietary RPO supplementation caused differential phosphorylation of MAPK and PKB/Akt during ischaemia/reperfusion injury. These changes in phosphorylation were associated with improved recovery and reduced cleavage of an apoptotic marker, suggesting that dietary RPO supplementation may offer protection through the MAPK and PKB/Akt signalling pathways during ischaemia/reperfusion-induced injury.

Role in cancer

Red palm oil contains the highest concentrations of natural tocotrienols and these have been found to display potent anticancer activity at treatment doses and have little or no effect on normal cell growth or viability.[16] Tocotrienols have been shown to induce apoptosis in breast cancer. It is also known that morphological and biochemical characteristics of apoptosis, such as nuclear and cytoplasmic condensation and DNA fragmentation, are mediated by the activation of caspases, which are cysteine proteases. Apoptosis is triggered by the activation of initiator caspases (caspase-8 or -9) that subsequently activate effector caspases (caspase-3, -6, and -7).

A study conducted using a highly malignant mouse mammary epithelial cell line to determine if tocotrienol-induced apoptosis is mediated through the caspase-8 or caspase-9 pathway, showed a significant increase in the activities of caspase-8 and -3 but not caspase-9. When tocotrienol, in combination with selected caspase-8 or caspase inhibitors was administered to the same epithelial cell line, it was found that they completely blocked tocotrienol-induced apoptosis and activation of caspase-8 and caspase-3. These findings showed that tocotrienol-induced apoptosis in highly malignant mammary epithelial cells is mediated through caspase-8 activation and potentially provide important information required in understanding the health benefits of tocotrienol-rich RPO in preventing or reducing the risk of breast cancer in women.[16]

Previous studies have shown that tocotrienols and not tocopherols displayed potent antiproliferative and apoptotic activity against breast cancer cells.[14,31,32] These studies suggest that tocotrienols from RPO may have significant value as therapeutic agents for breast cancer prevention and treatment.

Role in atherosclerosis

Current available literature indicate that very little work has been done on the influence of RPO that contains a higher concentration of carotenoids than refined, bleached and deodorised palm oil (RBO-PO). Wilson *et al*.[33] investigated the influence on hamsters fed RPO or RBO-PO or RBO-PO plus an RPO extract on plasma cholesterol levels and aortic accumulation versus hamsters fed on coconut oil. Their findings showed that plasma total cholesterol and non-HDL-cholesterol (non-HDL-C) were significantly lower in the hamsters fed RPO compared to coconut oil-fed hamsters. Plasma HDL-cholesterol concentrations were higher by 14% and 31%, respectively, in hamsters fed RBO-PO and RPO compared to the coconut oil-fed hamsters. The coconut oil-fed hamsters also showed significantly higher plasma lipid hydroperoxide concentrations as compared to those fed RPO or RBO-PO and RPO-PO plus RPO. Also, the coconut oil-fed hamsters had significantly higher levels of aortic total, free and esterified cholesterol as compared to the hamsters fed RPO. In conclusion, hamsters fed RPO, RBO-PO and RBO-PO plus RPO had lower total plasma cholesterol and non-HDL-cholesterol and higher HDL-cholesterol while accumulating less aortic cholesterol as compared to hamsters fed coconut oil. The total cholesterol content of the aorta of the hamsters fed coconut oil was significantly higher than that of the aorta of RPO-fed hamsters. The levels of free and esterified cholesterol were also higher in the coconut oil-fed hamsters. The ratio of free to esterified cholesterol was highest in the aortas of hamsters fed RPO, a reflection of lower ester deposition and thus less-severe atherosclerosis. This study clearly showed that RPO is less atherogenic than either RBO-PO or reconstituted palm oil.

Red palm oil is often stigmatised as a hypercholesterolaemic fat, mainly because of its palmitic acid content. However, in the above study, coconut oil was the most hypercholesterolaemic while RPO was found to be less cholesterolaemic than RBO-PO and RBO-PO plus PO (reconstituted RBO-PO). The results of the study are similar to those of Ng *et al*.,[34] who showed that consumption of RPO after a five-week intake decreased serum cholesterol concentrations in healthy volunteers. Previous work has shown that the presence of palmitic acid at the 2-position of a triglyceride molecule renders the triglyceride more cholesterolaemic and atherogenic.[35–37] It should, however, be noted that although RPO contains 40% palmitic acid, only an estimated 3% of the palmitic acid is in the 2-position, thus making RPO less cholesterolaemic. The study conducted by Sundram *et al*. also showed an increase in plasma HDL-cholesterol concentration in rats fed RPO.[38]

Studies show that adding RPO to the diet can reduce plaque deposition in arteries and therefore reverse the process of atherosclerosis. This has been demonstrated in animal and human studies. In one study, 50 atherosclerotic subjects were divided into two equal groups. At the beginning of the study, the degree of blockage of their carotid arteries was determined and found to range from 15% to 79%. Without any other changes to diet or medications, half of the subjects began taking a daily RPO supplement. The other half received a placebo (control group). The degree of atherosclerosis was monitored using ultrasound scans over an 18-month period. In the group receiving RPO, atherosclerosis was found to have halted in 23 of the 25 participants. In seven of these participants, atherosclerosis was shown to have regressed. In comparison, none of the subjects in the control group showed any improvement, and the condition in 10 of them had worsened.[39] This and other studies clearly reveal that RPO is beneficial to human health.

Producing a favourable response

A red palm oil diet has also been found to reduce platelet aggregation and decrease blood clotting,[40–43] although there has been an isolated case report of enhanced platelet aggregation and thrombocytopenia thought to be associated with the RPO diet.[44] However, in general, most studies indicate a beneficial role for RPO in reducing the thrombotic tendency of platelets.

Red palm oil has been reported to maintain normal blood pressure. The high antioxidant content of the oil reduces free radicals and keeps inflammation under control. In one study, investigators induced inflammation in the arteries of test animals. Inflammation is known to cause swelling which narrows arterial lumen, restricting blood flow to vital organs such as the heart. Half of the animals received RPO in their diet while the other half served as the control group. In the control group, arterial lumen was severely constricted and 42% of the animals died. However, those receiving the RPO showed far less inflammation and constriction, resulting in 100% survival.[2] This study supports the hypothesis that red palm oil protects against heart disease. This has been confirmed in populations where RPO is consumed regularly. For instance, heart disease in Malaysia, Indonesia, Papua New Guinea and Nigeria (where RPO is a major if not sole source of edible fat in the diet) is among the lowest in the world.[2,45]

The powerful antioxidant properties of RPO have also been shown to be of benefit in the protection against neurological degeneration. Two of the most significant factors that affect brain function are oxidative stress and poor blood circulation.[46] Oxidative stress generates free radicals that damage brain and nerve tissue, and poor blood circulation is known to affect the brain by restricting oxygen and glucose supplies. Some studies have found a correlation between oxidative stress, reduced blood flow to the brain and senile dementia, Alzheimer's disease, Parkinson's disease, Huntington's disease and even schizophrenia. It is reported that RPO-derived tocotrienols aid the brain by reducing oxidative stress and improving blood flow.

Glutamate-induced cell death in the presence of synthetic and dietary vitamin E has been reported, and it is believed that synthetic and dietary vitamin E is probably not sufficiently potent to prevent glutamate-induced cell death. However, tocotrienols from RPO is believed to have the potential to reduce the destructive action of glutamate. Laboratory studies suggest that tocotrienol-treated neurons appear to maintain healthy growth and motility, even in the presence of excess glutamate.[47]

Karaji-Bani *et al.*[48] reported a significant increase in HDL-cholesterol and significantly reduced triglyceride and LDL-cholesterol levels when supplementing rats' diet with RPO for three months. The authors also concluded that the use of RPO can be useful in preventing cardiovascular disease.

In another study, investigators reported a 10% decrease in total cholesterol in 36 hypercholesterolaemic subjects who received RPO capsules for four weeks. A follow-up study of 16 participants resulted in a 13% reduction in total cholesterol.[49]

In another study, 31 participants were given an RPO supplement on a daily basis for 30 days. Participants were told to continue with their normal diets. Results showed that RPO supplementation reduced total cholesterol and LDL levels in all the participants, and the extent of reduction of total cholesterol ranged from 5% to 36% and the reduction of LDL ranged from 0.9% to 37%. Importantly, it was also shown that the RPO reduced the LDL- to HDL-cholesterol ratio in 78% of the participants, demonstrating a highly significant and favourable response to RPO supplementation.[50]

The vitamin E component of RPO is reported to provide a rich source of tocotrienols, which have been shown to inhibit two human breast cancer cell lines *in vitro* (responsive MCF7 and unresponsive MDA-MB-231 cells). Nesaretnam *et al.*[51] reported that at low concentrations, a tocotrienol-rich fraction of RPO and other individual fractions (α, β and δ) can also inhibit the growth of another responsive human breast cancer cell line (ZR-75-1).

According to a study by Yamanushi *et al.*,[52] it was suggested that RPO carotene prevents lung tumourigenesis against active oxygen radicals by its protective effect on DNA. The authors also noted that, apart from the chemopreventive effect, the growth of the tumour in a mouse model used in the study was inhibited by the administration of RPO carotene, and the authors advocated further studies in order to elucidate the mechanisms and potential effects of RPO carotenoids.

In another study, Boateng *et al.*[53] compared the inhibitory effect of RPO and soybean oil (SBO) on azoxymethane (AOM)-induced aberrant crypt foci. Thirty-two male Fischer 344 rats were assigned randomly to four groups. Two groups received a control diet containing 7% and 14% SBO. Groups 3 and 4 received a treatment diet consisting of 7% and 14% RPO, respectively. The results showed that RPO intake reduced the incidence of AOM-induced aberrant foci and may therefore have a beneficial effect in reducing the incidence of colon cancer.

In another study, Marotta *et al.*[54] investigated the status of the reticuloendothelial system as assessed by superoxide anion generation by blood monocytes, erythrocyte oxidability and analysed serum fatty acids and cytokines in 24 patients with chronic pancreatitis. A dietary questionnaire was used at entry and was re-assessed at the end of the study using the model of a seven-day diet history. Patients were instructed not to consume fish oil supplement and refrain from olive oil dietary consumption, and were then put on a two-week wash-out period from such use when present. Patients were then given a sample of oil containing a specific, highly-purified RPO at 40 mL daily for two weeks to be used without frying or heating. The investigators reported that 22 patients fully complied with the supplementation protocol and that subjects reported good palatability of RPO and experienced no side-effects. Body mass index (BMI) and waist-hip ratio (WHR) as well as routine biochemical parameters remained stable throughout the study period and were comparable to age-matched controls. Compared to baseline values, patients with chronic pancreatitis who were fed RPO showed a significant improvement of the peak value of generated superoxide anions ($P<0.05$) and reduced erythrocyte oxidability ($P<0.01$). Red palm oil also significantly reduced tumour-necrosis factor-α and interleukin-6 ($P<0.05$). Taken as a whole, the results of the study suggest that dietary enrichment with RPO is able to improve significantly the oxidative inflammatory profile in patients with chronic pancreatitis and also beneficially correct their fundamental deficiencies in essential fatty acids. Owing to the multifactorial nature of chronic pancreatitis and its subtle worsening clinical condition, it would appear that dietary intervention with RPO should be considered as an amenable integrative therapeutic tool.

Conclusions

Current research supports the hypothesis that RPO plays a beneficial role in improving wellbeing and quality of life. As the second most used edible oil, it is rich in carotenoids, vitamin E, tocotrienols and other micronutrients. It has been shown to reduce the risk of atherosclerosis, can act as a therapeutic agent, enhances intestinal uptake of proteins, plays a role in the metabolism of sulphur amino acids and promotes reproductive capacity. It contains almost equal amounts of saturated and unsaturated fatty acids, with negligible amounts of the hypercholesterolaemic lauric and myristic fatty acids, while it is moderately rich in the hypocholesterolaemic monounsaturated oleic acid and has an adequate amount of linoleic acid. It should be noted that the majority of the properties and effects linked to RPO are believed to be mediated via its main triglyceride and minor non-glyceride components but also by the peculiar stereochemical configuration of the fatty acid isomeric position. These properties make RPO a safe edible oil rich in nutritional, physiological, therapeutic and biochemical benefits.

However, care should be exercised in RPO use. Moderate intake only is recommended as an excess may promote high cholesterol levels, thereby increasing the risk of cardiovascular disease. Frying with RPO is not encouraged as excessive heating increases the possibility of deterioration, which includes oxidation and the formation of toxic by-products. Heating and frying also affects RPO stability.

Clearly, further research is warranted across a wide spectrum of roles for red palm oil in relation to wellbeing and quality of life. □

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