Submitted: 28 July, 2024 Accepted: 17 October, 2024 Published: 30 September, 2025 DOI:10.22514/jomh.2025.112

REVIEW

JOMH Journal of Men's Health

Therapeutic potential of red palm oil as antioxidant for men's health

Yeonhee Pyo[1], Ki Han Kwon[2,*]

[1]Department of Beauty Cosmetics, College of Biomedical and Health Science, Konkuk University, 27478 Chungju, Republic of Korea
[2]College of General Education, Kookmin University, 02707 Seoul, Republic of Korea

***Correspondence**
kihan.kwon@kookmin.ac.kr
(Ki Han Kwon)

Abstract

Red palm oil (RPO) possesses therapeutic properties due to its high antioxidant potential and can serve as a natural treatment for various diseases, including cardiovascular diseases, chronic illnesses, skin issues and diabetes. While existing research has largely focused on the commercialization and application potential of RPO in specific sectors, this review aims to highlight its antioxidant, anti-inflammatory, and anti-cancer properties, and to outline potential strategies for utilizing RPO to improve men's health in the future. We analyzed the physiological therapeutic roles of RPO, emphasizing its use as a natural therapeutic agent, particularly in the treatment of cardiovascular diseases, chronic conditions, myocardial infarction, and hyperthyroidism. Additionally, we focused on the antioxidant, anti-inflammatory, and anti-cancer effects of RPO. The review concludes that further research is needed to explore RPO's physiological and pharmacological roles, especially as an antioxidant, anti-inflammatory, and anti-cancer agent, to better understand the pharmacological mechanisms underlying disease inhibition.

Keywords

Red palm oil; Antioxidant; Anti-inflammatory; Anti-cancer; Natural treatment; Health

1. Introduction

Men's health issues have typically been studied around cardiovascular disease, metabolic syndrome such as obesity, hypertension, hyperlipidemia, and type 2 diabetes and hormonal changes such as fatigue, loss of muscle mass, and decreased libido due to a decrease in the male hormone testosterone [1–3]. However, men's irregular lifestyles and dietary patterns centered around smoking and alcohol have led to a new men's health risk: oral health problems [4]. As such, oral problems in men can be a health risk, as they can lead to oral cancer, in addition to the major health problems men face [5]. Men are more likely than women to smoke, drink alcohol, and lead stressful lifestyles that contribute to periodontal disease. This can be an indicator of how risky a man's oral health status is [6]. Men have a higher incidence of periodontal disease than women, which is associated with lower dental visits. This makes the prevention and management of men's oral health very important [7].

Red palm oil (RPO) is a processed form of crude palm oil that has several health benefits, including anti-cancer effects, retention of β-carotene and vitamin E, prevention of vitamin A deficiency, and promotion of heart health [8]. RPO contains both saturated and unsaturated fatty acids, such as palmitic, stearic, myristic, oleic, linoleic, and linolenic acids [9]. These components, along with its rich antioxidant, anti-inflammatory, and anti-cancer properties, position RPO as a potential therapeutic agent for various health conditions. Research has shown that RPO may offer protective effects against fevers, hemorrhaging, hyperlipidemia, diabetes, and the adverse effects of chemical ingestion [10]. It is a rich source of phytonutrients that can prevent vitamin A deficiency and provide a natural source of carotenoids. Also, it is currently the focus of nutritional and toxicological studies [11].

Consumption of RPO has been shown to stabilize the function of the heart in hypertensive conditions and have a positive effect on the prevention and mitigation of cardiac oxidative stress [12]. RPO-fed mice showed increased expression of *superoxide dismutase* (SOD1, SOD2), glutathione peroxidase (Gpx), and activated nitric oxide synthase (NOS). This led to reduced elevated blood pressure and total NOS activity index, decreased mitochondrial SOD2 expression, and improving the relaxation function of the heart [13]. RPO is a potent antioxidant that is particularly beneficial to men's health. Pathologic inflammation results in oxidative stress, leading to an imbalance in antioxidants and subsequent cellular damage [14]. Therefore, it is essential for men to include RPO in their diet. Skin diseases, which are associated with oxidative stress, are of particular concern for men [15]. Numerous studies have highlighted the importance of antioxidants in combating oxidative stress in various diseases, such as cardiovascular disease, diabetes and Alzheimer's disease, which predominantly affect men [16]. The antioxidant mechanism of vitamin E, with its lipophilic and radical-scavenging properties, plays a crucial role in protecting men's health against oxidative stress [17]. As a natural source of vitamin E and β-carotene, RPO can

be utilized as a functional food tailored for men, offering a positive impact on their health and productivity through the provision of high-quality snacks, food groups, and meals [18].

Vitamin E constitutes 30% tocopherol and 70% tocotrienols in RPO. These components are highly effective against oxidative stress, lowering cholesterol, preventing cancer, and protecting against atherosclerosis. Extensive research has been conducted on its nutritional and health benefits [19]. Besides, its potent antioxidant properties make it an excellent addition to anti-ageing skincare products, especially those targeting skin, breast, and other cancers [20]. RPOs are being investigated commercially for use in cosmetics to prepare nanoemulsions. Attempts to produce vitamin E nanoemulsions using natural canola oil and replacing nonionic surfactants with natural ones for developing of food-grade blended surfactants [21]. The study found that vitamin E provided nutritional benefits and oxidative stability, and the optimal particle size for stability response was 150.10 nm with a value of 0.338 [22]. The yellow-orange discolouration of the skin could be due to malaria or hepatitis. However, if the levels are still normal, the cause of the jaundice could be an abnormal level of beta-carotene in the serum. This condition may occur due to low beta-carotene levels resulting from insufficient intake of RPOs, akin to localized pigmentation on the palms and soles of the feet [23].

The relationship between RPO and cardiovascular disease (CVD) is being studied extensively, with a focus on oxidative stress as a major contributor to global mortality. Increased oxidative stress is believed to be a common factor in various diseases [24, 25]. Therefore, removing oxidative stress is recommended as a nutritional dietary strategy to prevent CVD [26]. RPO contains carotenoids that are powerful dietary anticancer agents, and the active ingredient in vitamin E is a potent inhibitor of cholesterol biosynthesis [27]. Vitamin E also has anti-cancer and anti-thrombotic properties and is being studied as a dietary supplement for health promotion [28]. Moreover, vitamin A derived from RPO plays a crucial therapeutic role in maintaining men's eye health [29]. Vitamin A deficiency can lead to blindness, a significant global public health issue that affects men as well. Adequate intake of vitamin A from RPO is effective in preventing this deficiency, making it essential for men to regularly consume non-fried RPO. However, the presence of β-carotene can impact the appearance or taste of purified RPO, which is costly to produce. To address this, fortified RPO with retinyl palmitate is being explored as a viable option to enhance vitamin A intake in purified RPO, ensuring men receive the necessary nutrients for optimal eye health [30].

Several studies have confirmed that RPO in sealed bottles remains stable against light, oxygen and temperature, preserving its quality and potency. These studies have also demonstrated that RPO provides significant antioxidant benefits, such as preventing auto-oxidation and photo-oxidation, without altering the oil's fatty acid composition, vitamin E or carotene levels over a period of four months [31]. RPO stands out as one of the most successful natural antioxidant products, showing considerable promise in promoting men's health by reducing inflammation, modulating oxidative stress, and preventing vitamin A deficiency [32]. Researchers are increasingly focusing on the commercialization and application of RPO in targeted sectors relevant to men's health. This review will emphasize the therapeutic use of RPO specifically for men, detailing its antioxidant effects as demonstrated by biological experimental studies. We will explore RPO's antioxidant, anti-inflammatory, and anti-cancer properties, and discuss the future strategic direction for leveraging RPO in men's health promotion.

2. General properties and therapeutic efficacy of RPO

2.1 Physical and chemical characteristics of RPO

Palm oil, the second most commonly consumed vegetable oil worldwide, is obtained through the cultivation and production of red palm fruit, with meticulous agricultural practices being crucial for maximizing yield [33]. The extraction process typically yields about 20–22% oil from the fruit [34]. This oil benefits men's health by lowering cholesterol, providing antioxidants like vitamin E and β-carotene, and reducing the risk of thrombosis, atherosclerosis, and high blood pressure [35]. RPO, rich in β-carotene and vitamin A, may also protect against cancer and chronic illnesses common in men [36]. RPO is rich in antioxidants, including carotenoids, tocopherols, lycopene, tocotrienols, squalene, saturated and unsaturated fatty acids, and co-enzyme Q10. Alpha and β-carotenoids account for 90% of total carotenoids in RPO [37]. RPO can also help manage chronic liver diseases by flexibly regulating oxidative stress and down-regulating macrophage and monocyte inflammation parameters. This was demonstrated through RPO supplementation, which contains naturally fat-soluble tocopherols, tocotrienols, and carotenoids. A study of 60 children with genotype 1 hepatitis C virus (HCV) cirrhosis A/B found that only eight weeks of oral vitamin E or RPO treatment had a significant effect [38].

The most abundant natural source of carotenoids is RPO from *Elaeis guineensis*, which is commonly used as a cooking oil in India. This host detoxification system plays a crucial role in preventing cancer by guarding against chemical carcinogens [39, 40]. Vitamin A, a fat-soluble micronutrient, acts as an antioxidant and regulates oxidative stress, thereby preventing cancer development. Carotenoids, like vitamin A, also contribute to this protective mechanism. Supplementation with vitamin A and carotenoids is critical for the prevention and treatment of breast cancer, the most common malignant tumour in women. Vitamin A and carotenoids have cancer-fighting mechanisms and have been linked to genetic variants, cancer, and other diseases [41]. Vitamin A, including retinol and retinoic acid, comes in various forms and is essential for immunity and vision. Retinoids, on the other hand, regulate the growth and differentiation of many cell types in the skin and have anti-inflammatory wound-healing properties [42]. β-carotene is a major source of retinol and plays an important role in cystic fibrosis (CF) antioxidants. The daily intake of RPO has positive effects on CF patients due to its baseline intervention of carotenoids, retinol, and α-tocopherol for ~1.5 mg of β-carotene [43]. β-carotene also acts as an adjuvant to

increase the efficiency of therapeutic use, promoting the healing of duodenal ulcers and allowing for the storage of adequate serum concentrations of retinol. Therefore, it is encouraged to use β-carotene in combination therapy for patients [44].

The relationship between palm oil and CVD has been studied extensively. As a dietary supplement, palm oil has been found to lower serum cholesterol and prevent CVD, which is the leading cause of death worldwide. However, recent research has shown that RPO is effective in aiding cardiac recovery from ischemia-reperfusion injury. Dietary supplementation is considered to have high potential in treating cardiovascular health and forms an essential part of modern diets [45]. RPOs have the potential to act as natural antioxidants in cardiovascular disease by reducing oxidative stress and promoting nutrient utilisation efficiency. It is particularly significant as a dietary fat for health promotion as it can activate enzymes of liver drug metabolism and improve men's quality of life [46, 47].

Demonstrated six weeks of dietary supplementation with RPO restored myocardial phospholipid and cyclic adenosine monophosphate/cyclic guanosine monophosphate (cAMP/cGmp) levels, cardiac function, and improved cholesterol in rats [48]. Cholesterol has been linked to heart attacks, and it increases the heart's sensitivity and causes damage. Researchers have found that in Wistar rat animal models, taking RPO supplements can improve cardiac function and prevent cardiac injury by enhancing pro-survival kinases, anti-apoptosis, and nitric oxide/cyclic guanosine monophosphate (NO/cGMP), thereby reducing cardiac sensitivity [49]. RPO dietary supplementation also affects myocardial infarct size by regulating the relationship between RPO diet-induced matrix metalloproteinase-2 (MMP2) activity and protein kinase B/ras-related C3 botulinum toxin substrate (RAC)-alpha serine-threonine protein kinase phosphorylation. A study conducted on male Wistar rats revealed that taking RPO supplements for 5 weeks significantly reduced MMP2 activity and was more effective in reducing myocardial infarct size than sunflower oil (SFO) [50].

Liver disease is a major health concern that affects the quality of life of many people. The consumption of hepatic RPO has been shown to have a significant effect on liver disease lesions. Appropriate dietary interventions and food supplements are necessary for people with liver disease to prevent complications and the progression of the disease [51]. Skin changes are a characteristic phenomenon of liver disease caused by cirrhosis. This is a characteristic phenomenon of pathological processes. This medical condition, known as a hormonal disorder, is caused by liver damage and can result in various symptoms such as vascular changes, gynecomastia, axillary and pubic bone loss, nail changes, melanoma, or jaundice [52]. Additionally, studies have shown that consuming RPO for 15 weeks reduced blood pressure elevation in hypertensive rats, decreased heart size, and attenuated aortic media thickness. This suggests that RPO may be beneficial in protecting the cardiovascular system by preventing the development of hypertension [53]. Additionally, RPO can help prevent the worsening of glucose and lipid metabolism in hyperthyroidism. It also has a positive impact on blood glucose and lipid metabolism. The supplementation of RPO for 7 weeks did not cause an increase in serum cholesterol levels in male Wistar rats induced with hyperthyroidism (1 g/kg body weight/day). This indicates that RPO can be used as a potential treatment for hyperthyroidism [54]. Additionally, increased levels of glutathione in the liver indicate the positive role of RPO in promoting health. Table 1 (Ref. [38, 43, 48, 50, 53, 54]) shows an experimental example of RPO being used as a health promotion treatment.

2.2 Antioxidative properties of RPO

The antioxidant effects of RPO have been studied, and it has been found that it is more effective than regular palm oil. Moreover, RPO is stable against light, oxygen, and temperature, making it a strong antioxidant. Studies have shown that there is no degradation of vitamin E or carotene particularly in RPO, and is effective against auto-oxidation and photo-oxidation evaluations [55]. Furthermore, RPO's carotenoid content remains stable even after prolonged storage, indicating its suitability for long-term use [56]. Studies have also shown the effectiveness of RPO in managing complications arising from diabetes. RPO has antioxidant potential and has been found to improve superoxide dismutase (SOD) and plasma *oxygen radical absorbance capacity* (ORAC) in diabetes-induced rats after 7 weeks of treatment [57]. A study by Loganathan *et al.* [58] found that in 53 high-risk, abdominally overweight subjects, a 6-week diet including 45 g/day of red palm oil (RPO) significantly reduced low-density lipoprotein (LDL) levels and pro-inflammatory markers like *tumor necrosis factor-beta* (TNF-β), *interleukin-1 beta* (IL-1β), *C-reactive protein* (CRP), *high-sensitivity C-reactive protein* (hsCRP), *soluble intercellular adhesion molecule* (sICAM) and *soluble vascular cell adhesion molecule* (sVCAM). The reduction in oxidized LDL highlighted RPO's potential for cardiovascular protection through its antioxidant properties. Inhibition of LDL cholesterol oxidation may protect against CVD health, a major health concern in men, due to RPO's antioxidant activity [59].

In tests that measure the stability of antioxidants, RPO has been found to have a slower depletion of antioxidants compared to conventional palm oil due to its higher content of tocopherols/tocotrienols. The antioxidant effect of RPO is strong, and it is more stable than phenols due to lipid regeneration by tocopherols/tocotrienols of carotene radicals [60]. The antioxidant properties of RPO can also be seen in the reduction of oxidative stress-induced sperm damage in male Wistar rats (n = 54). Reactive oxygen species (ROS) can interfere with the preservation of fertility in males, but a diet supplemented with RPO for 60 days resulted in elevated SOD concentrations, catalase (CAT), dichlorofluorescein (DCF), and glutathione (GSH) levels. RPO appears to protect males from the adverse effects of ROS, which may have positive consequences for fertility preservation [61]. Also traditionally, RPO has been utilized as a reproductive supplement or fertility enhancer, contributing to the natural treatment of male libido, semen quality, and hormonal balance [62]. Vitamins B, C, A and E, along with minerals such as Mg, Se, Zn, Cu and Fe, as

TABLE 1. RPOs as therapeutic agents for health.

The related diseases	Compounds responsible for biological activity	Method	Result	References
Chronic disease	*Elaeis guineensis*	Vitamin E or RPO control experiment	RPO modulates oxidative stress and downregulates macrophage and monocyte inflammatory parameters	Catanzaro *et al.* [38]
β-carotene	CF	16-subject trial, 8 weeks of RPO (~1.5 mg of β-carotene per day)	Increased plasma β-carotene, retinol, and α-carotene	Sommerburg *et al.* [43]
RPO Supplement	Cardiovascular disease	Diet of a cholesterol rat model for 6 weeks	Reduce cholesterol, restore heart function, and improve myocardial phospholipids	Esterhuyse *et al.* [48]
RPO, SFO	Myocardial infarction	5-week diet of Wister male rat model	Reduced myocardial infarct size and MMP2 activation in the RPO dietary group	Bester *et al.* [50]
RPO	High blood pressure, cardiovascular disease	Rat model of 15-week RPO intake	Reduced aortic media thickness, reduced heart size	Boon *et al.* [53]
RPO	Hyperthyroidism	RPO diet induced hyperthyroidism in rats for 7 weeks	Increases glutathione and regulates blood sugar and lipids	Rauchová *et al.* [54]

RPO, red palm oil; CF, Cystic fibrosis; SFO, sunflower oil; MMP2, matrix metalloproteinase-2.

well as essential unsaturated fatty acids like linoleic acid and oleic acid, are employed as effective therapeutic agents and supplements for the treatment of male infertility. Additionally, amino acids such as lysine and arginine, along with phytochemicals like polyphenols, flavonoids, triterpenes, and steroids, are considered key factors contributing to the efficacy of these treatments [63]. Also in men's metabolic disease, RPO has been shown to regulate fat metabolism and improve insulin resistance, which may have a positive impact on systemic health as well as oral health [64]. SOD is an enzyme that plays a crucial role in antioxidant defence against oxidative stress in the body and may be a good therapeutic target. It treats a wide range of physiological and pathological conditions, including inflammatory diseases, cancer, cystic fibrosis, tongue hemorrhage or aging, rheumatoid arthritis, neurodegenerative diseases, and diabetes [65].

2.3 Anti-inflammatory efficacy of RPO

RPO is rich in nutrients, consisting of approximately 49–50% saturated fats, 37–40% monounsaturated fats, and 10–11% polyunsaturated fats. The primary fatty acids are palmitic acid (44–45%) and oleic acid (37–40%) [66]. RPO also contains 500–700 ppm of carotenoids, with β-carotene (55–60%) being the most abundant [67]. Additionally, RPO is a significant source of vitamin E, including both tocopherols and tocotrienols, with concentrations ranging from 600 to 1000 ppm. This composition makes RPO a potent antioxidant with potential health benefits [68]. Palm oil is rich in tocotrienols (T3s), which is a form of vitamin E that has been found to have potent anti-inflammatory effects. T3s have been shown to possess antioxidant and anti-inflammatory properties that are comparable to or even better than tocopherols (Tox), another form of vitamin E. T3s can be used to treat various inflammatory diseases, such as cardiovascular disease, stroke, and cancer, by reducing oxidative stress, melanin production, and skin damage. They also inhibit the release of inflammatory mediators, making them a beneficial nutritional supplement with no side effects in some clinical studies [69]. Inflammation is a natural response of the adaptive immune system, but excessive or chronic inflammation can lead to various diseases, such as autoimmune or auto-inflammatory diseases, neurodegenerative diseases, or cancer. Therefore, the development of anti-inflammatory drugs is crucial in the prevention of these diseases and cancer [70]. Natural anti-inflammatory drugs derived from traditional sources are safe and effective without causing damage to the neural mechanisms of the men's body. In contrast, anti-inflammatory drugs derived from chemical mixtures may cause side effects that need to be addressed. Therefore, the use of traditional natural anti-inflammatory compounds is highly recommended [71]. RPO has been found to reduce asymptomatic breast inflammation among women in rural Tanzania. This reduction was accompanied by changes in breast milk concentrations of anti-inflammatory cytokine IL-8 and *transforming growth factor-beta 2* (TGF-β2), as well as a decrease in the sodium-to-potassium ratio after RPO supplementation. Increased dietary intake has been shown to improve subclinical breast inflammation [72]. In male Wistar rats, RPO administered at a dose of 200 μL/day for 28 days reduced the activities of alanine aminotransferase, aspartate aminotransferase, alkaline phosphatase, and γ-glutamyltransferase in serum. This suggests an antioxidant effect of RPO. RPO

decreases the activities of alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), and gamma-glutamyl transferase (GGT) in serum, which binds to malondialdehyde (MDA), an indicator of oxidative damage in the liver, and reduces levels of inflammatory cytokines such as interleukin (IL)-1β, IL-6 and TNF-α [73]. Cytokines can be controlled using biological anti-inflammatories, recombinant cytokine receptor antagonists, or nutrients. Experiments have shown various anti-inflammatory effects in rheumatoid arthritis, inflammatory bowel disease, psoriasis and asthma. The substrate properties of cytokines can affect their production and action in a variety of signalling pathways. Changes in fatty acid composition regulate eicosanoid production and protein kinase C activation [74–76].

2.4 Anti-cancerous properties of RPO

Vitamin E found in RPO consists of three groups tocopherols (α-, β-, γ-TP) and unsaturated tocotrienols (TT). RPO contains approximately 50% saturated fatty acids and 50% unsaturated fatty acids, which play a significant role in its health benefits. Clinical trials have shown that vitamin E exhibits various biological activities, including antioxidant, anti-inflammatory, anti-cancer, neuroprotective, dermatoprotective, cognitive, bone health, life extension and plasma cholesterol-lowering effects [77]. Tocotrienols, in particular, are recognized for their potent antioxidant, neuroprotective, cholesterol-lowering, and anti-inflammatory properties. It has been confirmed that tocotrienols can reduce the metastatic and angiogenic properties of various cancer cells and are being studied for strategic use in targeted therapy when combined with natural compounds with anticancer activity. A combination of sesamin, epigallocatechin gallate, resveratrol, and ferulic acid has been shown to have synergistic anti-tumor effects on cancer cells as part of an anti-cancer strategy [78]. Vitamin E is considered a potential cancer treatment due to its safety profile, with its anticancer effects primarily attributed to tocopherols (TOCs) and tocotrienols (TTs). Among them, γ-TTs and δ-TTs have shown the highest anti-cancer activity by targeting molecular pathways involved in cell cycle inhibition, apoptosis, autophagy induction, and the inhibition of invasion, metastasis, and angiogenesis [79]. Additionally, the β-carotene found in RPO serves as an essential protective factor against oral cancer and can be an economic source of non-toxic beta-carotene for developing countries, particularly in alleviating oral leukoplakia in tobacco users. For example, in a study conducted in Kerala, India, individuals chewing betel quids were given β-carotene (180 mg/week) and vitamin A (100,000 IU/week) or vitamin A alone (200,000 IU/week), which suppressed leukoplakia development, regulated ROS production, and reduced cancer incidence [80]. Furthermore, delta-tocotrienols, derived from the tocotrienol-rich fraction of palm oil, have been shown to be effective against metastatic prostate and breast cancer, making them useful in identifying molecular targets in tumor cell cultures [81].

3. Potential antioxidant and therapeutic roles of RPOs and their health benefits

Palm oil is a type of fatty oil that is widely used in the food industry. It contains several bioactive components, including fatty acids, carotenoids, vitamin E, and phenolic compounds, which have a significant impact on men's health. RPO, in particular, has been found to offer various health benefits, such as anti-diabetic, cardioprotective, anti-inflammatory, and anti-thrombotic effects, when consumed in small amounts daily. This makes it a promising alternative to other types of fats [82]. Natural products, like palm oil, are being investigated for their potential therapeutic properties. They contain potent antioxidants, anti-apoptotic, and anti-inflammatory compounds that can be utilized to develop new disease treatments [83, 84]. Palm oil is a natural oil that is effective in lipid-based formulations and drug delivery. It contains tocotrienols, tocopherols, and carotene, which provide a combination of phytonutrients and triglycerides for improved bioavailability and solubility in drug applications. Palm oil is versatile in drug design and delivery, providing dynamic behavior and benefiting multiple formulations and drug delivery systems [85]. RPO is a natural antioxidant that has the potential to reduce oxidative stress, making it a useful treatment for patients with cardiovascular disease, cancer, and chronic diseases by improving their oxidative status [86]. RPO has various benefits for men's health. It is known to improve men's well-being and quality of life nutritionally, physiologically, and biochemically [87]. RPO is a great source of vitamin A and β-carotene, especially for children. Adding vitamin A and β-carotene to biscuits makes them trans-fatty acid-free and rich in antioxidants, making them a great snack for kids. In South Africa, a study conducted on 437 elementary school children demonstrated the positive effects of serum retinol treatment [88]. These are shown in Table 2 (Ref. [82, 85–89]). Isomerized red palm oil (IRPO) is a safe and cost-effective alternative to food fortification with retinyl ester fortifiers, and it is recommended for use in food-based and alternative medicines in developing countries with endemic diseases or vitamin A deficiency [89]. Interesterified-RPO as a therapeutic agent has physiological effects on lipid hemostasis in high-fiber patients, altering the serum cholesterol response. In 59 high-fiber patients, the application of RPO affected low-density lipoprotein cholesterol (LDL-C) responsiveness. Tissue plasminogen activator antigen was reduced by four weeks of RPO application, and a mechanistic effect of the non-glyceride component was demonstrated, suggesting an effect of RPO on lipid, hemostatic, and fibrin network properties [90, 91].

4. Conclusions

Current research has primarily focused on the application of RPO (red palm oil) in food products, supplements, and cosmetics. However, there is a pressing need to expand these efforts into pharmacological research to thoroughly explore RPO's potential as a natural antioxidant therapeutic agent, especially in the context of men's health. With its high concentrations of

TABLE 2. The role of RPO as an antioxidant, anti-inflammatory, and anticancer agent.

The role of RPO	Study subjects	Method	Result	References
Anti-inflammatory, antithrombotic, antidiabetic, antioxidant, cardioprotective	Palm oil, RPO, plam olein, palm stearin	Literature review, comparative research, processing technology analysis	RPOs are more stable than vegetable oils and could help extend life May develop into a healthy fat substitute	Sulaiman *et al*. [82]
RPOs help solve the problem of drug water solubility in lipid-based formulations, including bioactive substances such as tocotrienols, tocopherols, carotenes, *etc*.	The various components of RPO tocotrienols, tocopherols, carotene, *etc*.	Review studies on the design and effectiveness of RPO formulations and drug delivery systems Analyze the mechanisms by which formulations containing palm oil improve the bioavailability and solubility of drugs	RPOs can play an important role in lipid-based formulations and drug delivery systems, particularly contributing to improving the bioavailability and solubility of drugs	Efendy Goon *et al*. [85]
Antioxidant, oxidative stress modulation, improved blood lipid levels, and reduced total cholesterol levels	Adult male with dyslipidemia	Randomized, double-Blind, controlled clinical trial Experimental group: consume dried bread with RPO added Control group: consume dried bread without RPO added	Potential to be used as a healthy snack, with no adverse effects on biomarkers of oxidative stress	Harianti *et al*. [86]
Antioxidants, cardio-vascular health	Patients with cardiovascular disease, cancer, and other chronic conditions	Literature review	RPOs have protective effects against cardiovascular disease and oxidative stress-related conditions, and provide a range of health benefits, including lowering cholesterol levels, inhibiting oxidative stress, and inhibiting blood clot formation	Oguntibeju *et al*. [87]
Improved serum retinol	Randomized trials	Study subjects were randomized into three groups	RPO has been shown to improve vitamin A deficiency RPO is trans fat-free and rich in antioxidants to address vitamin A deficiency	van Stuijvenberg *et al*. [88]
Boost Vitamin A, prevent Vitamin A deficiency	Lactating mothers, infants, and children with vitamin A deficiency without clinical features	Different feeding trials and dietary experiments Incorporating RPOs into diets at the household level or adding RPOs to commercially manufactured products (*e.g.*, snacks, biscuits)	RPOs are a safe and effective way to prevent vitamin A deficiency	Benade *et al*. [89]

RPO, red palm oil.

vitamin A and β-carotene, RPO offers advantages over conventional palm oil, positioning it as a promising and stable therapeutic agent with significant implications for men's health. Its robust antioxidant response, coupled with emerging evidence that it may enhance protective effects against oxidative stress when combined with other plant extracts, underscores its therapeutic promise. To fully realize RPO's potential in clinical settings, future research should prioritize understanding its pharmacological roles, including its antioxidant, anti-inflammatory, and anti-cancer properties. This will involve elucidating the mechanisms of action, conducting large-scale clinical trials, and assessing its long-term safety and efficacy. Addressing these research gaps is crucial for establishing RPO as a viable therapeutic agent that can be integrated into innovative treatments aimed at promoting men's health and well-being. Additionally, while initial studies on RPO combined with other plant extracts have shown positive results, further research is needed to clarify these mechanisms and confirm their effectiveness. Therefore, future research should focus on solidifying RPO's role in clinical applications, ensuring it can effectively contribute to the prevention and treatment of diseases prevalent in men. Comprehensive studies, including large-scale human trials, are essential to fully evaluate RPO's therapeutic potential and its long-term impact on health.

ABBREVIATIONS

RPO, red palm oil; Gpx, glutathione peroxidase; NOS, nitric oxide synthase; CVD, cardiovascular disease; CF, cystic fibrosis; NO/cGMP, nitric oxide/cyclic guanosine monophosphate; MMP2, matrix metalloproteinase-2; SFO, sunflower oil; SOD, superoxide dismutase; ORAC, oxygen radical absorbance capacity; LDL-C, low-density lipoprotein; sICAM, soluble Intercellular adhesion molecules; CRP, C-reactive protein; hsCRP, high sensitivity C-reactive protein; sVCAM, soluble vascular cell adhesion molecules; CAT, catalase; DCF, dichlorofluorescein; GSH, glutathione; T3s, tocotrienols; Tox, tocopherols; TGF-β2, transforming growth factor-beta 2; TP, tocopherol; TT, tocotrienol; TOCs, tocopherols; TTs, tocotrienols; HCV, hepatitis C virus; cAMP/CGMP, cyclic adenosine monophosphate/cyclic guanosine monophosphate; RAC, ras-related C3 botulinum toxin substrate; TNF-β, tumor necrosis factor-beta; IL-1β, interleukin-1 beta; IRPO, isomerized red palm oil.

AVAILABILITY OF DATA AND MATERIALS

Not applicable.

AUTHOR CONTRIBUTIONS

YP and KHK—conceptualization; vali-dation; writing-review. YP—methodology, software; formal analysis, investigation, resources, data curation, writing-original draft preparation; editing, visualization. KHK—supervision. Both authors have read and agreed to the published version of the manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

ACKNOWLEDGMENT

Not applicable.

FUNDING

This research received no external funding.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

[1] Mollaioli D, Ciocca G, Limoncin E, Di Sante S, Gravina GL, Carosa E, *et al*. Lifestyles and sexuality in men and women: the gender perspective in sexual medicine. Reproductive Biology and Endocrinology. 2020; 18: 10.

[2] Haider A, Bengs S, Luu J, Osto E, Siller-Matula JM, Muka T, *et al*. Sex and gender in cardiovascular medicine: presentation and outcomes of acute coronary syndrome. European Heart Journal. 2020; 41: 1328–1336.

[3] Li J, Lee DH, Hu J, Tabung FK, Li Y, Bhupathiraju SN, *et al*. Dietary inflammatory potential and risk of cardiovascular disease among men and women in the U.S. Journal of the American College of Cardiology. 2020; 76: 2181–2193.

[4] Gheisary Z, Hoja I, Liu J, Papagerakis P, Weber LP, Fenton M, *et al*. Association of sleep quality and general, mental, and oral health with lifestyle traits (dietary intake, smoking status) in arthritis: a cross-sectional study from the Canadian community health survey (CCHS). Nutrients. 2024; 16: 2091.

[5] Akinkugbe AA, Garcia DT, Brickhouse TH, Mosavel M. Lifestyle risk factor related disparities in oral cancer examination in the U.S: a population-based cross-sectional study. BMC Public Health. 2020; 20: 153.

[6] Torrejon-Moya A, Gonzalez-Navarro B, Roca-Millan E, Estrugo-Devesa A, López-López J. Analysis of healthy lifestyle habits and oral health in a patient sample at the dental hospital of the university of Barcelona. International Journal of Environmental Research and Public Health. 2021; 18: 7488.

[7] Lipsky MS, Su S, Crespo CJ, Hung M. Men and oral health: a review of sex and gender differences. American Journal of Men's Health. 2021; 15: 15579883211016361.

[8] Urugo MM, Teka TA, Teshome PG, Tringo TT. Palm oil processing and controversies over its health effect: overview of positive and negative consequences. Journal of Oleo Science. 2021; 70: 1693–1706.

[9] Tan CH, Lee CJ, Tan SN, Poon DTS, Chong CYE, Pui LP. Red palm oil: a review on processing, health benefits and its application in food. Journal of Oleo Science. 2021; 70: 1201–1210.

[10] Krawczyk M, Burzynska-Pedziwiatr I, Wozniak LA, Bukowiecka-Matusiak M. Impact of polyphenols on inflammatory and oxidative stress factors in diabetes mellitus: nutritional antioxidants and their application in improving antidiabetic therapy. Biomolecules. 2023; 13: 1402.

[11] Bungau SG, Vesa CM, Bustea C, Purza AL, Tit DM, Brisc MC, *et al*. Antioxidant and hypoglycemic potential of essential oils in diabetes mellitus and its complications. International Journal of Molecular Sciences. 2023; 24: 16501.

[12] Yan Q, Liu S, Sun Y, Chen C, Yang S, Lin M, *et al*. Targeting oxidative stress as a preventive and therapeutic approach for cardiovascular disease. Journal of Translational Medicine. 2023; 21: 519.

[13] Katengua-Thamahane E, Szeiffova Bacova B, Bernatova I, Sykora M, Knezl V, Van Rooyen J, *et al*. Effects of red palm oil on

myocardial antioxidant enzymes, nitric oxide synthase and heart function in spontaneously hypertensive rats. International Journal of Molecular Sciences. 2017; 18: 2476.

[14] Teng KT, Loganathan R, Chew BH, Khang TF. Diverse impacts of red palm olein, extra virgin coconut oil and extra virgin olive oil on cardiometabolic risk markers in individuals with central obesity: a randomised trial. European Journal of Nutrition. 2024; 63: 1225–1239.

[15] Oyewole OE, Amosu AM. Public health nutrition concerns on consumption of red palm-oil (RPO): the scientific facts from literature. African Journal of Medicine and Medical Sciences. 2010; 39: 255–262; discussion 263–265.

[16] Narang D, Sood S, Thomas MK, Dinda AK, Maulik SK. Effect of dietary palm olein oil on oxidative stress associated with ischemic-reperfusion injury in isolated rat heart. BMC Pharmacology. 2004; 4: 29.

[17] Wang ZJ, Xie JH, Nie SP, Xie MY. Review on cell models to evaluate the potential antioxidant activity of polysaccharides. Food & Function. 2017; 8: 915–926.

[18] Niki E, Noguchi N. Dynamics of antioxidant action of vitamin E. Accounts of Chemical Research. 2004; 37: 45–51.

[19] Ziegler M, Wallert M, Lorkowski S, Peter K. Cardiovascular and metabolic protection by vitamin e: a matter of treatment strategy? Antioxidants. 2020; 9: 935.

[20] Alkandari S, Al-Hassawi F, Aldughpassi A, Sidhu JS, Al-Amiri HA, Al-Othman A, *et al*. Pilot scale production of functional foods using red palm olein: Antioxidant, vitamins' stability and sensory quality during storage. Saudi Journal of Biological Sciences. 2021; 28: 5547–5554.

[21] Mushtaq A, Mohd Wani S, Malik AR, Gull A, Ramniwas S, Ahmad Nayik G, *et al*. Recent insights into nanoemulsions: their preparation, properties and applications. Food Chemistry: X. 2023; 18: 100684.

[22] Sundram K, Sambanthamurthi R, Tan YA. Palm fruit chemistry and nutrition. Asia Pacific Journal of Clinical Nutrition. 2003; 12: 355–362.

[23] Mehmood T. Optimization of the canola oil based vitamin E nanoemulsions stabilized by food grade mixed surfactants using response surface methodology. Food Chemistry. 2015; 183: 1–7.

[24] Pigazzani F, Gorni D, Dyar KA, Pedrelli M, Kennedy G, Costantino G, *et al*. The prognostic value of derivatives-reactive oxygen metabolites (d-ROMs) for cardiovascular disease events and mortality: a review. Antioxidants. 2022; 11: 1541.

[25] Dubois-Deruy E, Peugnet V, Turkieh A, Pinet F. Oxidative stress in cardiovascular diseases. Antioxidants. 2020; 9: 864.

[26] Meléndez-Martínez AJ, Stinco CM, Mapelli-Brahm P. Skin carotenoids in public health and nutricosmetics: the emerging roles and applications of the UV radiation—absorbing colourless carotenoids phytoene and phytofluene. Nutrients. 2019; 11: 1093.

[27] Senoner T, Dichtl W. Oxidative stress in cardiovascular diseases: still a therapeutic target? Nutrients. 2019; 11: 2090.

[28] Didier AJ, Stiene J, Fang L, Watkins D, Dworkin LD, Creeden JF. Antioxidant and anti-tumor effects of dietary vitamins A, C, and E. Antioxidants. 2023; 12: 632.

[29] Thirunavukarasu AJ, Ross AC, Gilbert RM. Vitamin A, systemic T-cells, and the eye: focus on degenerative retinal disease. Frontiers in Nutrition. 2022; 9: 914457.

[30] Dong S, Xia H, Wang F, Sun G. The effect of red palm oil on vitamin a deficiency: a meta-analysis of randomized controlled trials. Nutrients. 2017; 9: 1281.

[31] Zhu C, Cai Y, Gertz ER, La Frano MR, Burnett DJ, Burri BJ. Red palm oil-supplemented and biofortified cassava gari increase the carotenoid and retinyl palmitate concentrations of triacylglycerol-rich plasma in women. Nutrition Research Reviews. 2015; 35: 965–974.

[32] Tuell DS, Los EA, Ford GA, Stone WL. The role of natural antioxidant products that optimize redox status in the prevention and management of type 2 diabetes. Antioxidants. 2023; 12: 1139.

[33] Kibrom TS. Oil palm boom: its socioeconomic use and abuse. Frontiers in Sustainable Food Systems. 2023; 7: 1–17.

[34] Martis R, Al-Othman A, Tawalbeh M, Alkasrawi M. Energy and economic analysis of date palm biomass feedstock for biofuel production in UAE: pyrolysis, gasification and fermentation. Energies. 2020; 13: 5877.

[35] Muhammad Ismail Tadj NB, Ibrahim NI, Tg Abu Bakar Sidik TMI, Zulfarina MS, Haji Mohd Saad Q, Leow SS, *et al*. Safety and efficacy of oil palm phenolic supplementation in improving lipid profile among hyperlipidemic adults: a phase 2, randomized, double-blind, placebo-controlled clinical trial. Frontiers in Pharmacology. 2023; 14: 1190663.

[36] Souganidis E, Laillou A, Leyvraz M, Moench-Pfanner R. A comparison of retinyl palmitate and red palm oil β-carotene as strategies to address vitamin A deficiency. Nutrients. 2013; 5: 3257–3271.

[37] May CY, Nesaretnam K. Research advancements in palm oil nutrition. European Journal of Lipid Science and Technology. 2014; 116: 1301–1315.

[38] Catanzaro R, Zerbinati N, Solimene U, Marcellino M, Mohania D, Italia A, *et al*. Beneficial effect of refined red palm oil on lipid peroxidation and monocyte tissue factor in HCV-related liver disease: a randomized controlled study. Hepatobiliary & Pancreatic Diseases International. 2016; 15: 165–172.

[39] Manorama R, Chinnasamy N, Rukmini C. Effect of red palm oil on some hepatic drug-metabolizing enzymes in rats. Food and Chemical Toxicology. 1993; 31: 583–588.

[40] El-Kott AF, Bin-Meferij MM, Eleawa SM, Alshehri MM. Kaempferol protects against cadmium chloride-induced memory loss and hippocampal apoptosis by increased intracellular glutathione stores and activation of PTEN/AMPK induced inhibition of Akt/mTOR signaling. Neurochemical Research. 2020; 45: 295–309.

[41] Kim JA, Jang JH, Lee SY. An updated comprehensive review on vitamin a and carotenoids in breast cancer: mechanisms, genetics, assessment, current evidence, and future clinical implications. Nutrients. 2021; 13: 3162.

[42] Polcz ME, Barbul A. The role of vitamin A in wound healing. Nutrition in Clinical Practice. 2019; 34: 695–700.

[43] Sommerburg O, De Spirt S, Mattern A, Joachim C, Langhans CD, Nesaretnam K, *et al*. Supplementation with red palm oil increases β-carotene and vitamin A blood levels in patients with cystic fibrosis. Mediators of Inflammation. 2015; 2015: 817127.

[44] Chen QH, Wu BK, Pan D, Sang LX, Chang B. Beta-carotene and its protective effect on gastric cancer. World Journal of Clinical Cases. 2021; 9: 6591–6607.

[45] Odia OJ, Ofori S, Maduka O. Palm oil and the heart: a review. World Journal of Cardiology. 2015; 7: 144–149.

[46] Albrahim T, Alotaibi MHM, Altamimi NMM, Albariqi AMA, Alqarni LAO, Alassaf SNA, *et al*. The impact of dietary consumption of palm oil and olive oil on lipid profile and hepatocyte injury in hypercholesterolemic rats. Pharmaceuticals. 2022; 15: 1103.

[47] Mancini A, Imperlini E, Nigro E, Montagnese C, Daniele A, Orrù S, *et al*. Biological and nutritional properties of palm oil and palmitic acid: effects on health. Molecules. 2015; 20: 17339–17361.

[48] Esterhuyse AJ, du Toit EF, Benadè AJ, van Rooyen J. Dietary red palm oil improves reperfusion cardiac function in the isolated perfused rat heart of animals fed a high cholesterol diet. Prostaglandins, Leukotrienes and Essential Fatty Acids. 2005; 72: 153–161.

[49] Szucs G, Bester DJ, Kupai K, Csont T, Csonka C, Esterhuyse AJ, *et al*. Dietary red palm oil supplementation decreases infarct size in cholesterol fed rats. Lipids in Health and Disease. 2011; 10: 103.

[50] Bester D, Esterhuyse AJ, Truter EJ, van Rooyen J. Cardiovascular effects of edible oils: a comparison between four popular edible oils. Nutrition Research Reviews. 2010; 23: 334–348.

[51] Mandato C, Di Nuzzi A, Vajro P. Nutrition and liver disease. Nutrients. 2017; 10: 9.

[52] Sato T. Cutaneous manifestations of liver cirrhosis. Japanese Journal of Clinical Medicine. 1994; 52: 170–173.

[53] Boon CM, Ng MH, Choo YM, Mok SL. Super, red palm and palm oleins improve the blood pressure, heart size, aortic media thickness and lipid profile in spontaneously hypertensive rats. PLOS ONE. 2013; 8: e55908.

[54] Rauchová H, Vokurková M, Pavelka S, Vaněčková I, Tribulová N, Soukup T. Red palm oil supplementation does not increase blood glucose or serum lipids levels in Wistar rats with different thyroid status. Physiological Research. 2018; 67: 307–315.

[55] Loganathan R, Subramaniam KM, Radhakrishnan AK, Choo YM, Teng KT. Health-promoting effects of red palm oil: evidence from animal and human studies. Nutrition Reviews. 2017; 75: 98–113.

[56] Ping BTY, Idris CAC, Maurad ZA. Oxidative stability of refined red palm olein under two Malaysian storage conditions. Journal of Oleo Science.

2020; 69: 1209–1218.
[57] Ayeleso AO, Oguntibeju OO, Aboua YG, Brooks NL. Effects of red palm oil and rooibos on sperm motility parameters in streptozotocin-induced diabetic rats. African Journal of Traditional, Complementary and Alternative Medicines. 2014; 11: 8–15.
[58] Loganathan R, Vethakkan SR, Radhakrishnan AK, Razak GA, Kim-Tiu T. Red palm olein supplementation on cytokines, endothelial function and lipid profile in centrally overweight individuals: a randomised controlled trial. European Journal of Clinical Nutrition. 2019; 73: 609–616.
[59] Ahotupa M. Lipid oxidation products and the risk of cardiovascular diseases: role of lipoprotein transport. Antioxidants. 2024; 13: 512.
[60] Schroeder MT, Becker EM, Skibsted LH. Molecular mechanism of antioxidant synergism of tocotrienols and carotenoids in palm oil. Journal of Agricultural and Food Chemistry. 2006; 54: 3445–3453.
[61] Aboua YG, Brooks N, Mahfouz RZ, Agarwal A, du Plessis SS. A red palm oil diet can reduce the effects of oxidative stress on rat spermatozoa. Andrology. 2012; 1: 32–40.
[62] Salhi S, Rahim A, Chentouf M, Harrak H, Bister JL, Hamidallah N, *et al*. Reproductive enhancement through phytochemical characteristics and biological activities of date palm pollen: a comprehensive review on potential mechanism pathways. Metabolites. 2024; 14: 166.
[63] Sadogh A, Gorji N, Moeini R. Herbal foodstuffs in Avicenna's recommended diet to improve sperm quality and increase male fertility; an evidence-based approach. Journal of Integrative and Complementary Medicine. 2021; 19: 47–70.
[64] Zhao X, An X, Yang C, Sun W, Ji H, Lian F. The crucial role and mechanism of insulin resistance in metabolic disease. Frontiers in Endocrinology. 2023; 14: 1149239.
[65] Younus H. Therapeutic potentials of superoxide dismutase. International Journal of Health Sciences. 2018; 12: 88–93.
[66] Arturo A, Alejandra RP, Steven S, Heather B, Valente A. Palm oil and coconut oil saturated fats: properties, food applications, and health. World Journal of Food Science and Technology. 2023; 7: 9–19.
[67] Kartika OP, Dwi S, Erliza H, Darmono T. Processing, characteristics, and potential application of red palm oil—a review. International Journal of Oil Palm. 2020; 3: 40–45.
[68] Barouh N, Bourlieu-Lacanal C, Figueroa-Espinoza MC, Durand E, Villeneuve P. Tocopherols as antioxidants in lipid-based systems: the combination of chemical and physicochemical interactions determines their efficiency. Comprehensive Reviews in Food Science and Food Safety. 2022; 21: 642–688.
[69] Zainal Z, Khaza'ai H, Kutty Radhakrishnan A, Chang SK. Therapeutic potential of palm oil vitamin E-derived tocotrienols in inflammation and chronic diseases: evidence from preclinical and clinical studies. Food Research International. 2022; 156: 111175.
[70] Dinarello CA. Anti-inflammatory agents: present and future. Cell. 2010; 140: 935–950.
[71] Haller OJ, Semendric I, George RP, Collins-Praino LE, Whittaker AL. The effectiveness of anti-inflammatory agents in reducing chemotherapy-induced cognitive impairment in preclinical models—a systematic review. Neuroscience & Biobehavioral Reviews. 2023; 148: 105120.
[72] Afeiche MC, Iroz A, Thielecke F, De Castro AC, Lefebvre G, Draper CF, *et al*. The dietary inflammatory index is associated with subclinical mastitis in lactating European women. Nutrients. 2022; 14: 4719.
[73] Ajuwon OR, Marnewick JL, Oguntibeju OO, Davids LM. Red palm oil ameliorates oxidative challenge and inflammatory responses associated with lipopolysaccharide-induced hepatic injury by modulating NF-κβ and Nrf2/GCL/HO-1 signaling pathways in rats. Antioxidants. 2022; 11: 1629.
[74] Xu D, Cui K, Li Q, Zhu S, Zhang J, Gao S, *et al*. Docosahexaenoic acid alleviates palmitic acid-induced inflammation of macrophages via TLR22-MAPK-PPARγ/Nrf2 pathway in large yellow croaker (Larimichthys crocea). Antioxidants. 2022; 11: 682.
[75] Ysrafil Y, Sapiun Z, Slamet NS, Mohamad F, Hartati H, Damiti SA, *et al*. Anti-inflammatory activities of flavonoid derivates. ADMET and DMPK. 2023; 11: 331–359.
[76] Radzikowska U, Rinaldi AO, Çelebi Sözener Z, Karaguzel D, Wojcik M, Cypryk K, *et al*. The influence of dietary fatty acids on immune responses. Nutrients. 2019; 11: 2990.
[77] Kanchi MM, Shanmugam MK, Rane G, Seth G, Kumar AP. Tocotrienols: the unsaturated sidekick shifting new paradigms in vitamin E therapeutics. Drug Discovery Today. 2017; 22: 1765–1781.
[78] Montagnani Marelli M, Marzagalli M, Fontana F, Raimondi M, Moretti RM, Limonta P. Anticancer properties of tocotrienols: a review of cellular mechanisms and molecular targets. Journal of Cellular Physiology. 2019; 234: 1147–1164.
[79] Constantinou C, Charalambous C, Kanakis D. Vitamin E and cancer: an update on the emerging role of γ and δ tocotrienols. European Journal of Nutrition. 2020; 59: 845–857.
[80] Stich HF, Brunnemann KD, Mathew B, Sankaranaryanan R, Nair MK. Chemopreventive trials with vitamin A and beta-carotene: some unresolved issues. Preventive Medicine. 1989; 18: 732–739.
[81] Mudit M, Behery FA, Wali VB, Sylvester PW, El Sayed KA. Synthesis of fluorescent analogues of the anticancer natural products 4-hydroxyphenylmethylene hydantoin and delta-tocotrienol. Natural Product Communications. 2010; 5: 1623–1626.
[82] Sulaiman NS, Sintang MD, Mantihal S, Zaini HM, Munsu E, Mamat H, *et al*. Balancing functional and health benefits of food products formulated with palm oil as oil sources. Heliyon. 2022; 8: e11041.
[83] Sun W, Shahrajabian MH. Therapeutic potential of phenolic compounds in medicinal plants—natural health products for human health. Molecules. 2023; 28: 1845.
[84] Castejón-Vega B, Giampieri F, Alvarez-Suarez JM. Nutraceutical compounds targeting inflammasomes in human diseases. International Journal of Molecular Sciences. 2020; 21: 4829.
[85] Efendy Goon D, Sheikh Abdul Kadir SH, Latip NA, Ab Rahim S, Mazlan M. Palm oil in lipid-based formulations and drug delivery systems. Biomolecules. 2019; 9: 64.
[86] Harianti R, Marliyati SA, Rimbawan R, Sukandar D. Potential of dried bread enriched with red palm oil to improve lipid profile, and control oxidative stress: an experimental study in adult men with dyslipidaemia. International Food Research Journal. 2022; 29: 686–697.
[87] Oguntibeju OO, Esterhuyse AJ, Truter EJ. Red palm oil: nutritional, physiological and therapeutic roles in improving human wellbeing and quality of life. British Journal of Biomedical Science. 2009; 66: 216–222.
[88] van Stuijvenberg ME, Dhansay MA, Lombard CJ, Faber M, Benadé AJ. The effect of a biscuit with red palm oil as a source of beta-carotene on the vitamin A status of primary school children: a comparison with beta-carotene from a synthetic source in a randomised controlled trial. European Journal of Clinical Nutrition. 2001; 55: 657–662.
[89] Benade AJ. A place for palm fruit oil to eliminate vitamin A deficiency. Asia Pacific Journal of Clinical Nutrition. 2003; 12: 369–372.
[90] Nestel PJ, Mori TA. A review of low-density lipoprotein-lowering diets in the age of anti-sense technology. Nutrients. 2023; 15: 1249.
[91] Scholtz SC, Pieters M, Oosthuizen W, Jerling JC, Bosman MJ, Vorster HH. The effect of red palm olein and refined palm olein on lipids and haemostatic factors in hyperfibrinogenaemic subjects. Thrombosis Research. 2004; 113: 13–25.

How to cite this article: Yeonhee Pyo, Ki Han Kwon. Therapeutic potential of red palm oil as antioxidant for men's health. Journal of Men's Health. 2025; 21(9): 5-13. doi: 10.22514/jomh.2025.112.