ORIGINAL ARTICLE

Characteristics of fatty acid composition and minor constituents of red palm olein and palm kernel oil combination

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ABSTRACT

Red palm olein (RPOl) is one of the derivatives of palm oil. It contains a high composition of unsaturated fatty acids such as oleic and linoleic, whereas palm kernel oil (PKO) contains more saturated fatty acids of lauric acid. RPOl provides high nutrient contents such as squalene, Vitamin E, and carotene, whereas PKO that is rich in lauric acid can fight Gram-positive microorganisms. This research aims to study the chemical characteristics of RPOl, PKO, and the combination. A combination of RPOl with four different concentrations of PKO (20%, 50%, 80%, and 100%) was analyzed to obtain the composition of fatty acids, squalene content, Vitamin E levels, total carotene, and saponification numbers. RPOL contains high levels of squalene, Vitamin E, and total carotene, followed by RPOl and PKO combination of oil, with a higher percentage of RPOl in its composition. The increase of the PKO level added to the combination will decrease the saponification number and increasing the acid number. Therefore, it can be concluded that RPOl could be the source of squalene, Vitamin E, carotenoids, and oleic acid, whereas PKO is the largest source of lauric acid.

Key words: Carotenoids, fatty acid, palm kernel oil, red palm olein, squalene, Vitamin E

INTRODUCTION

The oil palm produces crude palm oil (CPO) and palm kernel oil (PKO).[1] While CPO is developed from the fruit, the modified refining process develops the red palm oil (RPO). The palm oil refinery process consists of the degumming or the separation of gum, deacidification (neutralization), bleaching, and deodorization. During the bleaching process, the minor components of palm oil, especially carotene, are mostly discarded as waste for the purpose of obtaining clear-colored cooking oil. By modifying the purification with, CPO is then processed to produce RPO. RPO is the palm oil derivatives that are obtained without going through a bleaching process with the aim of maintaining the carotenoid content.[2] RPO is rich in unsaturated fatty acids such as oleic and linoleic. PKO, on the other side, is rich in saturated fatty acids, namely lauric acid.[3]

RPO contains carotenoids and also other minor components, such as Vitamin E, and squalene which are antioxidants in palm oil.[4-6] Vitamin E, squalene, and carotene are natural antioxidants widely used in topical formulations. These antioxidants play a significant role in protecting

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biomembranes against peroxidation, protecting the skin from sunlight while maintaining skin moisture, and increasing body endurance.[7] For the reasons above, a research on the characterization of the chemical compounds of RPO and PKO combination was conducted.

MATERIALS AND METHODS

Materials

The materials used in this research are RPO and PKO. Other materials are sodium hydroxide (NaOH), boron trifluoride (BF_3), methanol, hexane, sodium chloride (NaCl), hydrochloric acid (HCl), potassium hydroxide (KOH), ethanol, Vitamin C, and phenolphthalein.

Sample preparation

Samples of RPO and PKO are combined in the following ratios of 100:0, 80:20, 50:50, 20:80, and 0:100. Furthermore, the five samples were characterized by the fatty acid composition, squalene, Vitamin E, and total carotenoids. In addition, the combinations of oil samples were tested for saponification numbers.

Determination of fatty acid composition

An accurately weighed 0.025 g of sample in a test tube was combined with 1.5 ml of 0.5 N methanolic NaOH. The test tube was tightly closed and vortexed for 1–2 min. The samples were then heated in 100°C water bath for 5 min and brought to room temperature. About 2 ml of BF_3 methanol was added into and it was vortexed for 1–2 min. The test tube was then closed tightly and reheated at 100°C for 30 min. Additional 5 ml of saturated NaCl was added into the test tube to be closed and vortexed again. Vortex was conducted until two layers were formed. The top layer was moved into the vial to be later analyzed using the gas chromatography–mass spectrometry (GCMS) tool.[8]

Determination of squalene composition

An accurately weighed 0.5 g of sample in a test tube was combined with 5 ml of ethanol–Vitamin C 0.1% and was homogenized with a vortex. The samples were heated at 80°C for 15 min. About 3 ml of 50% KOH was added into and brought to room temperature. It was homogenized with a vortex and reheated at 80°C for 30 min. About 10 ml of 40% ethanol was added into and brought to room temperature and then homogenized again. Ten milliliters of hexane was taken using a 10 ml volumetric pipette and added to the sample. They were homogenized again with a vortex for 1 min. The sample was then analyzed using the GCMS tool.[9]

Determination of Vitamin E levels

A sample weighed 2 g was brought into a 10 ml volumetric flask. Hexane was added and adjusted to reach 10 ml mark level and then homogenized. About 2 ml of sample in a 10 ml volumetric flask was combined with methanol and adjusted to reach 10 ml mark level and then homogenized again. Then, the sample was poured into a centrifuge bottle (centrifuge for 30 min at 3000 rpm). The sample was then analyzed using ultra-performance liquid chromatography.[10]

Determination of total carotenoids

A sample weighed 0.04 g was brought into a 10 ml volumetric flask. Hexane was added and adjusted to reach 10 ml mark level. The sample was then analyzed using a spectrophotometer. Absorbance at a wavelength of 446 nm was read.[11]

Determination of the saponification value

A sample weighed 2 g was brought into a 500 ml Erlenmeyer flask. KOH-alcoholic solution 0.5 N was added about 25 ml. Then, the Erlenmeyer was connected to an air conditioner (upright cooler) and boiled over a water bath for half an hour. The sample was then titrated and brought to room temperature with HCl 0.5 N and phenolphthalein as indicators.[12]

RESULTS AND DISCUSSION

Determination of fatty acid composition

RPO is mainly composed of oleic acid and linoleic acid, the unsaturated fatty acids. Meanwhile, PKO contains more lauric acid which is a saturated fatty acid.[3,13] As a result, a combination of RPO and PKO produces new oil types containing more diverse composition of unsaturated and saturated fatty acid composition. The fatty acid composition of red palm olein, palm kernel oil, and oil combination is shown in Table 1. Based on analysis results, RPO shows no caproic fatty acids in the content. On the other hand, RPO and PKO combinations show richer composition and do contain caproic fatty acids. Lauric acid (C: 12-0) and myristic acid (C: 14-0) are found to be greatest in PKO, 45.61% and 16.25%, respectively. The level of content is then followed by the RPO-PKO combined oil that is greater than the content of RPO. The percentage of palmitic acid (C: 16-1), oleic acid (C: 18-1), and linoleic acid (C: 18-2) is found the greatest in RPO, with a value of 42.23%, 41.58%, and 10.71%, respectively.

Fatty acids with 12–14 carbon chains provide a good function for foaming, while fatty acids with 16–18 carbon chains are good for hardness and detergent power. Fatty acids with <12 carbon chains can cause skin irritation, while fatty acids with more than 18 carbon chains constructed soap that has a very low solubility.[14] Saturated fatty acids like lauric acid are the most active saturated fatty acids against Gram-positive microorganisms.[15,16] In the body, lauric acid will be converted into monolaurin which has antibacterial ability, and the modification of lauric acid can protect the skin from bacterial infections.[17] The higher lauric acid in a fatty acid composition will affect the antibacterial activity of liquid soap. Each type of fatty acid will have different properties in

soap. The properties of the resulted soap are determined by the quality and composition of the fatty acids used.[14]

Saponification value

The saponification value is determined by the number of milligrams of KOH required to develop a reaction with 1 g of fat. Oil, which is composed of short carbon chain fatty acids, shows a high saponification value when compared to oil which is composed of long carbon chain fatty acids.[1] The saponification values of RPO, PKO, and the combination are shown in Figure 1.

Based on the results, RPO has relatively smaller saponification rates compared to PKO and blended oil. Hence, the red palm olein (RPOl) is better used as a soap with a gentle form (liquid), whereas PKO is better used as a soap with a hard form (solid). However, the mixture of both shows better saponification value so that it will produce liquid soap with a good cleaning action.[18]

Squalene

Squalene is a triterpene group compound found in the skin lipid layer of about 13%.[19] The squalene content in RPO, PKO, and the combination is shown in Figure 2.

The data showed that the level of squalene in RPO decreases along with the addition of PKO. RPOL showed a relatively higher squalene content compared to PKO. Squalene serves as a reducer of singlet oxygen radicals, which protects the human skin surface from lipid peroxidation due to ultraviolet (UV) exposure and other oxidative damage. It is not very susceptible to peroxidation.[20]

Vitamin E

Vitamin E is an antioxidant that is mostly soluble in body fat; thus, it is important in skin protection. The content of Vitamin E in RPO, PKO, and the combination is shown in Figure 3.

Based on the data, it can be seen that the content of RPOL has a very high Vitamin E content compared to PKO. The use of Vitamin E on the skin aims to protect skin tissue against oxidative damage caused by UV irradiation *in vivo*. In previous studies, the administration of Vitamin E significantly decreased the epidermal lipid hydroperoxides formed after UV irradiation.[21] In addition, Vitamin E has been shown to be efficacious in the treatment of melasma by depigmentation mechanism by disruption of lipid peroxidation in melanocyte membranes, increasing intracellular glutathione levels, and inhibiting tyrosinase.[22]

Carotenoid

Carotenoids are one of the antioxidants that have the potential to inhibit singlet oxygen. Carotenoids can also be found in skin tissue in the form of α-, γ-, β-carotene, lycopene, lutein, zeaxanthin, and their isomers. The total

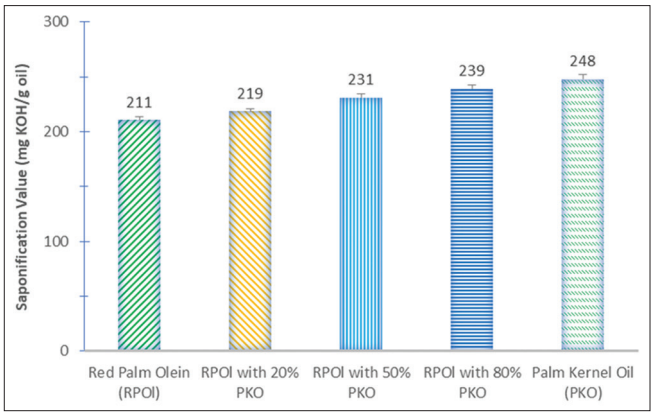

Figure 1: Saponification value of red palm olein, palm kernel oil, and oil combinations

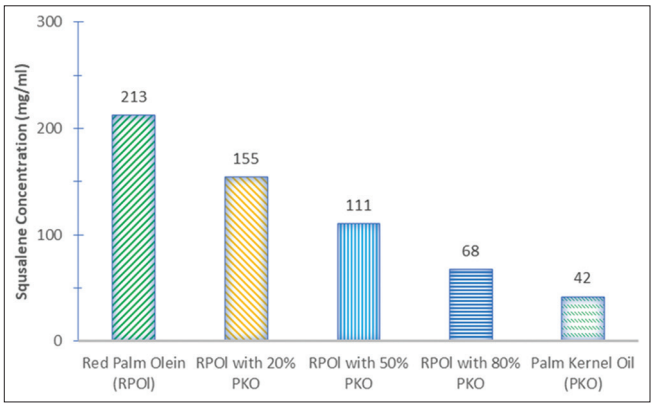

Figure 2: Saponification value of red palm olein, palm kernel oil, and the combination

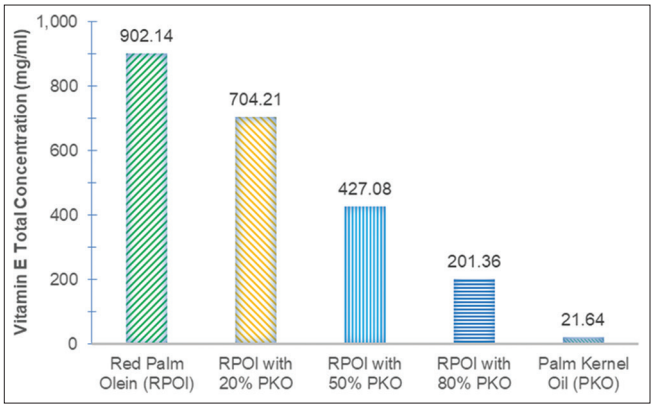

Figure 3: Vitamin E concentration of red palm olein, palm kernel oil, and the combination

carotenoids in RPO, PKO, and the combination are shown in Figure 4.

Based on the data, it can be seen that RPO has higher total carotenoid content compared to PKO. High carotenoid content causes red color in RPO, compared to PKO which has a low carotenoid content causing yellow color.[23] The potential use of carotenoids as antioxidants, especially in

Table 1: The composition of fatty acid in red palm olein, palm kernel oil, and oil combination

Fatty acids	Oils (%)				
	RPOl	RPOl with 20% PKO	RPOl with 50% PKO	RPOl with 80% PKO	PKO
Caproic acid (6:0)	0	0.01	0.04	0.11	0,12
Caprylic acid (8:0)	0.01	0.40	1.39	2.33	2.85
Capric acid (10:0)	0.01	0.39	1.41	2.44	3.01
Lauric acid (12:0)	0.18	6.20	21.83	36.65	45.61
Myristic acid (14:0)	0.86	2.79	8.10	13.15	16.26
Palmitic acid (16:0)	42.24	37.63	26.45	16.01	9.70
Palmitoleic acid (16:1)	0.15	0.12	0.09	0.04	0.01
Stearic acid (18:0)	3.65	3.53	2.88	2.54	2.34
Oleic acid (18:1)	41.59	38.53	30.75	22.24	17.14
Linoleic acid (18:2)	10.72	9.86	6.65	4.23	2.78
Linolenic acid (18:3)	0.21	0.18	0.13	0.05	0.01
Arachidic acid (20:0)	0.28	0.26	0.19	0.14	0.10
Gadoleic acid (2:1)	0.11	0.11	0.09	0.08	0.08
SFA	47.23	51.20	62.30	73.36	79.99
UFA	52.77	48.80	37.70	26.64	20.01

SFA: Saturated fatty acid, UFA: Unsaturated fatty acid, RPOl: Red palm olein, PKO: Palm kernel oil

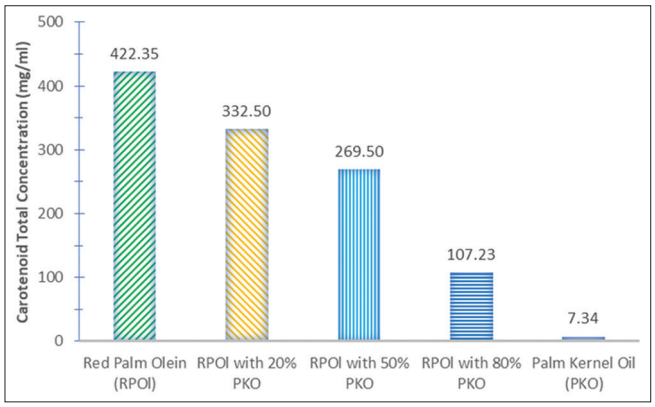

Figure 4: Carotenoids concentration of red palm olein, palm kernel oil, and the combination

the skin as an inhibiting agent of UVA and UVB radiation.[24] Carotenoids have a function as antioxidants that can inhibit UVA and UVB radiation on the skin.

CONCLUSION

It is concluded that the combination of RPO and PKO produces oil with more diverse characteristics. The high level of RPO in the mixture content will produce higher levels of squalene, Vitamin E, and total carotene. The combination oil of RPOL with 20% PKO produced a balanced composition of oleic acid and lauric acid. These combinations also a high concentration of carotenoid, Vitamin E, and squalene, which means great potential for health supplement. This oil combination contains high levels of carotenoids, vitamin E, and squalene, so it has the potential to be used as a source of natural medicine.

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Conflicts of interest

There are no conflicts of interest.

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