# Minor Components of Palm Oil

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**ABSTRAK**

*Minyak sawit mentah mengandungi banyak komponen surih yang mustahak seperti karoten, vitamin E, sterol, squalene, phospholipid dan ubiquinone. Walaupun komponen ini hanya 1% tetapi nilainya tinggi. Kebanyakannya dimusnah atau dikeluar dari minyak sawit dalam proses penapisan. Ini merugikan industri sebab komponen surih ini boleh dipulih. Beberapa komponen ini mempunyai ciri mustahak dalam bidang perubatan dan kesihatan.*

## INTRODUCTION

Crude palm oil contains a number of important minor components such as carotenoids, tocopherols and tocotrienols, sterols, ubiquinones, triterpenes, phopholipids, glycolipids, terpenic and aliphatic hydrocarbons (*Table 1*) (Goh *et al.*, 1982; Maclellan, 1983; Rossell *et al.*, 1983). The percentage of these minor components in crude palm oil is about 1% but their combined economic value is much more. So far only carotenes, tocopherols and tocotrienols have been produced commercially. There are potentials for recovering the other minor component and they present an opportunity to increase the net value of palm oil. Malaysia produced 8.3 million tonnes of palm oil in 1998. The amount of potential minor components that is available for commercial exploitation amounts to 83 000 tonnes. The market value of natural carotenes ranges from RM3000-RM5000 per kg, while that of natural palm tocotrienols can range from RM3000-RM7000 per kg. At these market values, the combined worth of the minor components has much more value than the palm oil itself. An important criterion for economical viable method of recovery of these minor components is that the extraction must not change the characteristic of palm oil. In the commercial recovery of palm carotenes, palm oil is converted to methyl ester, which is the by-product. This is not as attractive as extracting it directly from crude palm oil, where oil become the by-product. Similarly, the recovery of palm vitamin E through the esterification of palm fatty acid distillate (PFAD) produces methyl esters as a by-product. The market for palm methyl esters is small, hence, this will limit the production capacity of vitamin E. The concentration of vitamin E in PFAD can range from 0.1% to 4%.

**TABLE 1. MINOR COMPONENTS OF CRUDE PALM OIL**

| Component | Concentration (ppm) |
|---|---|
| Carotenoids | 500 - 700 |
| Tocopherols | 600 - 1 000 |
| Sterols | 326 - 627 |
| Squalene | 200 - 500 |
| Phospholipids | 20 - 80 |
| Glycolipids | 1 000 - 3 000 |
| Triterpene alcohols | 40 - 80 |
| Methyl sterols | 40 - 80 |
| Aliphatic alcohols | 100 - 200 |
| Aliphatic hydrocarbons | 50 |
| Methyl esters | 50 |
| Ubiquinones | 10 - 80 |
| Wax esters | trace |

Sources: Goh *et al.* (1982), Maclellan (1983), Rosell *et al.* (1983).

## CAROTENOIDS

Palm oil is one of the richest sources of natural carotenes. Its concentration can range from 400 ppm to 3500 ppm, depending on the species of oil palm. The carotene concentration of palm oil from the commercial planting material ranges from 500-700ppm. It contains 15 times more retinol equivalent (vitamin A) than carrots, and 30 times more than tomatoes. The major carotenes present

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in palm oil are α- and β- carotene, which make up more than 90% of the total carotenes. The other carotenes are phytoene, phytofluene, δ-carotene, γ-carotene, ζ-carotene, neurosporene, β-zeacarotene, α-zeacarotene, and lycopene (*Table 2*) (Yap *et al.*, 1991). β-Carotene, in particular has been known for its pro-vitamin A activity. Others such as lycopene and phytoene have been shown to possess anti-cancer properties. Recent studies have shown that these carotenes possess protective properties against certain types of cancers (Alam *et al.*, 1984; Mathew-Roth *et al.*, 1982; Peto *et al.*, 1981; Swartz *et al.*, 1986; Stitch *et al.*, 1988; Murakoshi *et al.*, 1992).

**TABLE 2. COMPOSITION OF CAROTENES IN CRUDE PALM OIL**

| Carotene | Concentration (%) |
|---|---|
| Phytoene | 1.27 |
| *Cis*-β-Carotene | 0.68 |
| Phytofluene | 0.06 |
| β-Carotene | 56.02 |
| α-Carotene | 35.16 |
| *Cis*-α-carotene | 2.49 |
| ζ-Carotene | 0.69 |
| γ-Carotene | 0.33 |
| δ-Carotene | 0.83 |
| Neurosporene | 0.29 |
| β-Zeacarotene | 0.74 |
| α-Zeacarotene | 0.23 |
| Lycopene | 1.30 |

Source: Yap *et al.* (1991).

In Malaysia itself, the potential availability of natural carotenes is about 4000 tonnes per year. This is destroyed during the refining process and represents a potential loss to the palm oil industry. There are a number of ways of extracting carotenes from palm oil (Ooi *et al.*, 1994; Tan and Salleh, 1992; Lion, 1976) but only two are commercially used. The commercial production of palm carotenes is limited to about 10-15 tonnes a year.

## TOCOPHEROLS

Palm oil is also a rich source of natural vitamin E. The concentration of vitamin E in palm oil ranges from 600-1000 ppm and consists of the tocopherols and tocotrienols. Tocopherols are the most common vitamin E found in vegetable oils. However, palm oil vitamin E also consists of tocotrienols which have been reported to have important nutritional and physiological properties (Qureshi *et al.*, 1991). In the refining process, some of the vitamin E is removed from the oil and retained in the palm fatty acid distillate (PFAD). It was reported that refined, bleached and deodorized (RBD) palm oil, palm olein, and palm stearin retained approximately 69%, 72% and 76% respectively of the vitamin E. The vitamin E found in palm oil includes α-tocopherol, γ-tocopherol, α-tocotrienol, γ-tocotrienol and δ-tocotrienol (*Table 3*). Vitamin E is a known antioxidant and recent studies also showed that it helps reduce the risk of stroke and heart disease by preventing oxidation of bad LDL cholesterol. Tocotrienols were also reported to have anti-cancer and tumor suppressive properties.

The potential availability of natural vitamin E from the palm oil industry is about 6000 tonnes. However, 70%-75% of it is retained in the refined oil, with the balance in the PFAD. Commercial production of natural vitamin E is mainly of α-tocopherol while that of tocotrienol is still in the planning stage (Gapor *et al.*, 1993). As with palm carotenes, the most attractive way to extract palm vitamin E is to get it directly from the oil; otherwise there will be limitations in their production. Vitamin E is a high value product and its recovery from palm oil is an attractive venture.

**TABLE 3. TOCOPHEROLS AND TOCOTRIENOLS IN CRUDE PALM OIL**

| Composition | Concentration (ppm) |
|---|---|
| α-Tocopherol | 279 |
| γ-Tocopherol | 61 |
| α-Tocotrienol | 274 |
| γ-Tocotrienol | 398 |
| δ-Tocotrienol | 69 |
| Total | 1 081 |

## STEROLS

Sterols are present in most oils and fats. However, cholesterol is present mainly in animal fats and in

very small amounts in vegetable oils. The major sterols present in palm oil are stigmasterol, sitosterol and campesterol (*Table 4*). The total sterol content in palm oil is between 300-600ppm. The cholesterol content in palm oil is negligible (less than 13ppm). The sterols in refined palm oil products are further reduced during the refining process and are collected in PFAD. Sterols are important raw materials for the pharmaceutical industry. They can be converted into useful steroid derivatives. Plant sterols have also been used as cholesterol blockers to lower serum cholesterol level. It is possible to recover them from palm oil and this presents a further opportunity for increasing the range and value of palm oil products.

**TABLE 4. STEROL COMPOSITION OF CRUDE PALM OIL**

| Sterol | Concentration (ppm) |
|---|---|
| Sitosterol | 218 - 370 |
| Stigmasterol | 46 - 66 |
| Campesterol | 90 - 151 |
| Cholesterol | 7 - 13 |
| Others | 2 - 18 |

## SQUALENE

Squalene is a polyunsaturated aliphatic hydrocarbon which occurs widely in both plants and animals. One of the richest sources of squalene is the liver of deep sea sharks. As an antioxidant, squalene has been reported to have preventive effects against carcinogenesis. Crude palm oil has 200-500ppm squalene while PFAD has been shown to contain 1%-2%. Squalane, a more stable product is derived from squalene. Both squalene and squalane are used in skin care products. Palm oil can be a source of squalene for commercial production.

## PHOSPHOLIPIDS

Phospholipids are the polar lipids found in crude palm oil (Gee *et al.*, 1985). The phospholipids are suspected to have deleterious effects on the oil quality and are mostly removed during the refining process. Crude palm oil contains 5-130 ppm of phospholipids, represented mainly by phosphatidylcholine (*Table 5*). Phospholipids are also known as lecithin. Most of the commercial lecithin is produced from soyabean oil and used widely as emulsifiers in the food and pharmaceutical industry. The amount of phospholipids in crude palm oil is small compared to what is available from soyabean oil.

**TABLE 5. PHOSPHOLIPID COMPOSITION OF CRUDE PALM OIL**

| Phospholipid | Composition (%) |
|---|---|
| Phosphatidylcholine | 36 |
| Phosphatidylethanolamine | 24 |
| Phosphatidylinostol | 22 |
| Phosphatidylglycerol | 9 |
| Diphosphatidylglycerol | 4 |
| Phosphatidic acid | 3 |

## OTHER MINOR COMPONENTS

The other minor components present in palm oil are glycolipids, ubiquinones, triterpenic alcohols, aliphatic alcohols and hydrocarbons, methyl esters, methyl ketones, and wax esters. Most of these components are present in small amounts except for glycolipids and are not known to have important properties except for ubiquinones (*Table 1*). Ubiquinones are known to be ten times more effective as antioxidants than vitamin E and are present in less than 10ppm. In a recent study on LDL by Stocker *et al.*(1991), ubiquinols were shown to be the most effective antioxidant against peroxyl radicals.

## CONCLUSION

Palm oil is an important source of natural minor components. Some of these are high value products, which are destroyed or removed during the refining process. The minor components like carotenes, vitamin E, sterols and squalene, which are destroyed or removed, present a potential loss to the palm oil industry. This amounts to millions of ringgit per year. The development of technologies to recover these components will increase the competitiveness and advances the process technology of the industry.

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