Palm Oil Supply and Disappearance: A Review

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INTRODUCTION

The palm oil industry has been a significant driver in the economic development of Malaysia and has established itself in the international oil and fats business. The Malaysian palm oil industry has gained strength each year to promote its growth to a new level. In 2008, the industry recorded export earnings of oil palm products to RM 65.2 billion from RM 45.1 billion in the previous year. The national average fresh fruit bunch (FFB) yield increased by 6% to 20.18 t ha^{-1} as against 19.03 t ha^{-1} achieved in 2007, while the average oil yield per hectare also posted a 6.5% year-on-year increase to 4.08 t ha^{-1}, the highest since 1987.

There was a substantial year-on-year increase of 12% in the production of Malaysian palm oil from 15.82 million tonnes in 2007 to 17.73 million tonnes in 2008 (*Table 1*). A bigger growth than 2007/2006, of 0.36%, suggests that palms were recovering from the low production cycle after a smaller increase in the previous year.

Crude palm oil (CPO) production in January 2009 at 1.33 million tonnes was 0.15 million tonnes lower compared to 1.48 million tonnes in December 2008. The year-on-year quantum contracted by 6.6% or 0.94 million tonnes as compared to 1.42 million tonnes in January 2008, and further declined to 1.19 million tonnes in February 2009. As usual, production picked up in subsequent month and continued its upward swing in the following month, but the amount was smaller compared to the corresponding months in the previous year. The monthly FFB yield for the first six months of 2009 was lower by an average of 0.13 t ha^{-1} compared to the previous year (*Figure 1*).

With lower production in the beginning of the year, total palm oil production for the first six months of 2009 had contracted by 3.43% to 7.92 million tonnes compared to 8.20 million tonnes in 2008 subsequently, import of palm oil in the first half of the year grew by 10.5% to 0.32 million tonnes to cater for the need of the refining sector.

The beginning stock of palm oil in 2008 rose to 1.68 million tonnes, and with imports of palm oil at 0.32 million tonnes and the year's production of 17.73 million tonnes, total palm oil available for trade was 19.98 million tonnes. In 2008, 15.41 million tonnes of palm oil was exported and together with estimated disappearance within the country, resulted in 1.99 million tonnes of stocks-carry-over in January 2009. Based on this estimation, the total availability of palm oil for trade in 2009 is expected to be 19.61 million tonnes, lower by 1.85% than in the previous year.

Malaysian exports of palm oil had increased substantially by 1.67 million tonnes or 12.12% in 2008 compared to 13.74 million tonnes in the previous year, amidst global recession and also higher palm oil price. For the first six months of

TABLE 1. MALAYSIAN PALM OIL PRODUCTION (million tonnes)

Year	2007	2008	Jan-June 2008	Jan-June 2009
Production	15.82	17.73	8.20	7.92

Source: MPOB.

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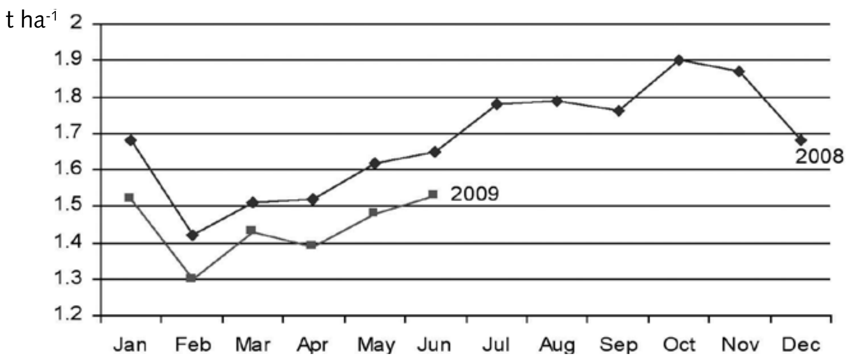


Source: MPOB.

Figure 1. Monthly fresh fruit bunch (FFB) yield (t ha^{-1}).

2009, about 7.57 million tonnes of Malaysian palm oil products were exported. The amount posted an increase of 9.18% compared with corresponding period in 2008.

China PR continued to be the largest importer of palm oil from Malaysia, accounting for 22.3% of total export of palm products (1.69 million tonnes). However, China's import was lower by 5.3% against the same period last year due to improved domestic oil output and slower growth in consumption (*Table 2*). Refined, bleached and deodorized (RBD) palm olein was the major palm oil product amounting to 1.24 million tonnes (73.5%) (*Figure 2*). Compared to the corresponding period in 2008, the amount declined by 12%.

The second largest palm product imported from Malaysia was RBD palm stearin with uptake increasing from 0.15 million tonnes in mid 2008 to 0.26 million tonnes in mid 2009. CPO was the third largest palm product imported with the quantum increasing slightly from 0.14 million tonnes to 0.15 million tonnes respectively for the first half of 2008 and 2009. These three products accounted for 97.7% of the total import from Malaysia. Other products included palm acid oil, RBDH palm stearin, palm fatty acid distillate, and refined, bleached, deodorized and hydrogenated (RBDH) stearin.

For the first half of 2009, Pakistan was the second largest importer of Malaysian palm oil with imports totalling 0.93 million tonnes, an increase of 67.7% compared to 0.56 million tonnes in the same period in the previous year (*Table 3*). This was partly induced by tariffs reduction on seven palm products by 10% Margin of Preference (MoP) which took effect on January 2008. The tariff will further be reduced by 5% starting from January 2010. Pakistan currently accounted for 12.35% of total export of Malaysian palm oil products. About 0.37 million tonnes of RBD palm oil was imported comprising 39.1%, followed by 0.27 million tonnes of RBD palm olein and 0.21 million tonnes of CPO (*Figure 3*). These three products accounted for about 90% of the palm products imports.

Exports to the European Union (EU) increased marginally by 1.25% to 0.88 million tonnes compared to 0.87 million tonnes over the same period in 2008 (*Table 4*). EU is currently the third largest importer of Malaysian palm oil. Palm oil export to Germany had increased substantially from 0.02 million tonnes to nearly 0.07 million tonnes, compensating the export slowdown to Netherlands from 0.53 million tonnes to 0.48 million tonnes. Major palm oil products imported by the EU were CPO (0.50 million tonnes), RBD palm olein (0.09 million tonnes), RBD palm stearin (0.10 million tonnes), palm fatty acid distillate (0.06 million tonnes), and palm mid fraction (0.03 million tonnes) (*Figure 4*).

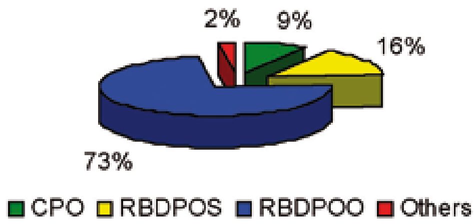
India was the fourth largest importer of Malaysian palm oil products with a total volume of 0.68 million tonnes up to the mid 2009 (*Table 5*), a significant increase of 0.43 million tonnes or 172% over the same period in 2008. A wide variety of palm products (*Figure 5*) with amount increasing due to reduction in customs duties, especially zero duty for crude oils and a very low 7.5% for refined oils. In the first half of 2009, CPO import totalled at 0.32 million tonnes to become one of two major palm products accounting for 47% of the total import. Import of CPO had tripled against the same period last year. RBD palm olein import amounted to 0.25 million tonnes, a five-fold increase over the equivalent period in the previous year. Imports of other palm products had also expanded except palm fatty acid distillate (PFAD) and palm acid oil (PAO).

USA was the fifth largest importer of the Malaysian palm products with import declining by 5.84% from 0.48 million tonnes in 2008 to 0.45 million tonnes in equivalent first six month period in 2009 (*Table 6*).

TABLE 2. EXPORT OF PALM OIL PRODUCTS TO CHINA (million tonnes)

Year	Amount
2007	3.84
2008	3.79
Jan-June 2008	1.78
Jan-June 2009	1.69

Source: MPOB.



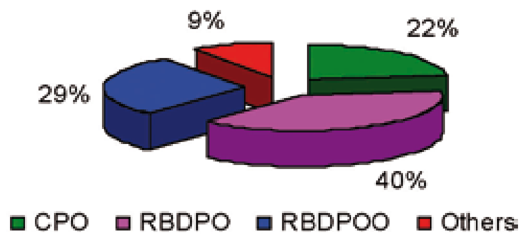
Note: CPO = crude palm oil.
RBDPOS = refined, bleached, deodorized palm oil stearin.
RBDPOO = refined, bleached, deodorized palm oil olein.
Source: MPOB.

Figure 2. Export composition of palm oil products to China in 2009 (January-June).

TABLE 3. EXPORT OF PALM OIL PRODUCTS TO PAKISTAN (million tonnes)

Year	Amount
2007	1.07
2008	1.26
Jan-June 2008	0.56
Jan-June 2009	0.93

Source: MPOB.



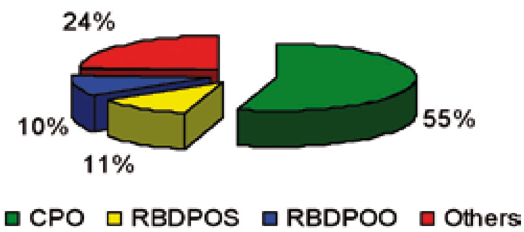
Note: CPO = crude palm oil.
RBDPO = refined, bleached, deodorized palm oil.
RBDPOO = refined, bleached, deodorized palm oil olein.
Source: MPOB.

Figure 3. Export composition of palm oil products to Pakistan in 2009 (January-June).

TABLE 4. EXPORT OF PALM OIL PRODUCTS TO EUROPEAN UNION (EU) (million tonnes)

Year	Amount
2007	2.06
2008	2.05
Jan-June 2008	0.87
Jan-June 2009	0.88

Source: MPOB.



Note: CPO = crude palm oil.
RBDPOS = refined, bleached, deodorized palm oil stearin.
RBDPOO = refined, bleached, deodorized palm oil olein.
Source: MPOB.

Figure 4. Export composition of palm oil products to European Union (EU) in 2009 (January-June).

Major palm products imported from Malaysia were RBD palm olein (0.10 million tonnes), RBD palm oil (0.19 million tonnes), and RBD palm stearin (0.11 million tonnes). Other imported products included PFAD (0.04 million tonnes) and small amount of palm mid fraction (*Figure 6*). A substantial decrease in the imports of RBD were registered, particularly palm olein (31.7%) and RBD palm stearin (12.1%).

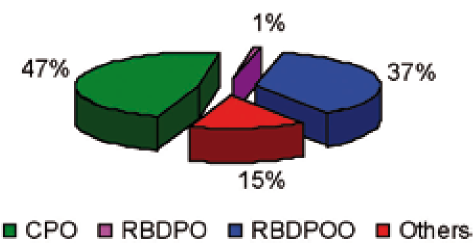
Egypt was the sixth largest importer of the Malaysian palm oil products. About 0.32 million tonnes was imported in the first half of 2009, registering a substantial increase of 0.27 million tonnes from 0.01 million tonnes in the corresponding period in 2008. The upsurge compensated declining exports of Malaysian palm oil products to Gulf countries, particularly United Arab Emirates and Jordan.

Japan, with imports of 0.28 million tonnes, was the seventh largest importer of the Malaysian palm oil products, accounting for about 3.6% of the total amount. Imports edged up by 0.01 million tonnes compared to the same period in 2008 (*Table 7*). Japan imports comprised of RBD palm oil (0.12 million tonnes), RBD palm olein (0.10 million tonnes), palm mid fraction (0.01 million tonnes), and crude

TABLE 5. EXPORT OF PALM OIL PRODUCTS TO INDIA (million tonnes)

Year	Amount
2007	0.51
2008	0.97
Jan-June 2008	0.25
Jan-June 2009	0.68

Source: MPOB.



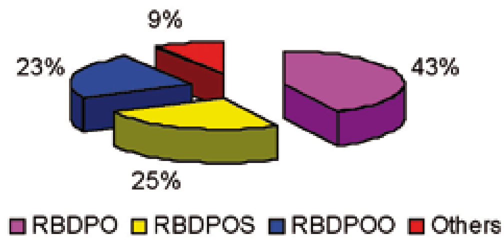
Note: CPO = crude palm oil.
RBDPO = refined, bleached, deodorized palm oil.
RBDPOO = refined, bleached, deodorized palm oil olein.
Source: MPOB.

Figure 5. Export composition of palm oil products to India in 2009 (January-June).

TABLE 6. EXPORT OF PALM OIL PRODUCTS TO USA (million tonnes)

Year	Amount
2007	0.79
2008	1.05
Jan-June 2008	0.48
Jan-June 2009	0.45

Source: MPOB.



Note: RBDPO = refined, bleached, deodorized palm oil.
RBDPOS = refined, bleached, deodorized palm oil stearin.
RBDPOO = refined, bleached, deodorized palm oil olein.
Source: MPOB.

Figure 6. Export composition of palm oil products to USA in 2009 (January-June).

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Palm Oil: Rich in Health Promoting Phytonutrients

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INTRODUCTION

The oil palm, *Elaeis guineensis*, is the source of palm oil – the 'tropical golden oil'. Malaysia is the world's largest exporter of this golden oil. Palm oil is a versatile oil with a wide range of uses in food and non-food areas. Triglycerides constitute the major component of crude palm oil, with smaller proportions of diglycerides and monoglycerides. The oil also contains other minor constituents, such as free fatty acids and phytonutrients. This composition determines the oil's physical, chemical and physiological characteristics. In food application, palm oil not only imparts functional properties as a heating medium (as in frying of foods) and in having spreadabilty (as in formulations for solid fat products like margarines and shortenings), but is also a good source of phytonutrients. The phytonutrients constitute only about 1% of the weight of crude palm oil. The prevalent phytonutrients found in palm oil are vitamin E, carotenes, phytosterols, squalene, co-enzyme Q10, polyphenols, and phospholipids. The component composition of crude palm oil is given in *Table 1*.

TABLE 1. COMPONENTS IN PALM OIL

Component	Percentage
Triglycerides	>90
Diglycerides	2-7
Monoglycerides	<1
Free fatty acids	3-5
Phytonutrients	1

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PALM OIL PRODUCTS AS SOURCES OF PHYTONUTRIENTS

Crude palm oil can be processed into various downstream products, and in the process phytonutrients are partially removed. Refined, bleached and deodorized (RBD) palm oil, the major processed product, is obtained from the bleaching and deodorization of crude palm oil. During this refining process, the carotenes are decomposed to result in a light yellow oil, while part of the other phytonutrients are retained in the RBD palm oil.

Another product, red palm oil (RPO) is obtained from crude palm oil through a novel low temperature process. Owing to this special process, RPO possesses a special flavour and aroma, and is rich in phytonutrients that include carotenes (thus giving the oil a bright red colour), vitamin E, phytosterols, phospholipids, squalene, phenolic acids, flavonoids and co-enzyme Q10.

Phytonutrients can also be recovered from the palm oil mill as well as from refinery by-products such as palm pressed fibre, palm oil mill effluent (Sambanthamurthi *et al.*, 2006) and palm fatty acid distillate (Ab Gapor *et al.*, 2002). Furthermore, in the process of producing palm biodiesel from crude palm oil, palm phytonutrient concentrate can be obtained as a by-product (Choo *et al.*, 2002). A list of the phytonutrients present in palm oil and their health benefits are shown in *Table 2*.

Vitamin E

Palm oil exhibits strong antioxidant properties due to the presence of a high amount of vitamin E, which comprises a mixture of various isomers of tocopherols and tocotrienols, often referred to as 'tocols'. Each of these tocopherol and tocotrienol sub-groups is composed of the α, β, γ and δ isomers. In the case of the palm tocols, the composition is

TABLE 2. PALM PHYTONUTRIENTS

Palm phytonutrients	Health benefits
Vitamin E (600-1000 ppm)	• Anti-cancer effects • Anti-angiogenesis • Antioxidant • Anti-arterosclerosis • Anti-ageing • Inhibition of cholesterol synthesis • Cardio-protection effects • Aid diabetes
Carotenoids (500-700 ppm)	• Pro-vitamin A activity • Cardio-protection effects • Anti-cancer
Phytosterols (300-620 ppm)	• Cholesterol lowering properties
Squalene (250-540 ppm)	• Cardio-protective effects • Inhibition of cholesterol synthesis • Anti-cancer
Phospholipids (20-100 ppm)	• Brain development • Energy endurance • Eases digestion and nutrition absorption
Co-enzyme Q10 (10-80 ppm)	• Enhance production of cellular energy • Antioxidative defence mechanism • Cardio-protective effects • Anti-cancer
Polyphenolics (40-70 ppm)	• Cholesterol inhibition • Aids various circulation problems • Anti-cancer

made up of γ-tocotrienols (46%), α-tocopherol(22%), α-tocotrienols (20%) and δ-tocotrienols (12%). Tocopherols have a long saturated carbon side-chain with chiral centres, and are generally present in common vegetable oils, namely, corn and soyabean oils. Tocotrienols, on the other hand, are structurally similar to tocopherols except that they have three unsaturated bonds in the carbon side-chain with only one chiral centre. This unique property enables tocotrienols to penetrate freely tissues with saturated fatty layers, thus, performing a more efficient metabolic function compared to tocopherols. Accumulations of tocotrienols in tissues manifest superb health benefits (Das *et al*., 2008).

Anti-cancer Effects

Several studies on tocols have provided convincing and prominent evidence on their anti-cancer properties. Nesaretnam *et al.* (2004) have conducted extensive investigations on the relationship between palm tocotrienols and breast cancer, and concluded that individual fractions of tocotrienols could inhibit human breast cancer cells irrespective of estrogen receptor status; however, α-tocopherol had no inhibitory effect on these cell lines. Recently, a similar study was conducted on androgen-independent human prostate cancer cells and similar conclusions were drawn, *i.e.* tocotrienols preferentially inhibited prostate cancer cells while α-tocopherols were found to have no effect (Nesaretnam *et al*., 2008). Furthermore, compelling evidence from yet another study on pre-cancerous, cancerous and highly cancerous mouse mammary epithelial cells displayed greater biopotency of tocotrienols as compared to tocopherols (McIntyre *et al*., 2000).

Natural Potent Antioxidant

Palm tocotrienols are well-known for their antioxidant property. Antioxidants are substances capable of scavenging free radicals or reactive oxygen species, thus are capable of protecting cells against oxidative damage. In a study evaluating the effect of antioxidants on lipid peroxidation, it was found that tocotrienols and tocopherols were effective in reducing acute and chronic lipid peroxidation caused by paraquat in the lungs of rats (Azlina *et al*., 2005). Lipid peroxidation is a chain reaction that provides a continuous supply of free radicals, which results in not only food rancidity but also damage to tissues *in vivo*, leading to cancer, inflammatory diseases, atherosclerosis and ageing. Palm α-tocopherol and γ-tocotrienol have been observed to protect against lipid peroxidation using a xenobiotic metabolizing enzyme that induces lipid peroxidation (Suzana *et al.*, 2005). LDL-lipid peroxidation initiates the pathogenesis of artherosclerosis, which is a condition where the walls of the arteries throughout the body begin to thicken or lose elasticity. The scavenger cell receptor on macrophages recognizes this modified (peroxidized) LDL (bad cholesterol). Studies by Suarna *et al*. (1993) have shown that tocotrienols and α-tocopherol could prevent LDL peroxidation.

Inhibition of Cholesterol Synthesis

Human trials have shown that the daily consumption of tocotrienols-enriched fractions of palm oil (200 mg *Palmvitee* capsule) by hypercholesterolemic subjects can result in a significant reduction of serum cholesterol, LDL cholesterol, Apo B, thromboxane (which is a potent inducer of platelet aggregation), platelet factor 4 (which inhibits the activity of heparin), and glucose levels within four weeks of the initial study period. They also singled out γ-tocotrienols as the most potent cholesterol-inhibitor. These reductions were reported to be consistent with the observations seen in animal models. Hence, it was suggested that tocotrienols could confer multiple cardiovascular benefits (Qureshi *et al*., 1991). Furthermore, tocotrienols, in particular γ-tocotrienol, were also found to decrease hepatic cholesterol production and thus, reduce plasma cholesterol levels in animals as well as cholesterogenesis. It was claimed that γ-tocotrienol acts by lowering cholesterol production in the liver (Parker *et al*., 1993). Delta (δ)- and γ-tocotrienols, which are also known as desmethyl tocotrienols as they have less methyl groups, are believed to be the only two isomers that possess the right molecular formula that promotes the reduction of cholesterol. Tocopherols, on the other hand, do not have a similar advantageous molecular structure that can impart such an effect (Song and Boyd, 2006).

Cardio-protective Effects

In a recent animal study, the tocotrienols-rich fraction (TRF) has been shown to confer cardio-protective ability. The rats were given oral gavages of various isomers of tocotrienols over two different periods. The results show the cardio-protective effect by aiding post-ischemic ventricular function and reducing myocardial infarct size. The highest cardio-protective effect was shown by γ-tocotrienol, followed by α- and δ-tocotrienols. Inhibition of normal cellular gene, C-Src activation and proteosome stabilization were found to be the reasons behind the cardio-protective properties of TRF (Das *et al*., 2008). Narang *et al*. (2004) demonstrated that the antioxidant vitamins in palm olein play a vital role in the protection of the rat's heart against oxidative stress induced by ischemic-reperfusion injury.

Aids Diabetes

Palm vitamin E was also reported to have the ability to recover glycemic status, inhibit oxidative damage and prevent DNA damage in a diabetic rat model (Budin *et al.,* 2006). In another study also conducted using a diabetic rat model, it was found that TRF could effectively prevent glycosylation of end-products in serum. Moreover, blood sugar and glycated haemoglobin were also found to decrease in diabetic rats following the administration of TRF in their diet (Nazaimoon and Khalid, 2002).

CAROTENOIDS

Crude palm oil is considered one of the world's richest natural plant sources of carotenoids which are responsible for the brilliant orange-red colour of palm fruit and crude palm oil. About 600 different naturally occurring carotenoids are known, of which 13 are found in crude palm oil. They are phytoene, phytofluene, *cis*-β-carotene, β-carotene, α-carotene, *cis*-α-carotene, ζ-carotene, γ-carotene, δ-carotene, neurosporene, β-zeacarotene, α-zeacarotene and lycopene. The major carotenes are β-carotene and α-carotene, accounting for 56% and 35%, respectively, of the total carotenoids present in crude palm oil. Carotenoids in plants largely serve as a constituent in the chromoplast for photosynthesis, and as protection against photo-oxidation as an oxygen sequencer. They can quench singlet oxygen and free radicals via the triplet state. Palm oil has 15 times more retinol (pro-vitamin A) equivalents than carrot, and 300 times more than tomato.

Pro-vitamin A Activity (retinol equivalent)

Of the 600 known carotenoids, only 10% are known to possess pro-vitamin A activity. The α-, β- and γ-carotenes are quantitatively the only carotenes in red palm oil that portray pro-vitamin A activity. Pro-vitamin A can be cleaved to yield retinaldehyde, and thence retinol and retinoic acid. Thus, the total amount of vitamin A in food is normally expressed as micrograms of retinol equivalents. Carotenoids are fat-soluble pigments which require fat for conversion into vitamin A. Thus, red palm oil is the perfect solution for the treatment of vitamin A deficiency (Rao, 2000). As a means of combating vitamin A deficiency, lactating mothers are encouraged to supplement their diet with carotenoid-rich red palm oil to promote retinols in maternal serum or breast milk (Lietz *et al*., 2000).

Cardio-protective Effects

Like tocotrienols, carotenoids have various protective and therapeutic effects on cardiovascular diseases. Even though the incorporation of carotenoids into LDL was found to be far lower than vitamin E, β-carotene could significantly prevent LDL oxidation, which is the major culprit in the occurrence of coronary heart disease (Parker, 1993). A strategy of preventing heart disease by looking at the effects of daily lycopene supplementation from tomato involving 19 healthy human subjects was conducted in Canada. Results of this study revealed that lycopene could significantly decrease serum lipid peroxidation and LDL oxidation although it did not change serum cholesterol levels (Agarwal and Rao, 1998).

Anti-cancer Properties

There is growing evidence that carotenoids can impart some protection against certain forms of cancer. An investigation on the consumption of dietary natural carotenoids and their level in serum has generally found that a lower level of carotenoid intake is associated with an increased incidence of breast cancer. In a case-control study involving 270 cases, Toniola *et al*. (2001) reported no inverse relation with lycopene level; however, significant inverse associations were found with α-carotene, β-carotene, α-cryptoxanthin, lutein and total carotenoids. Zhang *et al*. (1999) performed a full cohort analysis of the Nurses' Health Study concentrating on the role of dietary intake of carotenoids and the risk to breast cancer. The analysis showed an inverse association between the intake of carotenoids, mainly α-carotene and lutein or zeaxanthin, with breast cancer risk in pre-menopausal women but not among menopausal women. Results from another large-scale study, using plasma drawn from women enrolled in the Nurses' Health Study to evaluate the major plasma carotenoids and retinol associated with breast cancer risk, revealed a 35% reduction in breast cancer risk for women with the highest quintile of α-carotene (Tamimi *et al.,* 2005). Epidemiological studies on the effect of retinoic acid and palm oil carotenoids on breast cancer cell lines found no effect on estrogen-independent cells, but inhibited growth of estrogen-dependent cells (Nesaretnam *et al.*, 2000). There is also evidence that carotenoids, primarily α-carotene and β-carotene, could inhibit the growth of small cell lung cancers (Galligan *et al*., 1993).

PHYTOSTEROLS

Phytosterols are naturally occurring substances present in all plants and plant-based raw materials in foods. The major sources of phytosterols are unrefined plant oils, seeds, nuts and legumes. The major phytosterols in crude palm oil are β-sitosterol (60%), campesterol (13%), stigmasterol (24%) and cholesterol (3%). These phytosterols are structurally similar to that of cholesterol; the difference lies in the side-chain which contains additional double bonds and/or with a methyl or ethyl group. The typical Asian diet contains phytosterols of between 350 and 400 mg per day whereas a vegetarian diet contains 600 to 800 mg per day. Sterols are an essential component of cell membranes for both plants and animals.

Cholesterol-lowering Properties

The main focus of interest in palm phytosterols has been their cholesterol-lowering effect. Phytosterols have been incorporated as a functional additive into margarines, spreads and other high fat foods to reduce total cholesterol and LDL-cholesterol in consumers (Jones *et al*., 2003). A study on colectomized patients shows that margarines fortified with stanol ester can reduce the absorption and serum concentrations of cholesterol and plant sterols. Furthermore, although plant sterols were detectably absorbed, they would be eliminated effectively in bile without the formation of gallstones (Miettinen *et al*., 2000). It is likely that most of the cholesterol-lowering action is due to the suppression of intestinal cholesterol absorption and partially by suppression of cholesterol biosynthesis (Jones *et al*., 2003). A dietary intake of over 2 g per day of phytosterols/phytostanols could effectively decrease cholesterol absorption from the gut, reduce plasma cholesterol by about 10%, and reduce LDL cholesterol to around 10% to 15%, with minimal change in HDL (good cholesterol), and without causing malabsorption (Zadak *et al*., 2006).

SQUALENE

Squalene ($C_{30}H_{50}$) is a naturally occurring triterpene with a highly unsaturated aliphatic hydrocarbon chain. It is primarily found in shark liver oil (*Squalus* spp.), and a reasonable amount can be obtained from botanic sources like olive oil, palm oil, wheatgerm oil, amaranth oil and rice bran oil. Squalene, like other isoprenoids (namely carotenes, vitamin A, vitamin K, vitamin D, vitamin E, cyclic terpenoids compounds and dolichol), is a lipophilic antioxidant having unique characteristics which enable it to anchor itself to cell membrane (Kelly, 1999). This explains the presence of squalene as one of the major components of skin surface lipids. Squalene can easily produce oxygen by combining with water. Thus, it is an oxygen carrier with superior ability to transmit oxygen. In order to stabilize itself, squalene attaches to hydrogen ions from water and acids in the body, and at the same time releases oxygen to the body.

Inhibition of Cholesterol Synthesis

Research has shown that supplementing the human diet with 900 mg of squalene daily for seven to 30 days could be beneficial to cardiovascular health (Strandberg *et al.*, 1989). Results demonstrate that there was about 60% absorption with a 17-fold increase in serum squalene; however, no significant changes were reported in serum triglycerides and cholesterol contents. In addition, as squalene is incorporated mainly into tissues, it eventually becomes a metabolic precursor of cholesterol and other steroids (Kelly, 1999). In another double-blind study conducted to look at the combined effects of squalene (860 mg) and pravastatin (10 mg), either alone or in combination, for the treatment of hypercholesterolemia, 102 patients received either treatment or a placebo for 20 weeks. Even though pravastatin was more efficient than squalene in reducing total cholesterol, LDL-cholesterol and triglycerides as well as increasing HDL-cholesterol levels, a combination of pravastatin and squalene was found to be more efficacious in reducing total and LDL cholesterol, besides increasing HDL (good cholesterol) (Chan *et al.*, 1996).

Anti-cancer Properties

Squalene also has an amazing ability of enabling an organism to resist cancer. Researchers of numerous studies proposed that squalene may be the active component in olive oil that contributes to the cancer risk-reducing effect associated with olive oil intake. Murakoshi *et al.* (1992) reported that topically applied squalene was able to inhibit the tumour-promoting effect of mouse skin carcinogenesis. Administration of dietary squalene demonstrated inhibition in the formation of preneoplastic lesions against colon carcinogenesis without significant effects on the levels of serum cholesterol (Rao *et al.*, 1998). Yamaguchi *et al*. (1985) proved the effect of squalene in conjunction with an anti-tumour agent on promoting anti-tumour activity in a murine tumour system. Additionally, Yamaguchi *et al.* (1985) found that the administration of squalene resulted in some long-term survivors without significant toxicity effects on the host.

PHOSPHOLIPIDS

Phospholipids form the main building blocks in all living forms. These phytonutrients are present in small quantities in crude palm oil. The main phospholipids in palm oil are phosphatidylcholine, phosphatidylethanolamine, phosphatidylinositol and phosphatidyl-glycerol. Phospholipids are essential components of lipoproteins and biological membranes.

Brain Development

A study conducted by Suzuki *et al.* (2001) using an oral administration of phosphatidylcholine (lecithin) from soyabean and bovine brain cortex resulted in improvement in 'Morris water maze performance' by aged memory-impaired rats. The Morris water maze test reflects long-term spatial memory ability. Choline is a major building block of phosphatidylcholine, sphingomyelin and choline plasmologens. It is also used by our body as a precursor to make acetylcholine, a major neurotransmitter that permits neurotransmission. Therefore, an adequate supply of choline is essential for optimal nerve function. Choline is also important as prenatal supplementation. During pregnancy, maternal choline intake influences memory and brain development in the growing foetus. Pregnant and lactating women as well as their infants and children obtain choline mainly from formula or breast milk and food (Zeisel *et al.*, 1986). Consumption of foods low in phospholipids may lead to a depletion of phosphatidylcholine for the brain cells to have proper neurotransmission. Phosphatidylserine administration could also improve memory and other brain functions that tend to decline with age (Jager *et al.*, 2007).

Energy Endurance

Intense exercise causes a pronounced decline in choline concentrations in the blood. Thus, choline supplementation is important to replenish the plasma choline levels. Phosphatidylcholine has been shown to be 12 times more effective than inorganic choline salts in raising human blood choline levels. Overtraining is a natural hazard of competitive sports that can lead to decreased performance, injury, depressed immunity and psychological depression. Studies have also shown that phosphatidylserine administration can lessen the severity of exercise-induced stress while alleviating mental stress (Jager *et al.,* 2007). In addition, phosphatidylserine supplementation can also promote a desired hormonal status by blunting the increase of cortisol levels in atheletes (Starks *et al*., 2008).

Eases Digestion and Nutrient Absorption

In a study on gold fish using diets supplemented with soyabean lecithin, Lochmann and Brown (1996) reported an improvement in weight gain and feed efficiency. Increased phosphatidylcholine and other phospholipid fractions have proven to enhance the absorption of dietary lipid and to facilitate lipid transportation. Lecithin is able to dispense fat, thus aiding its breakdown and preventing its accumulation in the liver.

CO-ENZYME Q10

Co-enzyme Q10 is structurally related to the vitamins E and K. Commercial red palm olein contains 18-25 μg kg^{-1} of co-enzyme Q10. Co-enzyme Q10 is claimed to exhibit 10 times greater antioxidant property than vitamin E; however, the greater concentration of carotenes and vitamin E in palm oil tends to overshadow its viability.

Enhances Production of Cellular Energy

Co-enzyme Q10 is also known as ubiquinone. The most common form of co-enzyme Q (quinone) in mammals contains 10 isoprene units and is therefore known as co-enzyme Q10. It is a hydrophobic quinone that diffuses rapidly through the lipids of the inner mitochondrial membrane. Co-enzyme Q10 plays a vital role in the transport of protons across the inner mitochondrial membrane to synthesize ATP (adenine triphosphate), the energy currency in the cells. Mitochondria are literally the cell's energy factories and are generally located at the major sites of ATP utilization. In other words, the amount of mitochondria is correlated with the demand for ATP and with the physical properties of the tissues. Hence, due to the role of co-enzyme Q10 in energy production, it is an inevitable fact that a low concentration of this complex may be detrimental to health. This explains the reason for the abundant presence of co-enzyme Q10 in organs that require a large supply of energy, especially in the heart, liver, kidney and pancreas (Borekova *et al*., 2008).

Antioxidative Defence Mechanism

Clinically, co-enzyme Q10 is the first line antioxidant present in our defence system to counter excess oxidative stress. Being the only lipophilic antioxidant synthesized by our body, it is capable of reverting back to its reduced or oxidized (antioxidant) form in a normal cellular enzyme system. In a recent study, Niklowitz *et al.* (2007) reported that intracellular enrichment with co-enzyme Q10 in plasma and blood cells resulted in a long-lasting antioxidative defence mechanism.

Cardio-protective Effects

Most of the research on co-enzyme Q10 focuses on the heart where this nutrient is mostly concentrated. Research findings on the effects of co-enzyme Q10 in patients with heart disease are quite remarkable. In Japan, considerable research has been conducted in the safety assessment of co-enzyme Q10 in animals and humans. The Japanese government has been prompted to approve co-enzyme Q10 as a drug for the treatment of congestive heart failure way back in 1974. In 2001, co-enzyme Q10 was officially approved for use in food and dietary supplements in Japan (Hidaka *et al*., 2008). In a recent investigation by Verma *et al*. (2007) on the protective effect of co-enzyme Q10-loaded liposomes in rabbits with experimental myocardial infarction (commonly known as a heart attack), it was found that exogenous co-enzyme Q10 could effectively protect ischemic cells. Ischemic is a state where the blood supply is restricted.

Anti-cancer Properties

Co-enzyme Q10 also has anti-cancer properties of its own. In a study on mitochondrial co-enzyme Q10 concentrations in human breast cancer tissues from patients undergoing radical mastectomy and diagnosed with infiltrative ductal carcinoma, co-enzyme Q10 concentrations in the tumour tissues were found to be significantly lower than in the normal tissues. According to Portakal *et al*. (2000), this reduction may be due to an increase in reactive oxygen species in the malignant cells that causes overexpression of antioxidant enzymes, leading to the consumption of co-enzyme Q10.

POLYPHENOLICS

Palm fruit is also potentially an inexpensive source of phenolic antioxidants for the polyphenol market that is currently being dominated by polyphenols extracted from grapeseed and tea. While the fat-soluble components in palm oil have received considerable attention, relatively little importance has been given to the water-soluble components. Polyphenols are a large family of natural compounds that can be classified into phenolic acids and flavonoids. Major components of palm phenolics include p-hydroxy-benzoic acid, cinnamic acid, ferulic acid and caumaric acid, and the flavonoid rutin hydrate. Flavonoids are touted as some of the most potent free radical scavengers and ion chelators. Phenolics on the other hand act as free radical terminators. It has been claimed that malonyldialdehyde and flavonoids are more powerful than vitamin A, α-tocopherol or β-carotene as antioxidants (Middleton *et al*., 2000). An interesting study has shown that the free radical scavenging activity of palm phenolics is equivalent to that of green tea extract (Tan *et al.*, 2007).

Cholesterol Inhibition

Studies to evaluate the ability of phenolic compounds in red wine to enhance resistance against oxidation of human LDL *in vitro* (Frankel *et al*., 1993) and *in vivo* (Aviram and Fuhrman, 1998) have shown that phenolic substances inhibit the *c*opper-catalyzed oxidation of LDL. Moreover, these phenolics are found to be significantly better in inhibiting LDL oxidation compared to α-tocopherol. Studies have also shown that people with various circulatory problems in their extremities have benefited from flavonoid and phenolic intake. A recent review reported that tea flavonoids can improve endothelial function and reduce blood pressure, oxidative damage, blood cholesterol levels, inflammation and the risk of thrombosis (Engler *et al*., 2004).

Anti-cancer Properties

Cell culture studies using various prostate cancer cells indicate that quercetin, a flavonoid, can significantly inhibit the expression of specific oncogenes as well as genes controlling the cell cycle. In addition, quercetin can also reciprocally up-regulate the expression of several tumour suppressor genes (Nair *et al*., 2004). In a case-control study conducted on humans in the USA, the intake of lignans and flavonoids was associated with a reduction in breast cancer risk (Fink *et al*., 2007). Results from another remarkable study suggest that palm tocotrienols and plant flavonoids can act synergistically with each other, and enhance the efficacy of tamoxifen in exhibiting anti-proliferative activity of breast cancer cells irrespective of their oestrogen status (Guthrie *et al*., 1997).

CONCLUSION

Discovering the immense variety of phytonutrients in palm oil and learning of their superior health benefits have provided us with a platform to understand better and thus treasure more our golden oil. Palm oil is wholesome and is an excellent edible oil. Moreover, it is abundant in supply, competitively priced, and is also a rich source of many desirable nutrients which can help in the prevention and treatment of many disorders and diseases.

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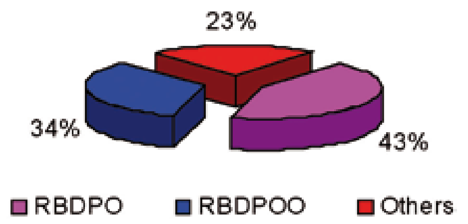
TABLE 7. EXPORT OF PALM OIL PRODUCTS TO JAPAN (million tonnes)

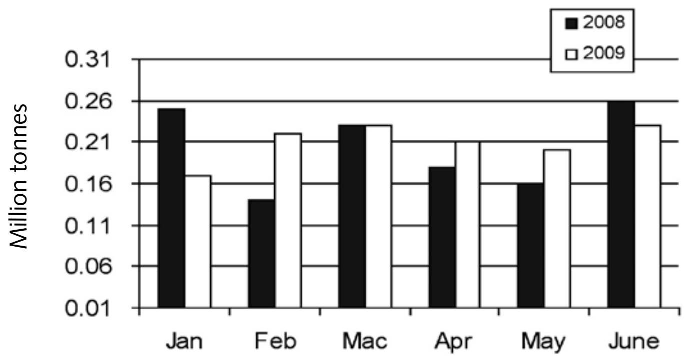
Year	Amount
2007	0.53
2008	0.55
Jan-June 2008	0.27
Jan-June 2009	0.28

Source: MPOB.



Note: RBDPO = refined, bleached, deodorized palm oil.
RBDPOO = refined, bleached, deodorized palm oil olein.
Source: MPOB

Figure 7. Export composition of palm oil products to Japan in 2009 (January-June).



Source: MPOB.

Figure 8. Malaysian palm oil domestic disappearence (million tonnes).

palm oil (0.01 million tonnes). Imports of double fractionated RBD palm olein increased by 21.7% to 0.02 million tonnes in the first half of 2009 (*Figure 7*).

For the first half of 2009, domestic disappearance[1] of palm oil increased by 4.2% or 0.05 million tonnes from 1.21 million tonnes during the corresponding period last year to 1.26 million tonnes (*Figure 8*). The average monthly palm oil disappearance was 0.21 million tonnes, higher compared to 0.19 million tonnes in 2008. The higher domestic disappearance during this period was mainly attributed to price competitiveness in the domestic market.

[1] The domestic disappearance of palm oil in the country measures the disappearance of palm oil in the domestic marketing system. It is arrived at by the following formula: opening stock + production + imports – exports – closing stock = domestic disappearance. Normally, the palm oil disappearance figures overstate actual consumption in the country because it includes among others, exports of palm-based finished products after further processing such as shortening, vegetable ghee and margarine; palm oil processed for oleochemical production which is destined for exports and estimated losses incurred by palm oil refineries during CPO refining.