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BIOTECHNOLOGY OF OIL PALM

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The Role of Biotechnology in Making Oil Palm the Major Supplier of Edible Oil and Renewable Industrial Feedstock

As the crop with the highest oil yield, oil palm has the potential to become a major supplier of edible oil and renewable industrial feedstock. Biotechnology offers several means by which this potential can be realised. PORIM's current objective in applying biotechnology to the palm is directed towards the production of high oleic acid for edible and industrial purposes. In the foreseeable future, it will also be possible to harness biotechnology for the production of novel chemicals such as thermoplastics and therapeutic agents in oil palm.

DITERIMA
12 FEB 1998
PUSAT MAKLUMAT SAWIT
PORIM

– Contributed by B. S. Jalani and Cheah Suan Choo

INTRODUCTION

The oil palm (*Elaeis guineensis Jacq.*) was introduced into Malaysia (then called Malaya) in 1870. However, it was not until 1917 that the first commercial plantation was established. Large-scale planting of the crop for oil started in the 1960s following the introduction of the Agricultural Diversification Policy of the Malaysian Government in the 1950s. The industry has since grown by leaps and bounds. *Table 1* shows the increase in oil palm cultivation and palm oil production since 1980.

Table 1.
Palm Oil Production in Malaysia

Year	Total Planted Area (million ha.)	Total Production (million tonnes)
1980	1.018	2.576
1985	1.483	4.133
1990	2.029	6.092
1995	2.533	7.811
1996	2.615	8.386
2000	2.87*	8.787*
2005	3.19*	9.901*

* Forecast

Source: Statistics Unit, PORIM

The oil palm industry in Malaysia is on the verge of change. Just as the government's diversification policy encouraged widespread cultivation of the crop about 30 years ago, our present aspiration to achieve industrialised nation status by the year 2020 is fueling research efforts towards increasing the use of palm oil as an oleochemical.

Oil palm has the highest oil yield per unit planted area compared with other oil crops (*Table 2*). As such, it has the potential to become a major source of renewable industrial feedstock. Recent developments in the field of biotechnology have led PORIM to develop strategies for the realisation of this potential.

Table 2.
Comparable Yields for Vegetable Oil Crops

Crop	Product	Oil Yield (tonnes/ha)
Oil palm*	Palm oil	3.60
Oil palm	Palm kernel	0.48
Soya bean	Seed	0.41
Groundnut	Seed	0.42
Cotton seed	Seed	0.19
Rapeseed	Seed	0.56
Sunflower	Seed	0.51
Coconut	Copra	0.36

* Refers to Malaysian hybrid DxP variety

Sources: PORIM, Oil World Annual 1995, PORLA

BIOENGINEERING

Genetic Engineering for Oil

Elucidation of the pathways of oil synthesis in plants started in the early 1950s. Since then the issue has been intensively studied in several laboratories and this has led to much interest in genetically modifying oil crops to change oil quality. As the quality of an oil is a reflection of its fatty acid composition (FAC), this determines its functionality. Thus changing the FAC of an oil can improve or extend its usage. Initial successes in genetically engineering plants for oil quality came in the production of high stearate and laurate containing rapeseed oils.

The FACs of oil palm and palm kernel oil (*Table 3*) render these oils applicable to both edible and non-edible uses. However, in order to venture into new markets, a change in FAC is desirable. PORIM's interest in applying gene technology to oil palm is for the pro-

Table 3.
Fatty Acid Composition (%) of Palm Oil and Palm Kernel Oil

Fatty Acid	Palm Oil	Palm Kernel Oil
C6	–	0.3
C8	–	4.4
C10	–	3.7
C12:0	0.2	48.3
C14:0	1.1	15.6
C16:0	44.0	7.8
C16:1	0.1	–
C18:0	4.5	2.0
C18:1	39.2	15.1
C18.2	10.1	2.7
Others	0.8	0.1
Iodine value	53.3	17.8
Saponification value	196	245

Source: PORIM

duction of oil with a high content of the monounsaturated fatty acid, oleic acid. Such an oil has the potential to open up markets for palm oil in the liquid oil sector. In addition, oleic acid is useful as an industrial feedstock.

A multi-disciplinary approach has been taken at PORIM for the implementation of a concerted programme to develop the tools and techniques required to genetically engineer oil palm. The strategy adopted is to alter the expression of genes of the enzymes controlling the levels of palmitic and oleic acids in palm oil so that as much of the palmitate as possible is converted to oleate.

Biochemical studies carried out on fatty acid synthesis in the oil palm mesocarp have indicated that the enzymes acyl ACP thioesterase and beta-keto acyl ACP synthase II control the levels of palmitate and oleate. Thioesterase activity in the crude extract showed a marked preference for palmitoyl ACP. Anion exchange chromatography resulted in the resolution of two peaks, one showing a marked preference for palmitoyl ACP and the other for oleoyl ACP. The results established that the chain termination reactions of C16:0 and C18:1 are independent, paving the way for reducing palmitate by switching off the palmitoyl ACP thioesterase gene.

At PORIM, the enzyme beta-keto acyl ACP synthase II, or KASII, has been purified more than 10,000-fold. The activity of the enzyme in the mesocarp correlates positively with the level of unsaturation of the fatty acids present in the crude mesocarp extract. Activity of KASII increased with fruit ripening, reaching a maximum at 20 weeks after anthesis. The results of these investigations suggest that high levels of palmitate in palm oil are likely to be due to low KASII activity and the specificity of thioesterase for palmitoyl ACP.

As commercial palm oil is extracted from the mesocarp of the fruit, any effort at *in vitro* gene manipulation to change the oil will have to be directed at this tissue. For this purpose, PORIM's researchers have given much attention to the identification and isolation of genes specifically expressed in the mesocarp during oil synthesis. As acyl carrier protein (AC) activity has been shown to be induced just before the start of oil synthesis, the gene of this protein serves as a temporal marker. Attempts at isolating the ACP gene have resulted in the identification of several putative cDNA clones from a mesocarp library.

Studies on differential gene regulation in the mesocarp employ the technique of comparing *in vitro* translated products of expressed genes during various stages of development. Stage-specific proteins have been identified. The techniques of differential hybridisation and subtractive probe hybridisation have picked out several mesocarp-specific clones from a mesocarp library. Northern blot analysis has confirmed the tissue-specificity of some of these clones.

Realising the need for a means to introduce the manipulated gene(s) into oil palm, much effort is being put into developing a reliable transformation method. Both direct DNA uptake and microprojectile bombardment have been attempted for this purpose. Transient expression of the beta-glucuronidase (GUS) reporter gene has been observed in various transformed tissues, including pollen, young fronds and embryogenic calli.

Oil palm has the potential to become a major source of renewable industrial feedstock.

Mapping Oil Quality Traits

While genetic engineering is receiving much attention, a quiet revolution is taking place in the field of molecular genomics. The techniques of molecular mapping and sequencing have been applied to a large number of crops. The ability to clone genes by map-based techniques already exists for plants with small genomes, such as *Arabidopsis thaliana* and those with very dense genetic maps, such as tomato.

In the effort to attain such capabilities for oil palm, construction of a genetic linkage map was initiated. The progenies of crosses selected for mapping are segregating for oil quality characteristics, thus facilitating the mapping of the genes controlling these traits.

Much effort is also devoted to the development of expressed sequence tags (EST) by single pass sequencing of oil palm cDNA clones. The sequencing effort has been rewarding in that about 20 percent of the sequences have homologies with genes in public electronic databases. In addition, these cDNAs also serve as markers for map construction. This will add value to the map as the identities of some of the markers will be known.

BIOMODIFICATION

The interconversion of oils and fats by the processes of interesterification and transesterification is a well established practice in the food industry. The prospect of being able to replace these energy intensive chemical processes with biologically catalysed ones occurring at near ambient temperatures has provided the impetus for much research into enzymic modification. The major enzyme for these processes is microbial lipase.

The simplest application of lipase is in the hydrolysis of lipids to fatty acids and glycerol. The process is useful in cases where chemical purity is not essential. In Japan, the process has been commercialised for the production of fatty acids for soap manufacture. Lipase-catalysed fat splitting has been shown to be adaptable to palm oil. The process is, however, not attractive commercially as the end-product is mainly a mixture of palmitic and oleic acids which does not fetch a high price.

The use of lipase for modifying palm oil and its fractions by interesterification is perhaps the more viable aspect of bio-modification of the oil.

The use of lipase for modifying palm oil and its fractions by interesterification is perhaps the more viable aspect of bio-modification of the oil. Recently, an immobilised process for the interesterification of palm oil was reported. Accumulation of triolein and tripalmitin was observed. However, the desired product of most of the processes developed is high-value cocoa butter. The process has been the subject of several patents, notably by companies in Japan and the United Kingdom. Commercialisation on a limited scale has been attempted.

A more imaginative approach to interesterifying palm oil exploits the specificity of lipase for the production of margarine and salad oils. Since lipase-catalysed interesterification does not give rise to *trans* fatty acids, it is particularly useful for hardening oils in the production of zero-*trans* margarine. Such a product will have a niche in today's health food market, as will palm oil interesterified with nutritionally desirable omega-3 polyunsaturated fatty acids.

BIOCONVERSION

It has been shown that vegetable oils are capable of generating a myriad of industrially important products through biological conversion. This is an attractive alternative to chemical processing as less energy is required and the products are more specific. The use of enzymes and microbial cells has been the most common way of achieving the conversion of fatty acids.

Enzymes such as lipoxygenase, desaturase, reductase and hydroxylase are applicable to the conversion of fatty acids. The reactions are difficult to commercialise as one has to contend with their need for expensive co-factors. In addition, the conversion tends to be multi-stage. For example, bioreduction of fatty acids to fatty alcohols requires three steps with the input of three co-factors, NADH, CoA and ATP. The prospect of harnessing such a process for industrial application appears distant.

The conversion of palm oil by microbial fermentation is however a feasible process. When fed to the yeast, *Candida lipolytica*, palm stearin is converted to an oil with over 50% unsaturated fatty acids. Another yeast, *C.rugosa*, also has the capability to transform palm oil into a more unsaturated oil.

Perhaps a more attractive process is the conversion of palm oil to biosurfactants. Several microorganisms are known to secrete compounds which have surfactant properties. These compounds can be glycolipids, acyl peptides, phospholipids, fatty acids or high molecular weight polymers. The use of palm oil as substrate for the production of glycolipid surfactants by yeast has also been reported. In another report, the yeast, *C.antarctica*, was found to produce a mixture of mannosylerythritol lipids (MEL) during growth in palm oil. Such observations warrant the need for further research as these biodegradable surfactants offer much in terms of environmental friendliness.

FUTURE PERSPECTIVES

It has been predicted that biotechnology will change industry in the next millennium. Instead of carrying out enzymic or microbial cell-mediated manufacturing, plants and animals could be transformed with genes to manufacture a wide array of industrial products and pharmaceuticals. The term "molecular farming" has been coined to describe this application. The recent demonstration that plants can be genetically transformed to produce polyhydroxybutyrate (PHB), a thermoplastic polymer, is an example of what is possible in the future.

It is rather tempting to take a peek at what might be feasible for oil palm as a bio-factory. In oil palm, most of the acetyl-CoA intermediate is presumably channeled into lipid biosynthesis. Transforming the palm with genes for plastic polymer synthesis can divert acetyl-CoA from lipid to PHB synthesis.

In plants, acetyl-CoA is also the precursor of the isoprenoid pathway for the biosynthesis of several biologically important compounds such as carotenoids, sterols, ubiquinones and monoterpenes. Several of these compounds are potentially useful as therapeutic drugs. In palm oil, these are present as minor components. However, knowledge of their biosynthesis at the molecular level should provide the key as to how the palm can be engineered to become a major source of pharmaceuticals.

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Presently, the most likely candidate for this *in vitro* approach is genetic manipulation of carotene biosynthesis. Knowledge of the molecular control of its synthesis is relatively advanced compared with those for tocopherols and tocotrienols, another class of compounds with therapeutic potential in palm oil. Given the productivity of the palm, such novel transformations are awaiting in the new "Age of Biology".

Natural Antioxidants from Palm Oil

Crude palm oil contains a number of natural antioxidants. Unsaponifiable materials, which account for 1% of the oil, are rich in carotenes and vitamin E (tocopherols and tocotrienols). Carotenoids and vitamin E, traditionally the most important biological antioxidants, are considered safe with no side effects. The newly discovered ubiquinones (UQ) have also been shown to possess antioxidant properties. Palm oil and palm oil products which are normally of the refined, bleached and deodorised forms, still contain some vitamin E and UQs. Technologies have been developed in PORIM to produce these antioxidants as well as carotenes from palm oil.

INTRODUCTION

The presence of healthy compounds in palm oil enhances its image as a nutritious oil. The nutritional value and beneficial properties of palm oil are derived from its minor components and high content of monounsatured fatty acids. The minor components of crude palm oil are carotenes, vitamin E (tocopherols and tocotrienols), sterols, phospholipids, glycolipids and squalenes (triterpenoids). Recently, palm oil was found to contain ubiquinone-9 (UQ9), ubiquinone-10 (UQ10), ergosterol, fucosterol and tocopherolquinone. The characteristics of minor components present can greatly affect the oil stability.

CAROTENOIDS

The carotenoid content of crude palm oil from Malaysia and Zaire varies between 500 and 700 ppm. A South American palm has been found to contain a higher concentration of carotenes (4900 ppm). Elucidation of carotenoid profiles of crude palm oil and several processed palm oils by chromatographic and spectrophotometric methods revealed 11 components of carotenoids. The carotenoid profile of palm oil is similar to that of carrots which is rich in α-carotenes (30-40%) and β-carotenes (50-60%).

Apart from their functions as precursors of vitamin A, carotenoids can quench singlet oxygen and serve as antioxidants in tissues, particularly under conditions of low oxygen tension. They can stimulate the immune response and protect against some types of induced cancers. Studies have shown that α-carotene isolated from palm oil has a higher potency than β-carotene to suppress carcinogenesis.

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A study was performed to determine the distribution of carotenoids in palm oil and to correlate the accumulation of carotenoids with protection against oxidative stress in rats. It was found that the higher the carotenoid content, the higher is the resistance of liver homogenates to *in vitro* induced lipid peroxidation. Also, α-carotene is a more effective antioxidant than lycopene which, in turn, is more effective than β-carotene. An *in vitro* study on the photoprotective and antioxidant activities of palm carotenes has revealed that palm carotenes can be effective photoprotective agents in the photosensitised oxidation of LDL samples. However, no significant protective effect was shown by carotenes in Cu^{2+} induced autoxidation of LDL.

Two novel methods were found effective in producing carotenoid-rich products such as carotene concentrate (>80,000 ppm) and deacidified and deodorised red palm oil. This concentrate has been tested for toxicological effect and found to be safe. In view of the importance of carotenoids for promoting health and disease prevention, methods have been developed to present them in different forms for pharmaceutical applications.

VITAMIN E

Palm oil is rich in vitamin E. Tocopherols and tocotrienols are present in Malaysian crude palm oil at 600-1000 ppm. The vitamin E content in palm oil is unique, represented mainly as tocotrienols (70 %) rather than the tocopherols (30 %). α-tocopherol and γ-tocotrienol account for the major portions of the total tocopherols and tocotrienols. Natural tocopherol, especially α-tocopherol, is a superior radical chain breaking antioxidant compared to synthetic ones. The presence of these natural vitamins E in palm oil ensure a longer shelf life for palm based products.

As vitamin E acts as an antioxidant, it obviously plays an important role in the stabilisation of oils and fats. The antioxidant activity of palm vitamin E

– Contributed by Hazura Abd Hamid and Choo Yuen May

components was confirmed by the rancimat method. The addition of 200-2000 ppm of α-tocotrienol, γ-tocotrienol or δ-tocotrienol separately to vitamin E-free refined, bleached and deodorised palm olein showed that these compounds were effective antioxidants. Increasing the vitamin E concentration increased the antioxidant activity. The effect of phospholipids on the radical scavenging activity of vitamin E in a bulk oil model was studied to clarify the mechanism of their antioxidant synergism. It was found that the enhancing effect of phospholipids for vitamin E in bulk oil originated from the elevation of its radical – scavenging activity. Phospholipids cannot act as the free radical scavenger nor the generators for vitamin E in this model system.

The vitamin E content in palm oil is unique, represented mainly as tocotrienols (70 %) rather than the tocopherols (30 %).

Vitamin E is a major fat-soluble antioxidant acting in the cellular membrane. The potential role of vitamin E in providing protection against free radical-mediated diseases has been the subject of many studies. α-tocotrienol was found to possess 40-60 times higher antioxidant activity against (Fe^{2++} ascobate) and (Fe^{2+} +NADPH)-induced lipid peroxidation in rat liver microsomal membranes, and 6.5 times better protection of cytochrome P-450 against oxidative damage than α-tocopherol. Vitamin E is also necessary for human metabolism.

Capsules of palm oil vitamin E mixture prepared by PORIM, also known as PALM VITEE, contain α-tocopherol and α-, γ- and δ-tocotrienols. A study in rats using PALM VITEE as the vitamin E source indicated that palm oil vitamin E may be more efficient than α-tocopherol alone in the protection of the heart against oxidative stress induced by ischemia-reperfusion. Palm oil vitamin E completely suppressed LDH enzyme leakage from an ischemic heart and inhibited the formation of endogenous lipid peroxidation. In an attempt to use vitamin E to suppress cholesterol synthesis in rat hepatocytes, δ-tocotrienol and γ-tocotrienol were found to be four times more suppressive than α-tocotrienol.

PORIM has developed a process for the production of pure vitamin E from palm fatty acid distillate (PFAD). PFAD is a by-product from the refining of crude palm oil. It is sold at a lower price than palm oil. The concentration of vitamin E in PFAD is 5-10 times higher than in crude palm oil. Thus, PFAD is a preferred source for the extraction of palm vitamin E. The pilot plant which is currently used for the production of palm vitamin E at PORIM has a production capacity of 5 kg of pure vitamin E per month.

UBIQUINONES

Benzoquinone derivatives such as plastoquinones and ubiquinone have important functional roles in photosynthesis and mitochondrial electron transport respectively. Ubiquinone homologues (UQs) which are widely distributed in plants have structures analogous to vitamin K_2 based on the 2, 3-dimethoxy-5-methylbenzoquinone nucleus with a variable terpenoid side chain containing one to 12 monounsaturated trans-isoprenoid units.

UQs bioactivities include antioxidation apart from their role in electron transport in energy metabolism and immunological competence. Many researchers have studied the use of UQs as antioxidants. Zamora and co-workers studied the comparative effectiveness of dietary β-carotene, vitamin E, selenium and UQ10 in rat erythrocytes and plasma. In this study, proteolysis of erythrocytes was found to be significantly lower in red blood cells from UQ10, β-carotene and selenium supplemented groups compared to the control group. Other researchers also found UQs to be effective antioxidants. In a study on physiological importance of unsaponifiable components in dietary fats, a mixture of tocopherols with ubiquinones and β-sitosterol was found to have the highest potency in inhibiting *in vitro* lipid peroxidation.

A more health conscious society has resulted in greater use of natural products as dietary supplements. Due to the nutritional value of UQs, their distributions and contents in foods have been widely studied. It was reported that some vegetable oils and fats contain a considerable amount of UQ9 or UQ10. Production of UQ10 is currently from bioengineered yeast. UQ10 as a dietary supplement can be obtained from pharmaceutical outlets. Our present study shows that quinones are present in crude palm oil (CPO) and its products.

Table 1 shows the content of UQs in CPO and various palm oil products determined by HPLC. As the samples were obtained from various mills and

Table 1. UQ10 Contents in Palm Oil and its Products

Sample	No*	Contents of UQ 10 (ppm)
Crude palm oil (CPO)	7	10-80
Bleached palm oil (BPO)	5	10-70
Refined, bleached, deodorised palm oil (RBDPO)	6	10-30
Refined, bleached, deodorised palm olein (RBDPOo)	5	10-20
Palm fatty acid distillate (PFAD)	5	0#
Crude palm kernel oil	2	0#
Fibre oil (FO)	2	5-10
Red palm oil (RPO)	2	5-10
Carotene concentrate	1	50

(*) Number of samples determined
(#) not detected

refineries, a range of concentrations was obtained. The content of UQ10 was found to decrease along the process line of producing palm oil products (from crude palm oil to refined, bleached and deodorised palm olein). Less than 5 ppm of the lower homologue UQ9 was detected in various palm oil fractions (crude palm oil, bleached oil and fibre oil). The presence of UQs in crude palm stearin, bleached palm stearin and refined, bleached and deodorised palm stearin was also detected. However the quantities for both UQs were found to be less than 5 ppm. Both UQs were not detected in unsaponifiable matters as well as in the UQ fraction (separated by TLC) of crude palm kernel oil. None of the UQs were detected in palm fatty acid distillate.

UQs are sensitive to alkaline, acidic and high temperature conditions. Therefore, it is not surprising that the content of UQ10 decreases along the process line. Various processes are used in the palm oil refinery to produce palm oil products. Loss of UQs could be due to phosphoric acid treatment in deodorisation and deacidification. Because of the non-volatility of UQs, none was detected in palm fatty acid distillate samples. UQ10 was also detected in palm carotene at 50 ppm.

Local Event

Palm Oil Familiarisation Programme

The Palm Oil Familiarisation Programme (POFP) 1997 was held from September 15-27 in Kuala Lumpur, Malaysia. This year's programme was the 17th in the series and was attended by 41 participants from 25 countries.

The 12-day programme included lectures, demonstrations, briefings, field trips and interactions with refineries, and members of other sectors of the industry. Participants also had the opportunity to visit PORIM's research and development facilities.

Participants were generally happy with the outcome of the programme. The lecture sessions provided much valuable information on palm oil. Participants also found the field visits fascinating and learnt much from the visits.

Similarly, interaction sessions with organisations of the Malaysian palm oil industry as well as with industry members were well received. Based on feedback from participants, the interactions were fruitful and mutually beneficial.

The Deputy Minister of Primary Industries officiated at the opening ceremony

The Director-General of PORIM briefed participants on the palm oil industry, export trade and future trends

The programme ended with a farewell dinner and presentation of certificates to participants

Participants were briefed on the various research and development activities in PORIM

British Update on *Trans* Fatty Acid Content of Fried Foods

The results of a survey of 16 widely consumed fried foods by a United Kingdom Government Ministry provide a useful update.

Although the subject of *trans* fatty acids (TFA) in foods is a matter of concern to people interested in nutrition, most available data on Western European diets are old or have been obtained by methods of uncertain validity, not least because analytical results on TFA are still highly method-dependent. The results of a survey of fried foods by a United Kingdom Government Ministry provide a useful update on this subject.

In a study by the Ministry of Agriculture, Fisheries and Food (MAFF), quoted in *Lipid Technology*, three to six samples of 16 widely consumed fried foods were collected from catering outlets in the UK and then pooled and analysed.

The analysis of the samples was done at the Oils and Fats laboratory of the Leatherhead Food Research Association (LFRA) by Dr Jens Kristott. The laboratory has FOSFA accreditation at advance level and used both infra-red (IR) and gas chromatography by AOCS methods.

Results by IR are listed in *Table 1* and it is seen that the TFA content of the extracted oils ranged from 2.2 percent for fish cakes to 21.8 percent for French fries from fast food chains.

– Contributed by T. P. Pantzaris and B.A. Elias

Of interest is that French fries from fast food chains had far higher TFA content than the same product from the smaller independent shops. Similarly, doughnuts from supermarkets had much higher TFA content than the same product from smaller take-away shops.

This is probably due to the fact that there are very few fast food chains and one of them is known to be using partially hydrogenated seed oils, while the independent shops with their intermittent frying operations, tend to use the naturally more stable oils (palm oil, palm olein).

Similarly, in the case of doughnuts, the factories supplying the large supermarkets face very keen competition for their contracts and often blend palm oil with seed oils, taking advantage of any price differences as they emerge. Their continuous processes and better control systems often enable them to use lower quality oils than the smaller take-away shops which mostly use palm oil or olein. Foods at these smaller shops are often consumed on the premises or just outside, and the owners are much more sensitive to consumer reaction.

References:

Food Information Surveillance Sheet on *Trans* Fatty Acids in Frying Oils and Fried Foods (No. 112 June 1997), The Ministry of Agriculture, Fisheries and Food (MAFF), UK.

Table 1. Trans-Fatty Acid Content of UK Fried Foods (mean values)

Type of Fried Food	n	Trans-Fatty Acid Content by IR (% of lipid)	(g/100g food)
French fries (independent shops)	5	7.7	0.7
French fries (fast food chains)	5	21.8	2.7
Oven chips (supermarkets)	5	14.5	0.5
Doughnuts (supermarkets)	5	10.6	1.2
Doughnuts (take-away shops)	4	3.8	0.6
Battered fish	4	7.4	1.0
Scampi	3	2.8	0.3
Onion bhaji	4	3.6	0.5
Sausage rolls	4	2.6	0.5
Scotch eggs	5	2.8	0.5
Spring rolls	3	4.3	0.4
Samosas	3	3.8	0.6
Kentucky Fried Chicken	3	4.0	0.8
Chicken thighs	6	4.8	0.8
Chicken Kiev (take-away shops)	3	5.4	1.0
Fish cakes	3	2.2	0.3

n, number of individual samples combined. IR, infra-red spectrophotometry analysis, AOCS Cd 14-61 (1993) (IUPAC 2.207)

Potential for Palm-based Anionic Surfactants

Countries with an ample supply of palm-based oleochemicals have good prospects of becoming producers of surfactants, as oleochemicals can be used in the production of surfactants.

Surfactants, or surface active agents, are used in various applications such as detergents (liquids, powder and bar), personal care products (shower gels/creams, shampoo, tooth paste, shaving creams, etc.), and agro and industrial chemicals (pesticides, plasticisers, deinking chemicals, processing aid, etc.).

A surfactant is a molecule that has amphiphatic moieties and preferentially sits at the interface between two immiscible media when placed in them. The presence of the molecule at the interface reduces the surface tension and promotes the miscibility of the two media. Because the molecule is active at the interface, it is called a surface active agent. The reduction in surface tension is the factor which contributes towards the desired outcome.

The majority of surfactants used worldwide is produced either from petrochemicals or oleochemical feedstock (see Table 1). Of the nine million tonnes of surfactants produced worldwide in 1996, only 20 percent were oleochemical based. And of the surfactants produced, 80 percent were used in detergents which had a global consumption of 43 million tonnes.

The consumption pattern in the US market indicates that anionics, nonionics and other surfactants accounted for 75.5 percent, 18.0 percent and 6.5 percent respectively.

Malaysia has 10 companies producing basic oleochemicals and four companies producing consumer products such as detergents and personal care products.

Palm based oleochemicals can be used to produce anionic surfactants (active ingredients) for local and foreign manufacturers to incorporate into their consumer products.

Table 1. Sources of Surfactants

Surfactant	Petrochemical Based	Oleochemical Based
Anionics	1. Linear alkyl benzene sulphonates (LAS or LABS) 2. Alcohol sulphates (FAS or SLS) 3. Alcohol ether sulphonates (FAES or SLES)	1. Sulphonated methyl ester (SME, MES or ASME) 2. Alcohol sulphates (FAS or SLS) 3. Alcohol ether sulphonates (FAES or SLES)
Cationics		1. Quaternary ammonium compound (Quats) 2. Esterquats
Nonionics	1. Nonyl phenol ethoxylates (NPE) 2. Alcohol ethoxylates (FAE)	1. Alcohol ethoxylates (FAE) 2. Alkyl polyglucosides (APG) 3. Alkanolamides
Amphoterics		1. Amine oxides 2. Betaines

Source: PORIM TT No. 48, June 1997 (68) by Zahariah Ismail, Salmiah Ahmad and Greentech Engineering Sdn Bhd

Palm-based Reduced Fat Spread

With increasing health awareness and dietary recommendations, the general trend now is towards reduced fat consumption. In this context, the reduced fat spread is regarded as being equal in quality to cold-spreadable margarine. It is spreadable at refrigeration temperature and is healthy as it uses polyunsaturated or *trans* fatty acid-free fats. It is used chiefly for spreading on bread.

Production of palm-based reduced fat spread is potentially a profitable commercial venture as the market for it is expected to increase rapidly with the increasing affluence of society and the rapid economic growth of the country. Concern for healthy living is also expected to become increasingly fashionable and this concern is usually associated with a reduced or fat free diet.

As consumers switch from fat products, alternative spreads with good qualities and reliable functional properties but with reduced fat content can offer benefits of convenience, health, improved taste and lower cost, and from the manufacturer's point of view, lower raw material costs.

Palm oil and its derivatives can therefore make significant contributions, especially from the standpoints of economy, nutrition and product texture. In particular, their fatty acid compositions and trace ingredients can offer positive nutritional benefits and specialised fractions can provide valid alternatives to chemically hardened fats.

Source: PORIM TT No. 44, June 1997 (64) by Noor Lida Mat Dian, Mohd Suria Affandi Yusoff and Mohd Noor Mamat

Colombia

Colombia is Latin America's largest producer and consumer of palm oil

Based on a PORIM TAS Country Study report by Mohammad Jaaffar Ahmad and T. Thiagarajan

With a production of about 380,000 tonnes of palm oil per year, Colombia is the largest producer and consumer of palm oil in Latin America. Palm oil is also the major vegetable oil consumed in Colombia.

As production can only meet 75 percent of its oils and fats requirement, about 170,000 tonnes of oils and fats have to be imported yearly. Imports of palm oil only constitute 2-3 percent of this amount, and are mainly to cater for the demand during the low production season. Imported crude palm oil mainly originates from neighbouring countries such as Ecuador.

While its production is mainly consumed locally, Colombian palm oil and palm products are also exported, mainly as crude palm oil, RBD palm stearin, margarine and soap. The major markets are Venezuela, Mexico and Honduras.

While Colombia is a major producer of soaps, and a major exporter of finished soaps in Latin America, not much palm stearin is used in soap production. Fatty acids are also not used widely in the soap formulation.

With most of Colombia at high altitude ranging between 1,000 to 3,000 metres, technical constraints limit palm oil's increased consumption within the country. However, the soap industry has been identified as a sector that can utilise more palm oil. PORIM has promoted fatty acids and soap noodles as raw materials in soap production and interest has been expressed in learning more about this method.

Given the sluggish economy and lack of security, it is unlikely that more oil palm will be cultivated. As a result it is estimated that Colombian production of palm oil will remain constant.

Palm Oil-based Printing Ink

Conventionally ink is made from petroleum products. The basic materials consist of solvent, resins, pigments and other additives. The composition and type of ingredients depend on the type of ink.

The two petroleum crises in 1973 and 1979 stimulated research to find alternatives for mineral oil and other petroleum derivatives in the manufacture of ink. In Malaysia, research has focused on palm oil due to its abundant supply.

Palm oil, being semi-solid in nature, has presented some difficulties. However, through the coordinated efforts of Coates Brothers (M) Sdn Bhd and PORIM, the problems have been overcome and the first palm oil-based printing ink has been made.

Two major newspapers, one in Malaysia and one in Singapore, took part in extended commercial runs of the palm oil web colour inks. Both found the results satisfactory and have been using the ink over the past four years.

All the required prerequisites were strictly tested and the conclusions were good. However the 'stiff consistency' of the ink has to be improved although it is still acceptable. Trials of the ink is in progress in other countries as well. The inks are also being used for printing on virgin and recycled paper by other companies with good results. It is estimated that Coates Brothers are producing about 400 tonnes of the palm oil web colour inks annually.

A significant advantage of PORIM's process is that no additional modification of existing commercial production facilities is required for the production of a palm-based ink. From the view of printers, the ink possesses a number of advantages over conventional ink. It gives a brighter and cleaner colour picture, resists rub-off better and does not pose environmental risks. In addition, the disposal of waste ink is easier, less expensive and not hazardous.

On a worldwide scale, some 100,000 tonnes of vegetable oils (this does not include palm oil) would be needed in the manufacture of printing ink by 1998. As such palm oil can also play a significant role in the printing industry.

Source: Palm Oil Developments No. 26

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(Palm Oil Information Online Service)
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In Brief

Anglia Oils Buys Procter and Gamble Brands

Anglia Oils Limited of Hull, UK, has purchased Procter and Gamble's (P&G) cooking oil brands, *Prep* and *Whirl*, informs *Oils and Fats International*.

The report stated that P&G in the UK had decided to concentrate on its core business of cleaning and hygiene products, and divest itself of oils and fats. The two oil brands are not new to Anglia as it has been manufacturing them on behalf of P&G for the past eight years. Anglia has appointed Quality Limited to carry out the sale and marketing of these brands, well known in the UK, to the rest of Europe.

The announcement was made together with news of further expansion and improvements to Anglia's plant at Hull.

P&G launched *Prep* in UK in 1969 with the slogan "the frying fat that pours". Both *Prep* and *Whirl* are believed to be based on lightly hydrogenated and fluidised soya oil. Targeted at the industrial and catering sectors, they competed against Unilever's UK-manufactured *Kriskol and Frytol*, which are believed to be based on palm olein.

In the intense competition, both companies have claimed high technology and are very secretive about their formulations. However, by using Malaysian olein, any refiner can offer equally, if not higher, quality frying oils at much lower prices. - *contributed by T.P. Pantzaris.*

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We invite readers to send in their comments, suggestions and technical news which could be published in this newsletter.

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