

# Value Addition from Crude Palm Oil – Integrated Production of Palm Biodiesel, Phytonutrients and Other Value-added Products\*\*

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## INTRODUCTION

Since the 1980s, MPOB (then PORIM) has been in the forefront of R&D in palm biodiesel and its downstream product applications. The MPOB palm biodiesel technology has since been successfully tested on a pilot scale and commercialized by transfer of technology. To date, 18 palm biodiesel plants have been built in Malaysia and eight are currently in operation.

With the declaration of the National Biofuel Policy in March 2006, the Malaysian Government has announced that starting from February 2009, the usage of a mandatory B5 biodiesel blend (5% palm biodiesel and 95% petroleum diesel) by all sectors in selected government agencies will take effect. This will be followed by nationwide implementation by 2010. The implementation of the mandatory blending of B5 biodiesel has called for a higher supply of palm biodiesel.

Palm biodiesel producers have always encountered the issue of price destabilization of palm oil, the starting material for palm biodiesel. This is related to the hike in crude oil prices and, to some extent, has prompted the industry to diversify their business through integration. With this in mind, MPOB has developed a full range of downstream

products derived from biodiesel production. This integrated process is now ready to be offered to the industry.

## INTEGRATED PALM BIODIESEL PILOT PLANTS

Integrated palm biodiesel pilot plants have been developed with new technologies with the aim of diversifying the downstream biodiesel activities, thus, making palm biodiesel production economically more viable and able to stand alone.

The integrated process starts with the production of palm biodiesel (palm oil methyl esters) from crude palm oil or palm oil products through an esterification or transesterification process. The mild conditions used in the production of palm biodiesel enable the phytonutrients (carotenes, vitamin E, squalene, sterols, co-enzyme Q and phospholipids) to remain intact in the palm biodiesel. This becomes a good source for the recovery of phytonutrients before the palm biodiesel is burnt as fuel.

Through fractional distillation and an integrated process which involves a total of nine pilot plants, downstream products from palm biodiesel have been successfully produced. These nine pilot plants are:

- a supercritical fluid chromatography (SFC) pilot plant;
- a supercritical fluid extraction (SFE) pilot plant;
- a short-path distillation pilot plant;
- a reaction pilot plant;

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\*\* This article is adapted from *MPOB Information Series No. 469* (June 2009).

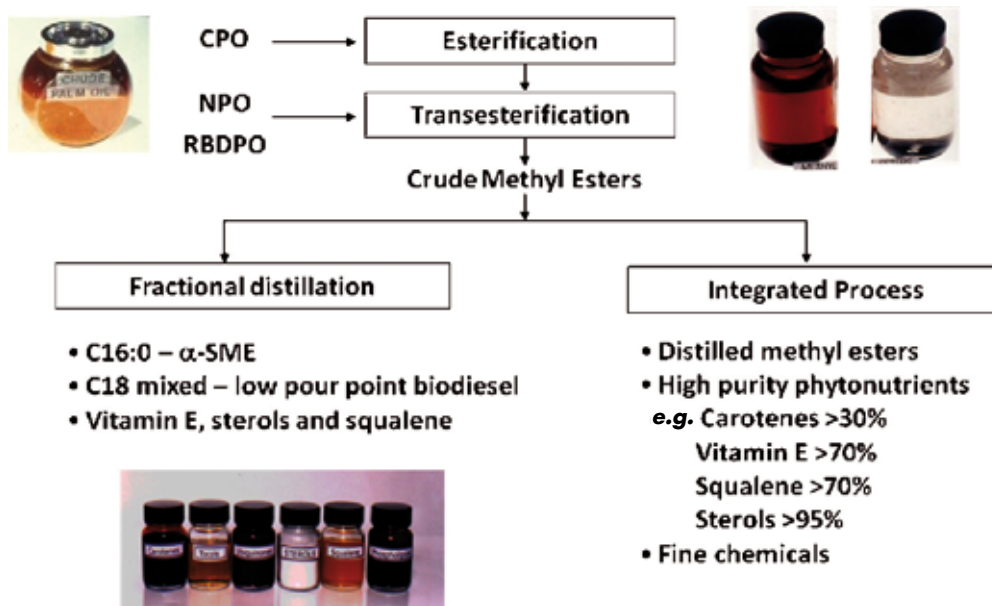


Figure 1. Integrated process for the production of palm biodiesel, phytonutrients and other value-added products.



Figure 2. Pre-treatment pilot plant.



Figure 3. Short path distillation plant.



Figure 4. Reaction pilot plant.



Figure 5. Dry and solvent fractionation pilot plant.

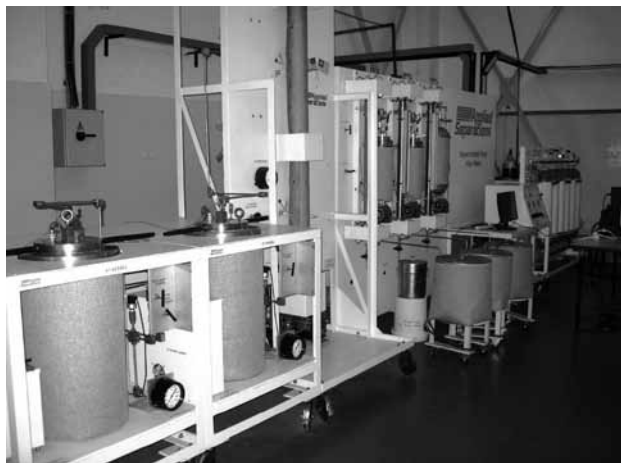


Figure 6. Supercritical fluid extraction pilot plant.



Figure 7. Fractional distillation pilot plant.



Figure 8. Supercritical fluid chromatography pilot plant.



Figure 9. Hydrogenation pilot plant.

- a dry and solvent fractionation pilot plant;
- a hydrogenation pilot plant;
- a pre-treatment pilot plant;
- an esterification pilot plant; and
- a fractional distillation pilot plant.

#### BENEFITS

A range of products can be obtained through the integrated process, namely high purity phytonutrients (carotenes, vitamin E, squalene, sterols, co-enzyme Q and their individual components) for various applications such as in

food, cosmetics, nutraceuticals, fine chemicals and pharmaceuticals. The concentrates of carotenes, vitamin E, squalene, sterols, lecithin and co-enzyme Q produced range from 30%-95%, while their individual components have been successfully produced with purity of more than 90%. As the integrated process uses minimal organic solvents, the resultant products are non-toxic and safe for consumption.

In addition, the distilled methyl esters produced not only can be used as biodiesel (meeting the cold soak filtration test as stipulated in ASTM D6751) but also as a feed-

stock in the oleochemical industry for the production of degreasers, lubricants, green solvents, etc. Methyl palmitate (C16 methyl ester) produced from fractional distillation is used in the production of detergents while C18 methyl esters, which consist of a mixture of methyl stearate, methyl oleate and methyl linoleate, is utilized as a low pour point (winter grade) palm biodiesel, thus solving the pour point problem of normal palm biodiesel when used in cold climate countries.

MPOB is ready to offer the integrated process in a whole or partial package to new and existing palm

biodiesel producers to help them make the production of palm biodiesel viable regardless of palm oil price fluctuations. Technical support and consultation will be given to those who take up the technology.

#### ECONOMIC FEASIBILITY

Capital investment for the commercial processing plant will depend on the types of products being produced. However, the return on investment (ROI) for the project will be in the range of 15%- 25%, and also be dependent on the market prices of raw materials, petrol, biodiesel and those of the phytonutrients.

#### CONCLUSION

An integrated process for the production of palm biodiesel and its downstream products is available. Nine pilot plants have been set up and commissioned for this purpose. Commercialization of the integrated process will be able to help make palm biodiesel production economically viable.

#### ACKNOWLEDGEMENT

The authors wish to thank the Director-General of MPOB for permission to publish the article. Thanks are also due to the supporting staff of the Biodiesel and Phytonutrient teams for their technical assistance.

#### FURTHER READING

CHOO, Y M; MA, A N and YUSOF BASIRON (1993). Palm oil methyl esters as diesel substitute; palm diesel. *PORIM Information Series No. 18*.

CHOO, Y M; CHENG, S F; YUNG, C L; LAU, H L N; MA, A N and YUSOF, B (2002). Palm diesel with low pour point for cold climate countries. *MPOB Information Series No. 260*.

CHOO, Y M; CHENG, S F; YUNG, C L; LAU, H L N; MA, A N and YUSOF, B (2002). Production of C16 and C18 mixed methyl esters. *MPOB Information Series No. 234*.

CHOO, Y M; NG, M H; MA, A N and YUSOF, B (2002). Production of individual carotene, tocopherols and cholesterol-free sterol from crude palm oil. *MPOB Information Series No. 347*.

CHOO, Y M; LAU, H L N; PUAH, C W; NG, M H; BONG, S C; MA, A N and YUSOF, B (2002). Production of phytonutrients (carotenoids, vitamin E, sterols, squalene, co-enzyme Q and phospholipids) from palm methyl esters. *MPOB Information Series No. 348*.

CHOO, Y M; CHENG, S F; YUNG, C L; LAU, H L N; MA, A N and YUSOF, B (2004). Palm-based industrial solvent. *MPOB Information Series No. 239*.

CHOO, Y M; NG, M H; MA, A N and YUSOF, B (2004). Production of co-enzyme Q<sub>10</sub> from crude palm oil. *MPOB Information Series No. 350*.

CHOO, Y M; CHENG, S F; YUNG, C L; MA, A N and YUSOF, B (2004). Palm-based general cleaning agent: degreaser. *MPOB Information Series No. 240*.

NG, M H; ABDUL, G M T; CHOO, Y M and MA, A N (2006). Palm tocopherols (tocopherols and tocotrienols) as standard reference materials (MRM3). *MPOB Information Series No. 398*.