Palm Phytonutrients: Opportunity Beyond Palm Biodiesel

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INTRODUCTION

The increasing global awareness of the rapid depletion of the non-renewable fuel and energy resources as well as the environmental concern of the world have resulted in the search for sustainable alternative fuels. One of the most promising alternative fuels is the vegetable oils and their ester derivatives or commonly known as biodiesel. Oil palm, the golden crop of Malaysia which yields an average of 3.5-5.0 t of palm oil per hectare per year, is regarded as the most cost-effective compared to any other oil crops. Thus, it offers a potential environmental-friendly and renewable alternative fuel source. In this respect, the Malaysian Palm Oil Board (MPOB) has embarked on an extensive research and development of palm oil methyl esters (palm biodiesel) and its products. Since the 1980s, MPOB has been in the forefront of research and development of palm biodiesel and has successfully developed several processes for converting crude palm oil (CPO) and its products into methyl esters for applications as biodiesel as well as feedstock for the oleochemicals.

The mild transesterification process for the production of palm biodiesel provides a unique opportunity for the recovery of various high-valued phytonutrients which were originally present in the CPO. Novel technologies incorporating clean, green and efficient supercritical fluid extraction (SFE), supercritical fluid chromatography (SFC), short path distillation and crystallization have been developed to recover these palm phytonutrients.

Palm phytonutrients are valuable in pharmaceuticals, nutraceuticals, fine chemicals, foods and cosmetics, as well as for the production of standard reference materials. New research findings show that all these phytonutrients are beneficial components that can contribute greatly to human well being.

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TECHNOLOGIES FOR THE PRODUCTION OF PALM PHYTONUTRIENTS

MPOB has developed several processes that involved mild reaction conditions to convert CPO to palm oil methyl esters to be used as biodiesel (Choo and Goh, 1987, Choo and Ong, 1987; Choo *et al.*, 1988; 1990). The mild conditions applied preserve the endogenous palm phytonutrients in the palm biodiesel (Choo *et al.*, 1987). Thus, this becomes a good source for the recovery of phytonutrients before these esters are burnt as fuel. Several processes have been developed for this purpose and they are depicted in *Figure* 1. The technologies developed include short path distillation, supercritical fluid technology (SFT), integrated process incorporating crystallization and solvent treatment. These are cleaner production technologies that use much less chemicals.

Short path distillation is a gentle distillation technology based on the differences of the vapour pressure of the components of interest. This distillation technology generates zero waste as both the distillate and residue are utilized for different applications. No organic solvent is used in the distillation/separation process. This technology has been successfully used to concentrate the palm phytonutrients according to their vapour pressures.

SFT is a green, clean, safe and environmental-friendly technology that uses supercritical CO_2 as the medium for extraction and isolation processes. It encompasses SFE and SFC. The supercritical fluid possess-

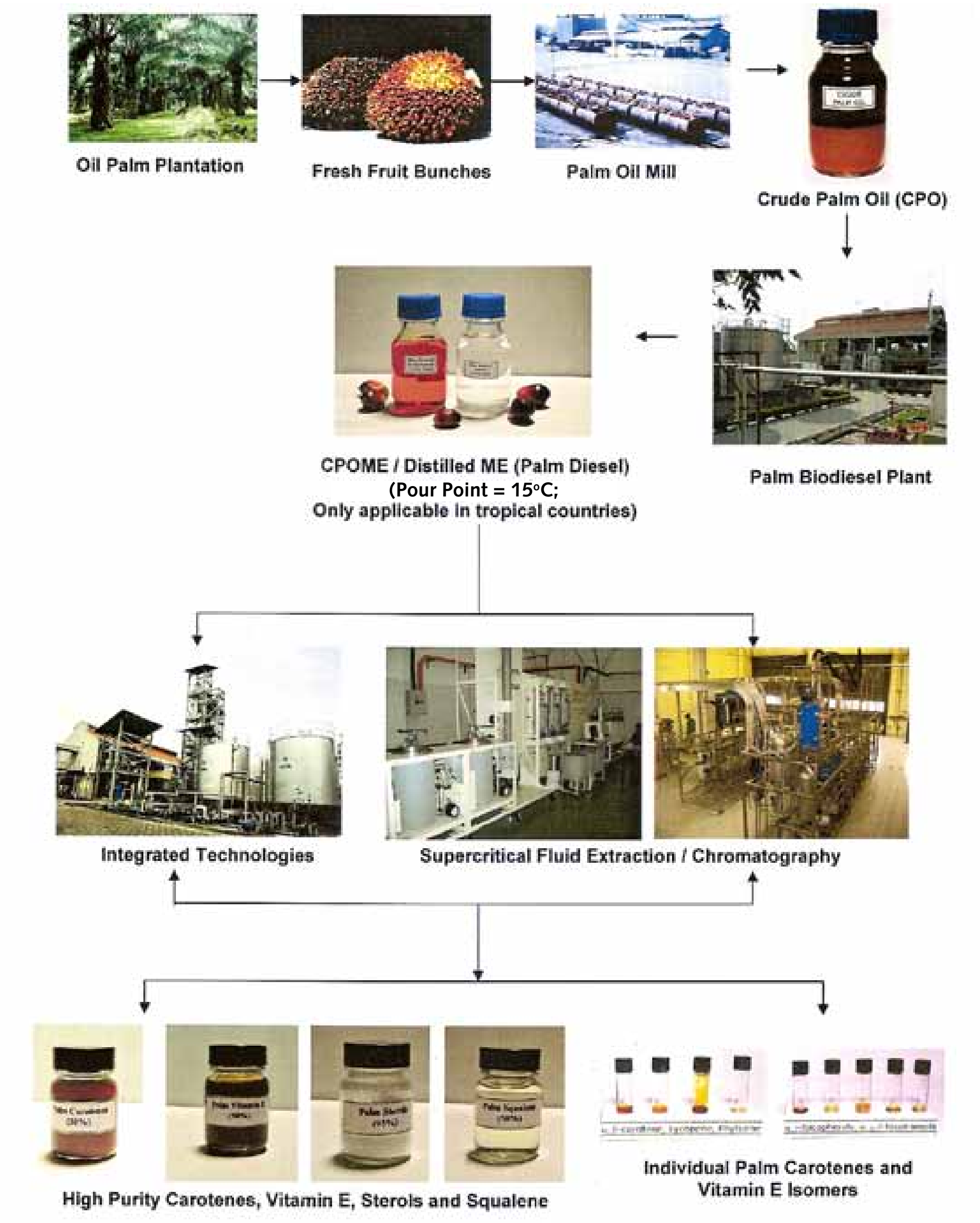

Figure 1. Production technologies of palm phytonutrients from palm oil methyl esters (palm biodiesel).

es both the properties of a liquid and a gas at its supercritical state. The most important feature in the SFT is the elimination of solvent usage as CO_2 is a gas in the atmosphere. SFT is used in the recovery and isolation of phytonutrients from palm oil methyl esters. High purity components (carotenes, vitamin E, sterols, squalene co-enzyme Q) (Choo *et al.*, 2003a) as well as the individual carotenes, tocols and sterols have been produced using SFC (Choo *et al.*, 2003b).

Recovery of four major phytonutrients from palm oil methyl esters namely carotenes, vitamin E, squalene and sterols has been achieved by using the integrated process developed. The integrated processing technologies include reaction, crystallization and solvent partitioning (Choo *et al.*, 2002a, b). The main advantage of the integrated technology is that the processes are carried out at relatively low pressure and temperature. This integrated technology also uses minimal organic solvents, thus reducing the capital investment for commercialization.

Technology for the isolation and production of individual carotene such as α-carotene, β-carotene, lycopene, phytoene and phytofluene with purity >90% has been accomplished. The individual vitamin E α-tocopherol (α-T), α-tocotrienol (α-T_3), γ-tocopherol (γ-T), δ-tocotrienol (δ-T_3) and γ-tocotrienol (γ-T_3), β-sitosterol as well as co-enzyme Q10 had also been isolated and produced (Choo *et al.,* 1996; 2003b; 2004a, b). The isolation, characterization and production of this new compound in high purity have also been accomplished.

The isolation and recovery of individual component of the phytonutrients is beneficial as they are much needed in the pharmaceuticals, nutraceuticals and fine chemical industries as well as for medical research. This is due to the fact that each of the individual component exhibit different properties from each other. The β-carotene for instance, exhibits 10 times more antioxidant activity than α-carotene while lycopene has been found to be a more powerful anticancer agent than the rest of the individual palm carotenes (Murakoshi *et al.,* 1989). Realizing the importance and values of all these phytonutrients, it is surely a waste to burn them away together with palm biodiesel as fuel. With the attractive market price of carotenes (30% in oil) at RM 760 kg^{-1} and that of vitamin E at approximately RM 1900 kg^{-1}, it merits serious consideration to invest in such a business proposition.

CONCLUSION

Various processes for the production of palm phytonutrients (carotenes, vitamin E, co-enzyme Q, sterols and squalene) have been successfully developed and some are being commercialized. These proven technologies are ready for commercial consideration.

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