INTRODUCTION

The oil palm industry plays an important role in the Malaysian economy in terms of employment and foreign exchange earnings. As the world’s largest producer of palm oil, Malaysia contributes more than 50% of global palm oil production. The palm oil processing industry, involving the processes of refining and fractionation, alone or in combination, is well developed in Malaysia. Most of the crude palm oil produced is processed locally for exports to overseas markets, mainly for foods applications. A by-product, known as palm fatty acid distillate (PFAD) is generated at the deacidification-deodorization stage of the refining process. Crude palm oil contains non-glyceride minor components which have been associated with health benefits, some of which are distilled off together with the free fatty acids to become part and parcel of the PFAD. The significance and potential of nutritionally useful palm-based compounds, falling into the category of phytochemicals in value-added applications, particularly in the nutraceuticals industry, has prompted research and development (R&D) in related areas.

PHYTOCHEMICALS, NUTRACEUTICALS AND FUNCTIONAL FOODS

Health is an important aspect of life. Thus, factors that can promote the maintenance and upgrading of health are of primary relevance. It is generally agreed that foods play a major factor in our health. Currently, the constituents of plants - phytochemicals are at the centre of attraction and research as these components are associated with the capacity to provide health benefits, both in food systems and in isolated forms. Harborne (1999) identified the major classes of plant chemicals as terpenoids, phenolic metabolites, alkaloids and other nitrogen-containing plant constituents. Phytosterols, flavonoids and sulphur containing compounds represent three groups of compounds found in fruits and vegetables, which may be important in reducing the risk of atherosclerosis (Howard and Kritchevsky, 1997). Some phytochemicals such as ascobic acid, carotenoids, vitamin E, polyphenols, isoflavone and phytosterols have been highlighted as physiologically-active ingredients that help fight certain diseases.

The term nutraceutical was coined by Dr Stephen DeFelice, Director of the Foundation for Innovation in Medicine (FIM) in 1989. A nutraceutical is any non-toxic food extract supplement that has scientifically proven health benefits for both disease treatment and prevention (Dillard and German, 2000). According to Hasler (2000), functional foods can be defined as those providing health benefits beyond basic nutrition and include whole, enriched or enhanced foods which have a potentially beneficial effect on health when consumed as part of a varied diet on a regular basis at effective levels. In Japan, a related terminology and concept is foods for specified health uses (FOSHU). The first FOSHU product - a hypoallergenic rice was approved in 1993. According to the Nutrition Improvement Law, FOSHUs are defined as foods in the case of which specified effects contributing to maintain health can be expected based on the available data concerning the relationship between the foods/food contents and health, as well as foods with permitted labelling which indicates the consumer can expect certain health effects upon intake of these particular compounds (Arai et al., 2001). The market for nutraceuticals and other health-related products is booming in advanced countries, and Gilmore (1997) reported that the US nutraceutical industry was worth US$ 11 billion, and growing at 12% annually. The nutraceutical and functional food industries which involve health-related claims see p. 17
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are governed by regulations, and in the case of the United States, the Nutrition Labelling and Education Act (NLEA) and Dietary Supplements Health and Education Act (DSHEA) are relevant.

FUNCTIONALITY OF PHYTOCHEMICALS FROM PALM FATTY ACID DISTILLATE (PFAD)

PFAD is a by-product from the physical refining of palm oil. Typical PFAD is composed of free fatty acids (81.7%), glycerides (14.4%), squalene (0.8%), vitamin E (0.5%), sterols (0.4%) and other substances (2.2%). There is increasing interest in nutraceuticals and other related industries that promote food-derived phytochemicals as their active ingredients. Utilization of PFAD as a source of phytochemicals would represent a value-addition strategy for the palm oil industry. Some components of PFAD, if isolated, would be useful bioactive phytochemicals for preparation of encapsulated products and for fortification of foods wherever appropriate, falling into the category of nutraceuticals or functional foods. Vitamin E, phytosterols and squalene are of particular interest and their beneficial effects are briefly highlighted as follows:

Vitamin E (tocopherols and tocotrienols)

Tocopherols and tocotrienols are known for their antioxidant activities in foods and biological systems (Ab Gapor et al., 1989; Burton and Traber, 1990). A review of the therapeutic potential of tocotrienol indicates that it is superior to tocopherol in terms of hypocholesterolemic, antithrombotic and anti-cancer effects, suggesting that tocotrienol may serve as an effective agent in the prevention and /or treatment of cardiovascular disease and cancer (Theriault et al., 1999a, b). The anti-cancer properties of tocopherols and tocotrienols have been confirmed, tocotrienols are better than tocopherols (Yu et al., 1999; McIntyre et al., 2000a; Nesaretnam et al., 2000). Black et al. (2000) reported that palm tocotrienols protect ApoE +/- mice from diet-induced atheroma formation. Palm vitamin E is a tocotrienols-rich product. Palm vitamin E was found to be effective in preventing the loss in bone mineral density and calcium content of orchidectomized male rats (Ima-Nirwana et al., 2000). Palm vitamin E has an anti-ulcer property that offers potential benefits in the prevention of gastric ulceration (Nafeeza et al., 2000). Supplementation with palm vitamin E can enhance certain immune parameters in hepatitis B patients (Wan Ngah et al., 1999).

Phytosterols

The major components of phytosterols are β-sitosterol, campesterol and stigmasterol. Several studies have demonstrated that consumption of phytosterols reduces cholesterol absorption and lowers serum total and LDL cholesterol levels in animals and humans (e.g. Malini and Vanithakumari, 1990; Jones et al., 1998; Plat et al., 2000). The use of phytosterols and their hydrogenated forms, phytostanols, as such or as esters, in functional foods as a cholesterol-lowering agent has now been well accepted by consumers. A certain spread in the market uses stanol ester, a hydrogenated sterol sourced from wood pulp as its cholesterol-lowering agent. Phytosterols may offer protection from colon, breast and prostate cancers (Awad and Fink, 2000). The β-sitosterol showed protective effects in an experimental system in which the incidence of large bowel cancer was reduced from 54% to 33% (Shamberger, 1984).

Squalene

The content and function of squalene in oils and fats have been reviewed (Ab Gapor and Hazrinya, 2000). The potential of squalene as an anti-cancer agent is worth serious attention. Based on epidemiological studies in several Mediterranean populations, Newmark (1997) suggested that the high squalene content of olive oil is a major factor in its cancer risk reducing effect. Hertzler et al. (1999) proposed that squalene has potential as a part of a chemotherapeutic regimen for human pancreatic cancer. Smith et al. (1998) reported that squalene inhibits chemically-induced lung tumorigenesis in mice. Squalene is a natural emollient and thus finds wide utilization in the cosmetics industry. The utilization of squalene in health foods and pharmaceutical industries has been well documented.

EXTRACTION OF PHYTOCHEMICALS

The challenge is to isolate useful phytochemicals and to deliver them in concentrated form to the market for the benefit of the consumers. Relevant efforts have been undertaken and progress has been made.

Research and development on the methods of recovery of vitamin E, phytosterols and squalene from PFAD are an on-going programme. The technology for the extraction of palm vitamin E has been developed (Ab Gapor et al., 1999) and valuable knowledge on the production of pure palm vitamin E at the pilot plant has been gained. Palm vitamin E has been made available for nutritional research and the results have been published accordingly, and its application as a hypocholesterolemic agent has been suggested (Qureshi et al., 1995).

Methods for the extraction of phytochemicals are investigated, and the production of phytosterols in the form of white crystals in the laboratory have been successful. Research on the production of squalene is also in progress and a pure colourless squalene has been produced. In order to capitalize on
palm-based phytochemicals, more efforts need to be undertaken.

CONCLUSION

The palm oil industry is blessed with a by-product (PFAD) which is relatively rich in bioactive phytochemicals. The situation presents a unique opportunity to utilize PFAD as a source of phytochemicals for nutraceuticals and the functional foods industries which are currently growing rapidly. Research and development on the recovery of value-added phytochemicals have resulted in the capacity for the preparation of a pure tocotrienols-rich fraction, squalene and phytosterols. More nutritional studies, relevant product development and marketing efforts would be useful in the promotion of palm-based phytochemicals in the multi-billion dollar health-related industries.

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