

Current Market Trend, Science and Challenges in Palm Carotenes and Tocotrienols

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THE GEMS OF CRUDE PALM OIL – CAROTENES AND TOCOTRIENOLS

Crude palm oil is an edible vegetable oil derived from the pulp of the fruit of oil palm (*Elaeis guineensis*). Originating in West Africa, oil palm is now commonly found in the Southeast Asian countries such as Malaysia, Indonesia and Thailand. By nature, crude palm oil possesses a high concentration of carotenes (500-700 ppm) and tocotrienols (up to 1000 ppm). Carotenes (alpha-carotenes and beta-carotenes) are dark red compounds. They are widely used as natural food colourants in the food and beverage industry, whereas tocotrienols, due to their unique health properties, have started to gain popularity among the manufacturers of dietary supplements and producers of functional foods and beverages as well as cosmetic companies in recent years.

CURRENT MARKET TRENDS

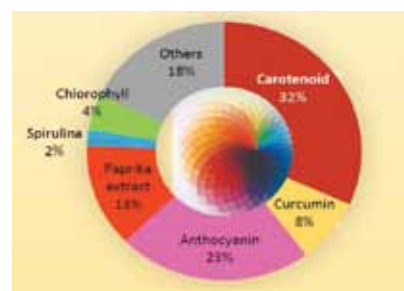
Growing health awareness and food safety concerns have led consumers to constantly source for simple, natural and non-genetically modified (GMO) ingredients rather than complex chemical compounds when choosing food products. This rising market trend is forcing manufacturers to turn towards clean labels such as 'natural', 'preservative-free', 'organic' and 'non-GMO ingredients'. In fact, large multi-national food and beverage manufacturers such as Nestlé, General Mills and Kraft have started reformulating their products with natural colours and

flavours. Similarly, major multi-national fast food chains such as *Pizza Hut* and *Subway* are removing synthetic colours and flavours in food preparation in order to meet the growing demand for natural food products by consumers.

GLOBAL MARKET - NATURAL FOOD COLOURANTS AND NATURAL SPECIALTY INGREDIENTS



According to the Global Natural Food Colours Market Analysis and Opportunity Assessment 2014-2020, the market size for natural food colours was valued at approximately USD 1.144 billion (approximately 54.9% of the total food colour market) in 2014. In 2020, the market size is projected will escalate to USD 1.7 billion (approximately 60% of the total food colour market), growing at a compound annual growth rate (CAGR) of 6.8%.



Carotenoids were predominantly used as natural food colourants and were valued at approximately USD 363.2 million (31.8% of the natural food colourant market share) in 2014. In addition, the global industry analysis on specialty ingredients market forecast for 2015-2021 reported a total value of USD 205.2 billion in 2014, and this is estimated to hit USD 320.6 billion by 2021, growing at a CAGR of 6.60%. The demand for natural food colourants and natural specialty ingredients is expected to increase, especially in Europe, North America and the Asia Pacific region.

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PALM MIXED CAROTENOIDS – NATURAL FOOD COLOURANT AND APPLICATION

Colour is an important characteristic of foods and beverages as it influences a consumer's perception of the taste and palatability of foods. Carotenoids are well-known colours and pigments found naturally in plants, including vegetables. In nature, crude palm oil is the richest source of mixed carotenoids. In terms of retinol (pro-vitamin A), palm mixed carotenoids is about 15 to 300 times in retinol equivalent more than in carrot, leafy green vegetables and tomato. As a natural food colourant, palm carotenoids are widely used in food applications such as in the dairy, confectionary, beverage and bakery industries.

Carotenoids, apart from possessing pro-vitamin A activity and natural pigment, are crucial to the antioxidant defense system in humans and therefore exhibit many beneficial health effects as discussed in the cohort studies which follow.

HEALTH BENEFITS OF MIXED CAROTENOIDS

In a recent cohort study conducted in the Netherlands involving 37 846 men and women in an European Prospective Investigation into Cancer and Nutrition, the dietary intakes of carotenoids by the recruits were followed through for a mean of 10 years. It was found that high intakes of α -carotene and β -carotene decreased the risks of type 2 diabetes among healthy men and women. Conversely, dietary intake of other individual carotenoids was not associated with diabetes risk.

Additionally, a recent paper in the *Journal of the American Medical Association (JAMA)* described a long-running prospective cohort with a total of 63 443 women from the Nurses' Health Study (NHS) and 38 603 men from the Health Professionals Follow-up Study (HPFS) which were followed up for 26 and 24 years, respectively. It was found that high intake of bioavailable carotenoids, particularly α -carotene, lutein and zeaxanthin, is inversely associated with age-related macular degeneration (AMD). Hence, it is strongly believed that the antioxidative action of macular carotenoids protects against photooxidative stress.

The association between serum levels of carotenoids (α -carotene, β -carotene, β -cryptoxanthin, lycopene and lutein/zeaxanthin) and breast cancer risk among Chinese women was examined. This study was conducted in Guangzhou, China, involving 521 females aged 25-70 years diagnosed with breast cancer, and it has demonstrated that serum levels of α -carotene, β -carotene and lutein/zeaxanthin exhibited inverse associations with breast cancer risk in pre- and post-menopausal women. Collectively, these cohort studies signify that mixed carotenoids play critical roles in minimising the development of chronic diseases.

The above scientific publications and market trend point to the fact that mixed carotenoids such as palm carotenoids exhibit unique health benefits with significant market potential. However, the current science and clinical studies on palm carotenes are still deemed insufficient, particularly for the dietary supplement market. More human clinical studies should be conducted with palm mixed carotenoids on various health aspects.

TOCOTRIENOLS – NATURAL SPECIALTY INGREDIENT AND SECOND GENERATION OF VITAMIN E

Vitamin E is composed of eight different compounds-four tocopherols and four tocotrienols. Research has examined the role of tocopherols in human health, but emerging science has been proving that tocotrienols offer distinct health benefits that tocopherols alone may not provide. The molecular structure for both tocotrienols and tocopherols are quite similar as both consist of a chromanol ring and a phytyl side chain but tocotrienols possess an unsaturated side chain, which enables the tocotrienols to penetrate more efficiently into the cell membrane and thus providing stronger biological effects. Hence, tocotrienol is touted as 'The unsaturated form of vitamin E'.

CURRENT SCIENCE ON PALM TOCOTRIENOLS

The science of tocotrienols has been progressing for the past 15-20 years. At the moment, there are more than 15 clinical studies published on the palm tocotrienol complex. These achievements cannot be accomplished without the effort, investment and collaboration between universities, the private sector and government agencies, particularly the Malaysian Palm Oil Board (MPOB) and Performance Management and Delivery Unit (PEMANDU).

Today, human clinical trials have demonstrated that tocotrienols provide many unique beneficial health properties such as neuroprotection (brain health), cardioprotection (heart health), hepatoprotection (liver health), and skin nutrition (hair growth and anti-aging, as well as protection against

UV rays). There are also new *in vitro* and animal studies that show other unique benefits of tocotrienols, such as radio-protection, bone health, metabolic syndrome support, eye health as well as anti-cancer activity.

While these studies on the palm tocotrienol complex are encouraging, the amount of research and number of publications compared with those of its cousin 'tocopherols' are still relatively small. According to PubMed, currently there are 57 603 publications on tocopherols, whereas the publications on tocotrienols total 1225, representing only 0.02% of the total number of publications on vitamin E. Hence, more collaboration and studies are needed, especially on human clinical studies to reveal the benefits of palm tocotrienols and at the same time to bring their health benefits to the consumers.

CHALLENGES: AWARENESS, REGULATION AND MARKET SIZE

Although the future for mixed carotenoids as natural colourants and tocotrienols as specialty ingredients is promising and carries potential, there are many obstacles and challenges *vis-a-vis* the regulatory system, market acceptance and consumer's awareness.

Beta-carotene has been recognised as a food colourant by the European Food Safety Authority (EFSA) and US Food and Drug Administration (FDA). These beta-carotenes can be derived from many sources such as palm oil, carrot, algae, *Blakeslea trispora*, as well as natural identical beta-carotene or synthetic beta-carotene. Although palm mixed carotenoids are listed as a permitted food additive under EFSA, it is not recognised as a food colourant by

US FDA (under CFR). Hence, the market size for palm carotenoids is relatively small compared with other carotenoids such as beta-carotene, lutein and curcumin which impart the same yellow-orange colours.

Palm tocotrienols are relatively new to many food regulatory and safety authorities unlike carotenes. While palm tocotrienols are recognised as GRAS (Generally Recognised as Safe) by US FDA, tocotrienols are not an approved ingredient in certain countries such as China and Korea, despite palm tocotrienols having similar chemical structure and biological activity as tocopherols (the regular vitamin E).

In addition to regulatory restrictions/constraints, palm tocotrienol is considered a new specialty ingredient by the manufacturers. On the other hand, manufacturers have been using tocopherols (synthetic or natural) as vitamin E in their formulations, which is recommended for daily intake. This limits the application and market size of tocotrienols. The market size for tocotrienols is estimated to be approximately 1%-3% only of the total vitamin E market. Hence, more work and efforts are needed for palm tocotrienols to be recognised as vitamin E and an approved ingredient in China, Korea and so forth, and thus expand its application and market size.

CONCLUSION

Palm oil is not only a staple cooking oil, but also a natural food colourant for thousands of consumer food products. Additionally, palm-derived tocotrienols – the less known vitamin E – should be strongly advocated to consumers considering its clinically proven unique health benefits that could ameliorate the progression of the chronic diseases of the century, such as stroke, ischemic heart disease and fatty liver.

It is high time that all stakeholders, including government representatives, business personnel, universities and producers, cooperate with each other to form a platform to ensure continuous breakthroughs in scientific research and development as well as market transformation. More importantly, Malaysian palm mixed carotenoids need to be recognised as a permitted natural food colourant, while palm-derived tocotrienols are accepted as a form of vitamin E by international food safety authorities, and there is increased awareness of the unique benefits of palm mixed carotenoids and palm-derived tocotrienols.

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