CURRENT RESEARCH

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Palm oil users require the oil to have good stability to ensure adequate shelf life in the products prepared from it. Many factors which are beyond the users' control influence the quality of palm oil, and good manufacturing practices must be applied at every step to ensure that high quality is maintained in the oil throughout the processing and transportation stages.

Palm oil has better resistance to oxidation than most other oils; this is due not only to its fatty acid composition but also to the roles played by its minor components. The work carried out on quality aspects of palm oil is diverse and deals with the palm fruits themselves, extraction of oil, and processing, storage and transportation.

FRUIT QUALITY

It is well known that the fruits themselves are the most important factor in the quality chain. Palm fruits deteriorate due to lipase activity (Hartley, 1988) and lipoxygenase activity (Ames, 1960). Early work on lipase in palm fruits led to some controversy (Oo, 1981; Tombs *et al.*, 1982), mainly because researchers were unable to locate the enzyme. However, Sambanthamurthi *et al.* (1995) conclusively demonstrated *in vitro* lipase activity in the 'oil body' fraction of oil palm mesocarp. The main reason why earlier work failed to detect lipase activity in the mesocarp was because they assayed for activity in the soluble fraction of the mesocarp instead of in the lipid bodies. Sambanthamurthi *et al.* (1991) also confirmed the results of Mohan Kumar *et al.* (1990), showing that chilling induced rapid hydrolysis of the oil in the oil palm mesocarp. Fortunately, since the oil palm is a tropical crop this phenomenon is not observed in practice. It does suggest a need for further control of harvesting and fruit collection especially during the cooler rainy periods, in order to avoid rapid deterioration.

Any damage to the fruit releases the lipase, causing dramatic increases in free fatty acids (FFA). Chong (1991) reported that the FFA of damaged fruits in palm spikelets could increase to 2% in 4 hours and up to 13% in 16 hours, in line with the observations of Bek-Nielsen (1977). Sterilization of the fruits could contribute another 0.5% to the FFA level. The need to prevent, or at least minimize, fruit damage through careful handling procedures and immediate delivery and processing cannot be over stressed.

ON PALM OIL QUALITY

The deterioration of fruits when stored in the sun is highlighted in Siew's and Mohamad's work (1992). Not only is there an increase in FFA levels upon fruit storage, but increased oxidation of the oil occurs, resulting in poorer

bleachability. The effect of fruit storage on the oil quality is confirmed in experiments carried out by Chan *et al.* (1992), in which fruits stored over a period of 14 days showed a distinct drop in oil quality. An increase from 0.67 to 1.10 was noted in the E_{269} value, while there was a 16% reduction in the carotene level. Palm fruits arriving at a palm oil mill are processed according to a 'first-in first-out' principle, which minimizes the storage time prior to extraction.

OIL QUALITY

The quality of palm oil is defined by several characteristics, including its colour upon refining, odour, and shelf life. These characteristics are important requirements for the consumer (Diffenbacher, 1990). The colour of refined oil is determined by the quality of the crude oil and the processing conditions. The colour of crude palm oil is strongly affected by its minor components. It is dark orange-red because of the presence of carotenoids. Preliminary studies on the isolation and identification of the compounds responsible for the colour of refined palm oil, show the presence of hydroxy-α-carotene 5,8-epoxide and chrysanthemaxanthin (Ooi *et al.*, 1993). These authors postulated that oxidation of the unsaturated fatty acids (*e.g.* oleic and linoleic acids) in palm oil gives rise to the formation of alkyl peroxide radicals which then attack the compound hydroxy-α-carotene to form hydroxy-α-carotene 5,6 epoxide and hydroxy-α-carotene 5,8 epoxide.

In a study by Tan *et al.* (1985), the colour development in heated refined palm oil was found to be related to phenols, in particular, para-hydroxybenzoic acid and other para-disubstituted aromatic compounds containing NH_2 groups. These compounds were found in the crude oils, which had to be pretreated in order to remove them to retard darkening.

Thus, not one compound, but probably several minor constituents are responsible for colour development in refined palm oil. This area of research is being actively pursued at present by Kuntom and coworkers (1993).

Tocopherols and tocotrienols (Vitamin E) are natural antioxidants in palm oil prod-

ucts. During refining the amount of the antioxidants may be reduced by the bleaching and deodorization process. Abd. Gapor (1990a) showed that while vitamin E is enriched in the olein fraction, only about 44%–89% of the original amount present is retained during refining. The wide range in the percentage retention of vitamin E is due to differences in the processing conditions. A milder set of conditions (such as low temperature and shorter residence time) result in greater retention of vitamin E in the oil, and hence to better stability because of the antioxidant effect.

While the tocopherols and tocotrienols have important roles in enhancing the oxidative stability of palm oil (Abd. Gapor, 1990b; Goh *et al.* 1990), other minor constitutents such as chlorophylls have adverse effects on it. Tan *et al.* (1994) have shown that palm oil has about 1558 $\mu g\ kg^{-1}$ chlorophyll, part of which is removed during bleaching.

In a study carried out by Siew *et al.* (1988), the average oxidative stabilities of refined palm oil, palm olein and palm stearin were found to be 54.7 (±13.2) hours, 44.7 (±8.4) hours and 55.8 (±15.8) hours, respectively, using the Rancimat Test (100°C). This study also showed that Rancimat test values of at least 54, 47 and 74 hours and above are to be recommended for good quality refined palm oil, olein and stearin, with longer shelf-life.

Taste and odour of an oil are by far the most important criteria for freshness. A good sensory panel can distinguish between fresh and rancid oils, and significant correlations have been found between the results of chemical tests such as peroxide, p-anisidine and totox values with the quality scores from a sensory method (Idris *et al.*, 1992). In general, palm oil has fewer problems of off-flavours and odours than most edible oils, because of its superior stability to oxidation.

PREDICTIVE TESTS FOR QUALITY

In order to gauge oil quality accurately, a variety of tests may have to be carried out. These include the determination of peroxide value, anisidine value, Deterioration of Bleachability Index (DOBI) (Swoboda, 1982), free fatty acids, *etc.* These standard tests are routinely carried on crude and refined palm oil and its products. Newer tests are being developed in our laboratory, particularly the hydrolytic and colour stability tests (Siew *et al.*, 1988). These predictive tests allow the industry to assess oil stability prior to shipment. In the search for tests to predict crude oil quality, research has concentrated on the minor components. For example, chlorophylls, carotenes and tocotrienols all play a role in the oxidative stability of crude and refined oils. A new technique using laser-induced fluorescence (LIF) has proven to be sensitive in detecting different oil quality (Tan *et al.*, 1995). This work showed that the level of LIF at 673 nm is high for good quality crude palm oil and low for poor quality oil. The authors proposed that this new technique could be used as an alternative to determining all the common oxidative and hydrolysis parameters, thus making it an attractive and rapid procedure.

CONCLUSION

Research on improving the quality of oil palm products, on quality monitoring and on the effects of minor components should supply answers relating to the questions 'How?', 'When?', 'What?' and 'Why?' in relation to oil quality. Armed with these answers and implementing the concept of total quality management, the palm oil industry can be expected to reach new heights of oil quality.

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