CHANGES OF β-CAROTENE CONTENT DURING HEATING OF RED PALM OLEIN

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ABSTRACT

Red palm olein is produced from crude palm oil through a milder refining process to yield oil that contains most of the carotenes and vitamin E originally found in crude palm oil (CPO). Red palm olein (RPOo) is the richest plant source of carotenoids and its vitamin E reaches 810 ppm, mostly in tocotrienol form. Vitamin E and β-carotenes play an important role as antioxidants that grant oxidative stability to the oil. In this study, RPOo was heated at 50°C, 100°C, 150°C and 200°C for 30, 60, 90 and 120 min for each temperature. The hydrolysis and oxidative stabilities of these oil samples were compared by determining peroxide value (PV), free fatty acid (FFA) and β-carotene content. Exposing the oil samples to the various heating times and temperature accelerated the formation of peroxides. Destruction of β-carotene was observed by increased in both temperature and time exposed to heat. Significant decrease of β-carotene was observed at higher temperature for longer time. The FFA did not play any significant role in the deterioration of the heated samples of red palm olein.

Keywords: red palm olein, β-carotene, peroxide value, free fatty acids.

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INTRODUCTION

Crude palm oil is a complex mixture consisting of over 99% glycerides that represent the major component of the oil. The minor components are carotenoids, tocopherols, tocotrienols, phytosterols and phosphatides (O'Holohan, 1997). RPOo is produced from crude palm oil through a milder refining process that enables the retention of most of the carotenes and vitamin E in the refined oil (Ooi *et al.*, 1994). Thus, RPOo is considered as one of the richest plant source of carotenes, which are precursor of vitamin A and vitamin E (Nagendran, 2000). Carotenes and vitamin E plays an important role as antioxidants that may grant oxidative stability to the oil.

The stability of a fat or oil depends partly on the extent that deterioration has occurred (Nor Aini *et al.*, 1992). In living tissues, lipid constituents such as unsaturated fatty acids are sufficiently stable by natural antioxidants and enzymes that prevent lipid oxidation. Once isolated from plant or animal material, lipids deteriorate readily (Krings and Berger, 2001). Common quality deteriorations that may occur during fat or oil processing are oxidation and hydrolysis. Criteria for assessing the extent of deterioration are necessary not only for scientific and industry interest but also from the aspect of health implications (Anon, 2004).

The extend of chemical changes occurring in the oils and fats are usually measured by chemical procedure that measure the primary and secondary products of lipid oxidation such as PV and AV. The FFA content is usually measured because this is still one reliable parameter for food quality and it is used as indication of hydrolysis. The main purpose of this study was to evaluate the thermal stability of heated RPOo.

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EXPERIMENTAL

Sample Preparation

RPOo was obtained from Carotino® Sdn Bhd. A total of 1500 ml of the olein was heated in a Pyrex beaker at 50°C, 100°C, 150°C and 200°C for 30, 60, 90 and 120 min for each temperature. The heated samples were allowed to cool to room temperature over night. Samples were withdrawn for analysis after every heating and cooling cycle, and were stored in freezer (-4°C) until used.

Peroxide Value (PV)

The PV was determined according to the AOCS method Cd 8b-90 (1989).

Free Fatty Acids (FFA)

FFA content was measured according to MPOB test method (2005).

β-Carotene Content

β-Carotene was measured by spectrophotometery method at wavelength of 450 nm according to the MPOB test method (2005).

Statistical Analysis

Statistical analysis was carried out using SAS program. Mean values for β-carotene content, PV and FFA was analysed using analysis of variance (ANOVA) procedure, followed by Duncan's multiple range test to determine significant differences ($p<0.05$).

RESULTS AND DISCUSSION

Figure 1 shows the heating effect on the β-carotene content of RPOo. At 50°C and 100°C, β-carotene losses were not significant with respect to time exposed to heat treatment. Increasing the heating time from 30 min to 120 min resulted in 3% or 6% reduction of β-carotene at 50°C or 100°C, respectively. The β-carotene content of the oil samples heated at 150°C for 30 min and 60 min were significantly ($p<0.05$) higher than the oil samples heated at same temperature for longer period, and the reduction of β-carotene was 10% at 120 min heating. Okiy and Oke (1981) reported a depletion of carotene content of palm oil heated at 15°C for 1 hr, their result was consistent with the finding in this study.

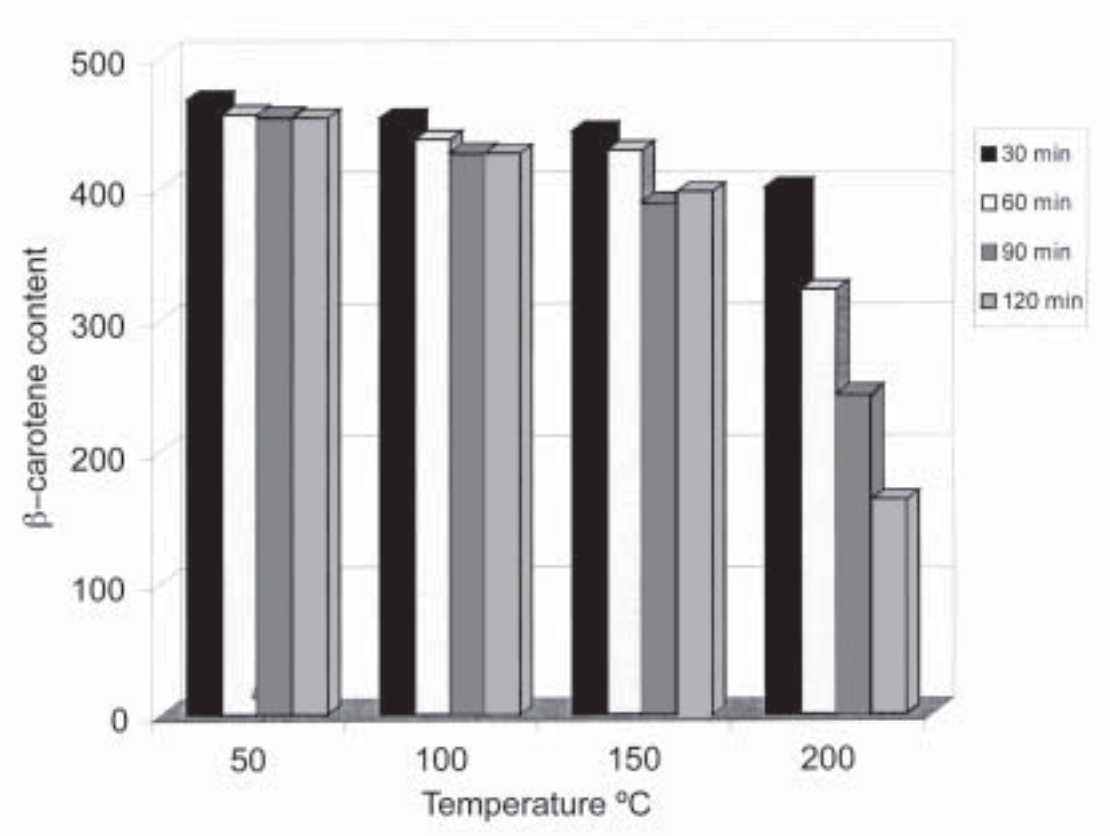

Figure 1. β-Carotene content of heated red palm olein.

Heating RPOo at very high temperature 200°C for 30 min resulted in only 15% loses of the β-carotene. However, increasing the time exposure at 200°C causes 59% reduction in the β-carotene content. These results implied that β-carotene content decreased with increasing storage temperature. This finding was in agreement with Chen *et al*. (1996), and Lin and Chen (2005) who observed that β-carotene exhibited a declining tendency following the increase of storage temperature in carrot and tomato juice stored at different temperatures.

Changes in the PV of the heated oil samples are given in *Table 1*. Edible oils with a PV of 7.5 meq kg^{-1} have been considered as unacceptable from a sensory point of view (Robards *et al.*, 1988). The PV's for the heated samples were all below this critical value. The PV increased significantly ($p<0.05$) with increasing temperature and time for all samples. This result was in accordance with the findings of Aidos *et al*. (2001) and Skara *et al.* (2004) who reported a significant increase of PV with increasing storage time in different fish oil. The result indicated the synergetic effect of high temperature combined with long time on the PV.

The primary products of lipid oxidation are hydroperoxides, therefore the result of PV give a clear indication of oxidation (Suja *et al.*, 2004). The PV of the oil samples heated at 200°C was fluctuating, and it was less than the PV at 150°C. The reduction of PV at elevated temperature could be attributed to the rapid decomposition of hydroperoxide to secondary oxidation product (Tan *et al.*, 2002). The trend of decreased PV with the increase of heating temperature was reported earlier by Okiy and Oke (1981).

The amount of FFA in fats and oils are measured as quality indicator, and because high level of FFA can be a presage of lipid oxidation. The FFA contents of the heated samples are presented in *Table 1*. Results of FFA showed that there was no significant difference among all samples heated at different temperature and time. This result was consistent with Okiy and Oke (1986) who reported that the changes of FFA during heating of palm oil were not significant. Other researchers (Warner and Mounts, 1993) reported an increase in FFA of oils with longer frying time and high temperature. The difference between the two studies is due to the fact that in the present study there was no frying process. Frying food results in increasing the water content of the oil and subsequently increases the hydrolysis and FFA content.

TABLE 1. PEROXIDE VALUE AND FREE FATTY ACIDS OF THE HEATED RED PALM OLEIN

Sample	PV (meq kg^{-1})	FFA
*A30	0.40 $^{fg\ \#}$	0.10^{a}
A60	0.90 ^{efg}	0.09 ^{a}
A90	1.10 ^{fg}	0.13 ^{a}
A120	0.60 ^{fg}	0.09 ^{a}
B30	0.8 ^{fg}	0.10 ^{a}
B60	1.7 ^{efg}	0.10 ^{a}
B90	1.6 ^{efg}	0.10 ^{a}
B120	3.0 ^{de}	0.09 ^{a}
C30	1.3 ^{fg}	0.10 ^{a}
C60	3.1 ^{cd}	0.10 ^{a}
C90	4.5 ^{bc}	0.13 ^{a}
C120	6.8 ^{a}	0.13 ^{a}
D30	5.5 ^{ab}	0.08 ^{a}
D60	2.3 ^{def}	0.13 ^{a}
D90	3.6 ^{cd}	0.10 ^{a}
D120	5.7 ^{ab}	0.10 ^{a}

Notes: *a, b, c and d represent heating temperature at 50°C, 100°C, 150°C and 200°C, respectively. The heating period is specified after the sample name. # Mean values within the same column bearing different alphabet shows significant differences ($p<0.05$).

CONCLUSION

Hydrolysis and oxidative stabilities of RPOo were evaluated. Heating the oil in various temperatures and time accelerate the formation of PV, which increases with the temperature. β-carotene losses were more pronounced with increasing time at elevated temperature. The FFA did not show any significant role in the deterioration of the heated samples.

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