Survey on Commercial Palm Olein and Oil Extracted from Snack Products in Selected Asian Countries – Part 2: Quantification of 3-monochloropropane-1,2-diol Esters (3-MCPDE)

Raznim Arni Abd Razak*; Azmil Haizam Ahmad Tarmizi* and Ainie Kuntom*

INTRODUCTION

The 3-monochloropropane-1,2-diol esters (3-MCPDE) is one of the food contaminants which develop when oils and fats undergo the refining process at high temperatures. The 3-MCPDE was first detected in 2006 in various edible oils and fats (Zelinkova *et al*., 2006). In crude or unrefined fats and oils, there is virtually no trace of 3-MCPDE; nevertheless, this constituent is detected in nearly all refined vegetable oils and fats, as well as animal fats (Weißhäar, 2008). Recent publications reported the occurrence of 3-MCPDE in lipid-containing products such as breads, cookies, mayonnaises and margarines (Küsters *et al*., 2011; Ermacora and Hrncirik, 2014).

* Malaysian Palm Oil Board (MPOB), 6, Persiaran Institusi, Bandar Baru Bangi, 43000 Kajang, Selangor, Malaysia.
E-mail: raznim@mpob.gov.my

Palm oil and its liquid fraction, namely palm olein, are extensively utilised in various frying applications (Matthäus, 2007). These products demonstrate inherent frying properties, and are therefore often regarded as heavy duty frying oils with stronger resistance against thermo-oxidation than most other vegetable oils (Ismail, 2005; de Marco *et al*., 2007; Ahmad Tarmizi and Ismail, 2008). Wide use of palm oil and its fractions for frying is due to their availability and competitive prices (Ahmad Tarmizi and Siew, 2008). The Malaysian Palm Oil Board (MPOB) initiated a survey to quantify 3-MCPDE in commercial cooking oils of pure palm olein as well as in oil extracted from selected snack products. Information obtained from the survey will be useful to edible oil processors and to the food industry in general.

COMMERCIAL COOKING OILS AND SNACK PRODUCTS

A total of 24 commercial cooking oil brands from seven Asian countries – Malaysia, Indonesia, Thailand, the Philippines, Vietnam, China and Pakistan – were quantified for their 3-MCPDE content. The samples were collected from supermarkets and edible oil processors. For the snack products, lipid was extracted from nine commercial samples obtained from China. The samples included expanded, fabricated, chips and stick products. Information associated with brands was not disclosed as codes were assigned to protect the identity of the products and producers for commercial reasons.

Quantification of 3-MCPDE was carried out following the

modified method of Abd Razak *et al*. (2012). The standard used in the quantification was deuterated free 3-MCPD. It should be noted that this method only analyses 3-MCPDE content, and no other related compounds, such as glycidyl esters. Analyses were performed in triplicate. The procedure for sample preparation is shown in *Figure 1*.

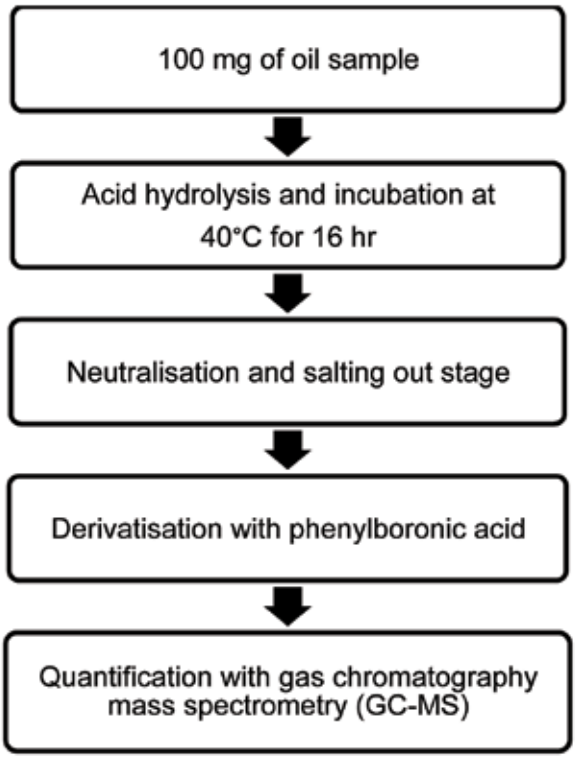

Figure 1. Sample preparation for 3-monochloropropane-1,2-diol esters (3-MCPDE) analysis.

QUANTIFICATION OF 3-MCPDE IN COOKING AND EXTRACTED OILS

The levels of 3-MCPDE in 21 commercial cooking oil samples of pure palm olein collected from Malaysia (MY - eight), Indonesia (ID - three), Thailand (TH - five), the Philippines (PH - three), Vietnam (VT - one) and Pakistan (PK - one) are shown in *Figure 2*. The results indicate that one of the Malaysian samples gave the lowest 3-MCPDE content of 0.5 mg kg^{-1}, whereas one sample from Thailand contained 3-MCPDE of almost 6.0 mg kg^{-1}. The Philippines samples yielded lower 3-MCPDE content over a narrow range from 1.1 to 2.0 mg kg^{-1} compared with the samples from Thailand with content ranging from 1.5 to 5.8 mg kg^{-1}. The cooking oils from Indonesia, Vietnam and Pakistan contained moderate levels of 3-MCPDE, although one of the Indonesian samples gave a value of less than 1.0 mg kg^{-1}. It is worth noting that cooking oils from Malaysia showed two distinctly different trends of 3-MCPDE content. Three of the samples contained relatively low 3-MCPDE (0.5 to 1.1 mg kg^{-1}) while the remaining five samples had content ranging between 1.5 and 2.9 mg kg^{-1}. From *Figure 2*, it may be seen that half the commercial cooking oils contained 3-MCPDE content of less than 2.0 mg kg^{-1}.

Similarly, palm olein samples were collected from edible oil processors in China. The three palm olein samples, which have different melting points (at 5°C, 8°C and 18°C), were quantified for 3-MCPDE content (*Figure 3*). It was noted that all the samples contained low levels of 3-MCPDE of just above 1.0 mg kg^{-1}. The results also show that an increase in melting point seemed, to some extent, to lower the 3-MCPDE concentration in the oils.

The oil extracted from nine commercial snack products from China, consisting of two expanded products, four fabricated products, two chips products and one stick product, were analysed for 3-MCPDE content and the results are summarised in *Figure 4*. Seven of the nine products gave a 3-MCPDE content of less than 3.0 mg kg^{-1}; four samples yielded 3-MCPDE of 1.0 to 2.0 mg kg^{-1} and one sample had less than 1.0 mg kg^{-1}. It was also noted that oil extracted from fabricated and chips products did not exceed 3.0 mg kg^{-1} of 3-MCPDE. However, expanded products had significantly higher 3-MCPDE values (4.0 to 7.0 mg kg^{-1}). It should be noted that all the oil extracts were purely palm olein. The high values in the extracts from expanded products might be due to the presence of water, sodium chloride or starch used to prepare the product, which upon frying will produce 3-MCPDE. Water and starch may have contained significant amounts of chloride that contributed to high 3-MCPDE content in the samples. The history of the palm olein used for frying of these snacks is unknown; hence, steps to mitigate the formation of 3-MCPDE during refining is necessary.

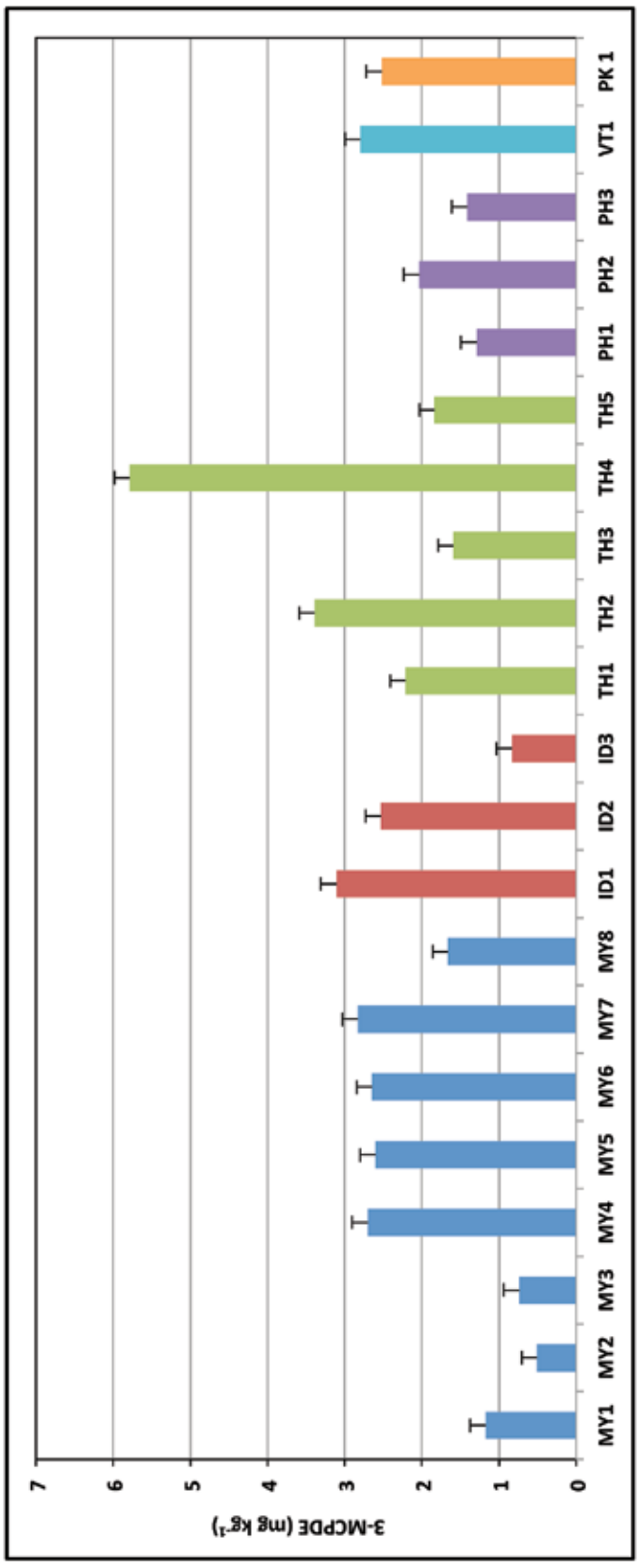

Figure 2. The 3-monochloropropane-1,2-diol esters (3-MCPDE) content in commercial pure palm olein cooking oil samples from Asian countries: Malaysia (MY), Indonesia (ID), Thailand (TH), the Philippines (PH), Vietnam (VT) and Pakistan (PK).

CONCLUSION

Quantification of 3-MCPDE in palm olein cooking oil samples from selected Asian countries and in oil extracted from commercial snack products in China was successfully carried out. Based on the data collected, it appears that it is possible for refiners to produce palm olein containing a lower level of 3-MCPDE. The 3-MCPDE level in processed palm oil can be reduced by using natural bleaching clay and optimised phosphoric acid dosage during the refining process. Washing of CPO prior to refining will also help in reducing 3-MCPDE in the refined oil. Indeed, improving the quality of cooking oil by lowering the content of 3-MCPDE will ensure that minimum amounts of 3-MCPDE are taken up by fried products during the frying process. Nevertheless, continuous monitoring of 3-MCPDE content in cooking oils and in the oil taken up by fried products should be carried out to estimate the presence of this contaminant. The data obtained will be useful to estimate exposure and for risk assessment of 3-MCPDE in fried foods consumed by the Asian population.

REFERENCES

ABD RAZAK, R A; KUNTOM, A; SIEW, W L; IBRAHIM, N A; RAMLI, M R; HUSSEIN, R and NESARETNAM, K (2012). Detection and monitoring of 3-monochloropropane-1,2-diol (3-MCPD) esters in cooking oils. *Food Control, 25(1)*: 355-360.

AHMAD TARMIZI, A H and ISMAIL, R (2008). Comparison of the frying stability of standard palm olein and special quality palm olein. *J. Amer. Oil Chem. Soc. 85(3)*: 245-251.

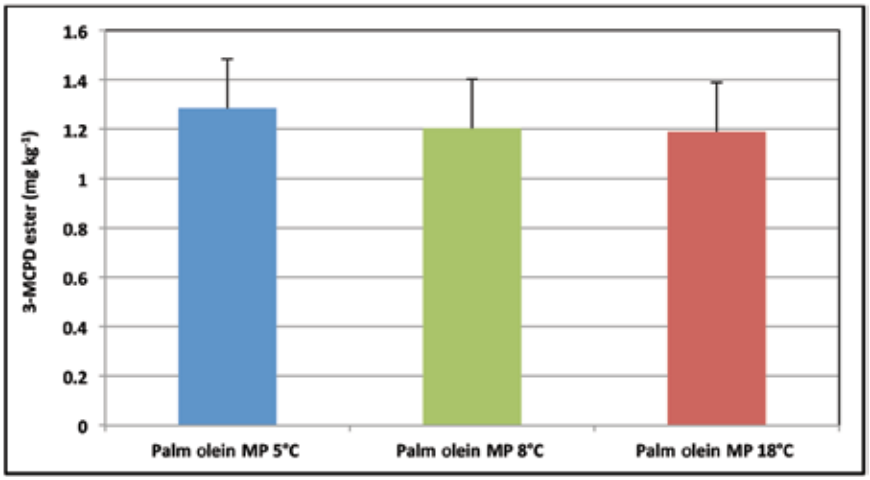

Figure 3. The 3-monochloropropane-1,2-diol esters (3-MCPDE) content in different grades of palm olein with different melting points (MP) from China.

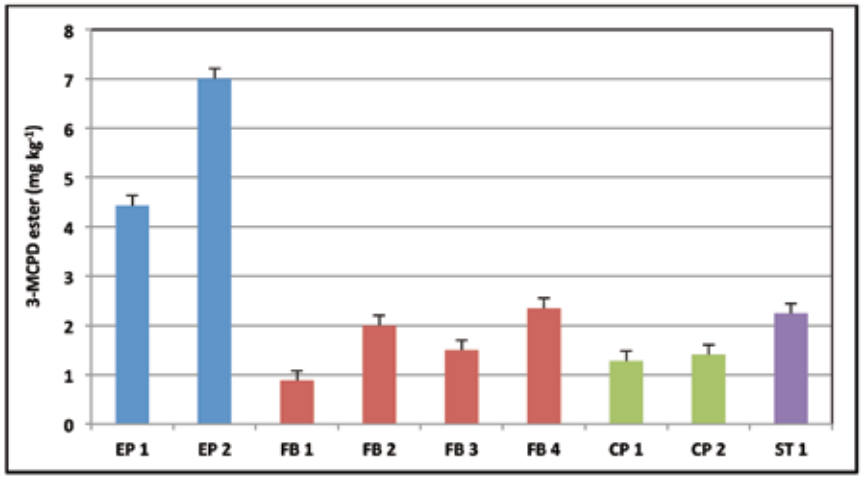

Figure 4. The 3-monochloropropane-1,2-diol esters (3-MCPDE) content in oil extracted from Chinese snack products [expanded (EP), fabricated (FB), chips (CP), sticks (ST)].

AHMAD TARMIZI, A H and SIEW, W L (2008). Quality assessment of palm products upon prolonged heat treatment. *J. Oleo Science, 57(12)*: 639-648.

DE MARCO, E; SAVARESE, M; PARASINI, C; BATTIMO, I; FALCO, S and SACCHI, R (2007). Frying performance of a sunflower/palm oil blend in comparison with pure palm oil. *European J. Lipid Science and Technology, 109*: 237-246.

ERMACORA, A and HRN K, K (2014). Development of an analytical method for the simultaneous analysis of MCPD esters and glycidyl esters in oil-based foodstuffs. *Food Additives and Contaminants: Part A, 31(6):* 985-994.

ISMAIL, R (2005). Palm oil and palm olein frying applications. *Asia Pacific J. Clinical Nutrition, 14*: 414-419.

K STERS, M; BIMBER, U; REESER, S; GALLITZEND RFER, R and GERHARTZ, M (2011). Simultaneous determination and differentiation of glycidyl esters and 3-monochloropropane-1,2-diol (MCPD) esters in different foodstuffs by GC-MS. *J. Agricultural and Food Chemistry, 59*: 6263-6270.

MATTHÄUS, B (2007). Use of palm oil for frying in comparison with other high-stability oils. *European J. Lipid Science and Technology, 109*: 400-409.

WEIßHÄAR, R (2008). Determination of total 3-chloropropane-1,2-diol (3-MCPD) in edible oils by cleavage of MCPD esters with sodium methoxide. *European J. Lipid Science and Technology, 110*: 183-186.

ZELINKOVÁ, Z; SVEJKOVSKÁ, B; VELÍŠEK, J and DOLEŽAL, M (2006). Fatty acid esters of 3-chloropropane-1,2-diol in edible oils. *Food Additives and Contaminants, 23*: 1290-1298.