Frying Performance of Palm Olein and High Oleic Sunflower Oil During Batch Frying of Potato Crisps

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INTRODUCTION

Deep fat frying has become a common way of cooking food such as potato crisps and French fries. The choice of the frying fat depends on many factors such as availability, price, frying performance, flavour and stability of the product during storage (Sebedio *et al.,* 1996). As deep fat frying is normally carried out at high temperatures (between 160°C-180°C) and in the presence of air and moisture, these frying oils and fats will undergo physical and chemical deterioration which will affect their frying performance and the storage stability of the fried products.

The objective of this study was to compare the frying performance of palm olein and high oleic sunflower oil during batch frying of potato crisps under laboratory conditions.

MATERIALS AND METHODS

Raw potato slices were supplied by Borden Food Products, Malaysia. Palm olein (IV 56.7) and high oleic sunflower oil (IV 84.8) were purchased from a local company. The high oleic sunflower oil was imported from Australia. Deep frying experiments on the two oils were carried out simultaneously using a stainless steel electrical open fryer (Frymaster brand, model H14-2SC) with split pot, of 11.5 kg capacity (for each pot) and equipped with an autolift stainless steel basket and automatic portable filter system.

About 11.5 kg of each oil was introduced into separate fryers. Each day, the oils were heated at 180 ± 2°C and allowed to equilibrate at this temperature for 30 min. Forty five batches of the raw potato slices, 300 g per batch, were intermittently fried for 4 min at intervals of 6 min, for 8 hr for five consecutive days.

The fryers were turned off at the end of the frying experiment each day and the oil was allowed to cool to 60°C. The oils in each fryer were filtered to remove debris using separate filters. About 250 g of frying oils from each fryer were sampled into amber bottles each day immediately after filtration and before the fryers were replenished with about 30% (w/w) of the fresh oils. The oil samples including the fresh ones (day 0) were spurged with slow bubbles of nitrogen from the bottom of the bottles and stored in a freezer at -20°C for subsequent physical and chemical analyses.

Fatty acid composition, peroxide and anisidine values, free fatty acid (FFA), total vitamin E (tocopherols and tocotrienols) were determined according to PORIM Test Methods (1995). Induction period was measured by Rancimat at 100°C. Smoke point was determined according to the AOAC Official Method Cc9a-48 (1989). Colour was determined using a Lovibond Tintometer with

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5¼” cell. The polar and polymer compounds were determined according to procedures described in IUPAC 2.507 (1979) and Peled *et al.* (1975) respectively. These frying oil quality parameters were graphically plotted using Microsoft Excel software to obtain the regression coefficient of the variables to determine if there are significant differences.

RESULTS AND DISCUSSION

The characteristics of the palm olein and high oleic sunflower oil that were used in the frying study are shown in *Table 1*. By comparing these data, it can be considered that the quality of the starting oils in general were good and comparable.

The fatty acid composition of the frying oils is shown in *Table 2*. The high oleic sunflower oil contained about 88% oleic acid (C18:1), twice the level found in palm olein (44%). From the results in *Table 2*, it was observed that as frying progressed, the linoleic acid (C18:2) content in both oils decreased progressively and the ratio of linoleic acid to palmitic acid dropped. Changes in the fatty acid composition of oils during frying, in particular the decrease in linoleic acid content and the drop in linoleic

TABLE 1. CHARACTERISTICS OF FRESH OILS USED FOR FRYING POTATO CRISPS

Parameter	Palm olein	High oleic sunflower oil
FFA (%)	0.065	0.055
Moisture and impurities (M&I)	< 0.1	< 0.1
Iodine value (Wijs)	56.7	84.8
Peroxide value (PV)	1.26	2.0
Anisidine value (AV)	1.38	3.7
Totox (2 PV + AV)	3.9	7.7
Colour (Lovibond)	2.7R	1.5R
Smoke point (°C)	212	225
Polymer compounds (%)	0.4	0.3
Polar compounds (%)	7.0	3.9
Total vitamin E (ppm)	610	535
Induction period (hr at 100°C)	43	23

TABLE 2. FATTY ACID COMPOSITION OF FRYING OILS

	Palm olein				High oleic sunflower oil			
Day	0	1	3	5	0	1	3	5
FAC								
C12:0	0.3	0.3	0.3	0.3	-	-	-	-
C14:0	1.0	1.1	1.1	1.1	-	-	0.1	-
C16:0	37.7	38.4	39.0	39.4	4.0	3.9	3.9	4.0
C16:1	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1
C18:0	4.1	4.1	4.1	4.2	3.1	3.1	3.1	3.3
C18:1	44.0	43.8	43.7	43.7	88.6	89.3	89.5	89.2
C18:2	11.9	11.6	11.0	10.4	5.5	2.7	2.7	2.8
C18:3	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3
Others	0.4	0.4	0.4	0.4	0.3	0.4	0.3	0.3
Ratio C18:2 to C16:0	0.32	0.30	0.28	0.26	1.38	0.69	0.69	0.70
Drop in ratio (%)		18.75					49.27	

to palmitic acid ratio are considered to be valid indicators of the level of deterioration (Alexander *et al.,* 1983; Thompson and Rae, 1983). The drop in the ratio for high oleic sunflower oil was found to be significantly higher compared to the drop in ratio for palm olein. This indicated that palm olein is more stable than high oleic sunflower oil with regards to changes in the fatty acid composition when the unsaturated fatty acid in the oil become oxidized during frying. The drop in ratio was 18.75% for palm olein compared to 49.29% in high oleic sunflower oil.

Colour was found to increase significantly faster in palm olein compared to high oleic sunflower oil (*Figure 1*). At day 5, the colour of the former was 15.2R compared to 5.4R of the latter. It is known that the colour increase in palm olein during heating and/or frying is relatively faster than in other oils. Palm olein also has a somewhat higher colour reading compared to the other oils. However, studies have shown that although palm olein may start with a higher colour value and darkens faster, this does not affect the colour of the fried products (Bracco *et al.,* 1981; Masashi *et al.,* 1985; Razali *et al.,* 1999).

It was observed that across five days of the frying experiment, FFA rise was slightly higher in palm olein than in high oleic sunflower oil (*Figure 2*). This higher value could be due to the fact that the initial FFA of palm olein (0.065%) was higher than that of high oleic sunflower oil (0.055%). At day 5 of frying, the FFA of palm olein and high oleic sunflower oil were 0.420% and 0.370% respectively. For both oils, these values were still below 0.5% which is the value normally used by snack food producers to discard the oil. However, the difference in FFA between the two oils was found not to be significant. In parallel to the increase in FFA, the smoke point of both oils decreased as frying progressed from day 1 to day 5 (*Figure 3*). At day 5, the smoke point had decreased to 180°C and 184°C, for palm olein and high oleic sunflower oil respectively. However, no smoke was visibly seen in both oils, even on day 5 of frying.

Figure 4 shows palm olein has a better oxidative stability, indicated by a longer induction period compared to the high oleic sunflower oil. At day 5, the induction period of palm olein had reduced somewhat but showed better resistance against oxidation than high oleic sunflower oil. The induction

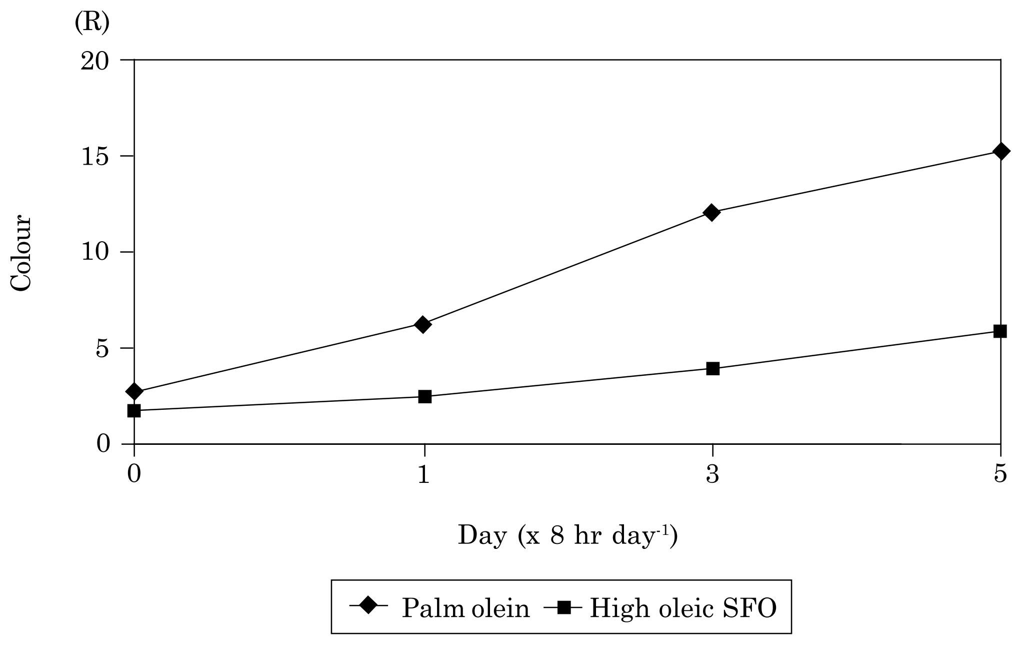

Figure 1. Colour changes.

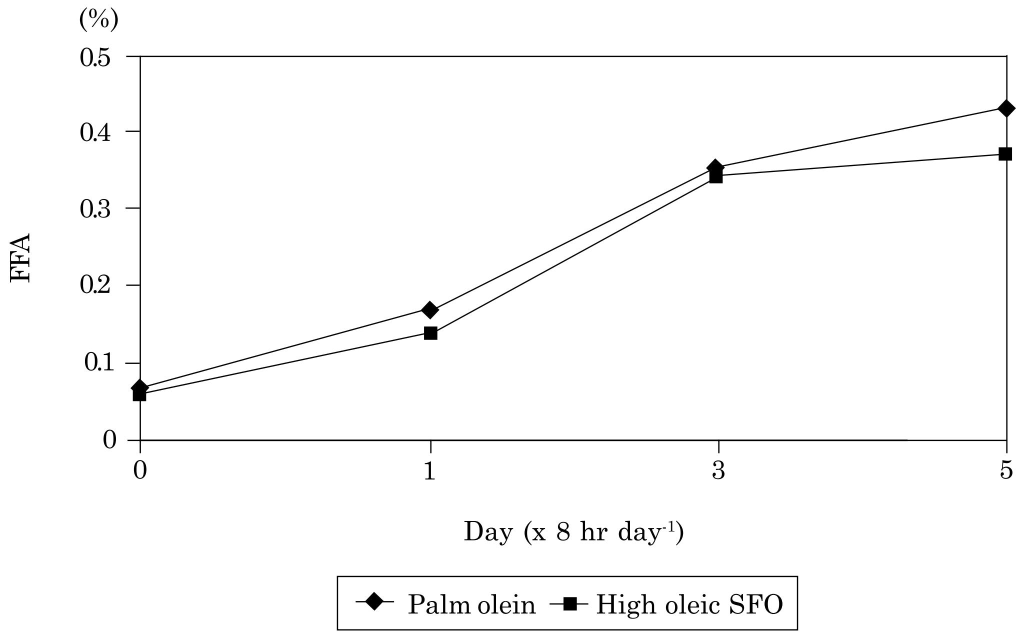

Figure 2. FFA content of frying oils.

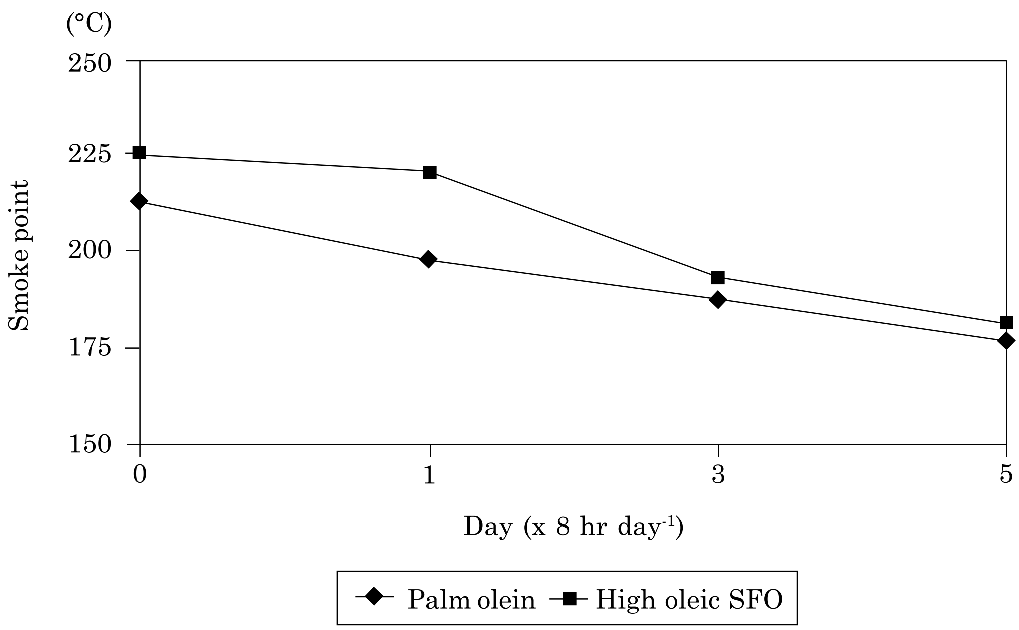

Figure 3. Smoke point.

period of high oleic sunflower oil on the other hand, reduced sharply even from day 1 (5.25 hr from 23 hr initially) compared to palm olein (19.4 hr from 40 hr initially).

Both palm olein and high oleic sunflower oil had an initial polymer compounds content of less than 0.5%, and this had only increased to about 1% on day 5 of frying (*Figure 5*).

Figure 6 shows the increase in the polar compounds content for both frying oils. The polar compounds content is one of the most objective and valid criteria for the evaluation of deterioration of oils and fats.

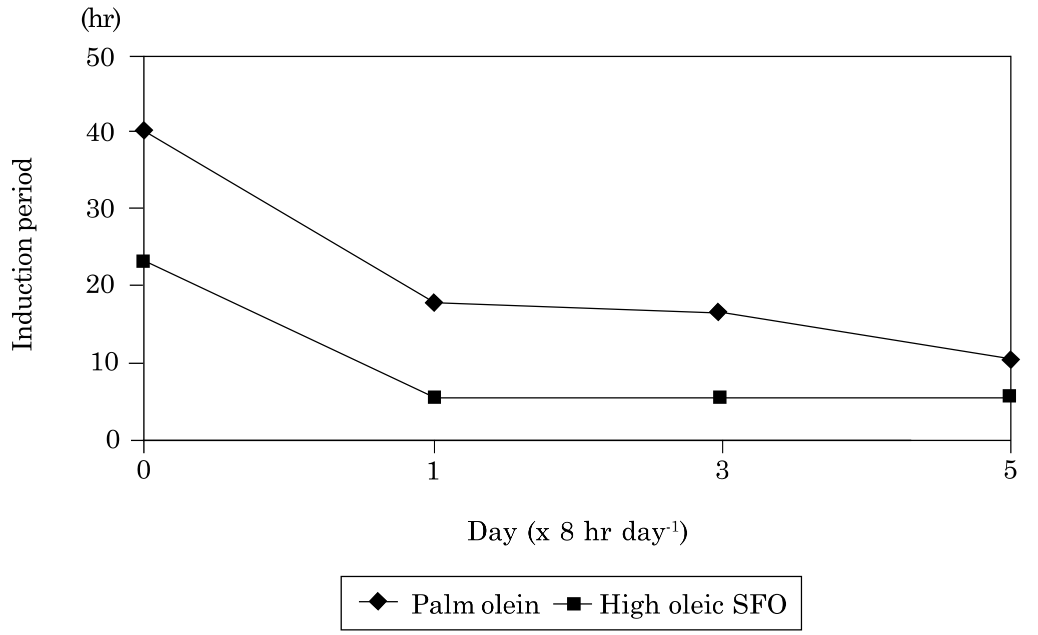

Figure 4. Induction period (hr).

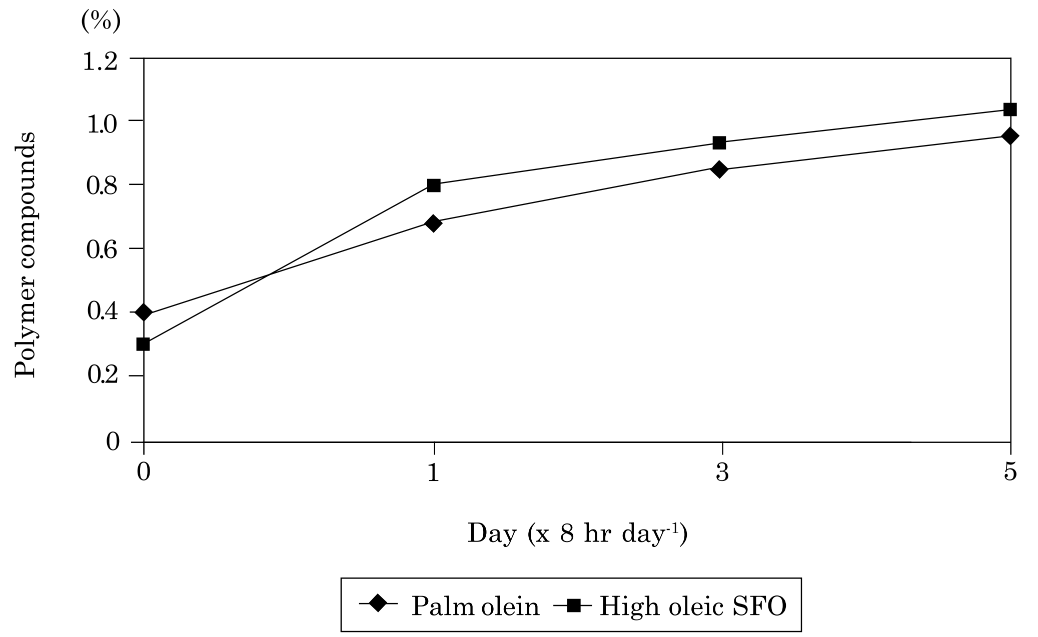

Figure 5. Polymer compounds (%).

Polar compounds increase during frying as a result of oxidation of fatty acids (Billek *et al.,* 1978). As frying progressed, it was observed that the rate of increase in the polar compounds was relatively slower in palm olein than in the high oleic sunflower oil. The initial polar compounds contents were 7.00% and 3.87%, in palm olein and the high oleic sunflower oil respectively. At day 5, polar compounds contents increased to 15.60% and 17.00%, for palm olein and high oleic sunflower oil respectively.

Although the polar compounds content of high oleic sunflower oil was higher compared to palm olein at day 5, both oils were

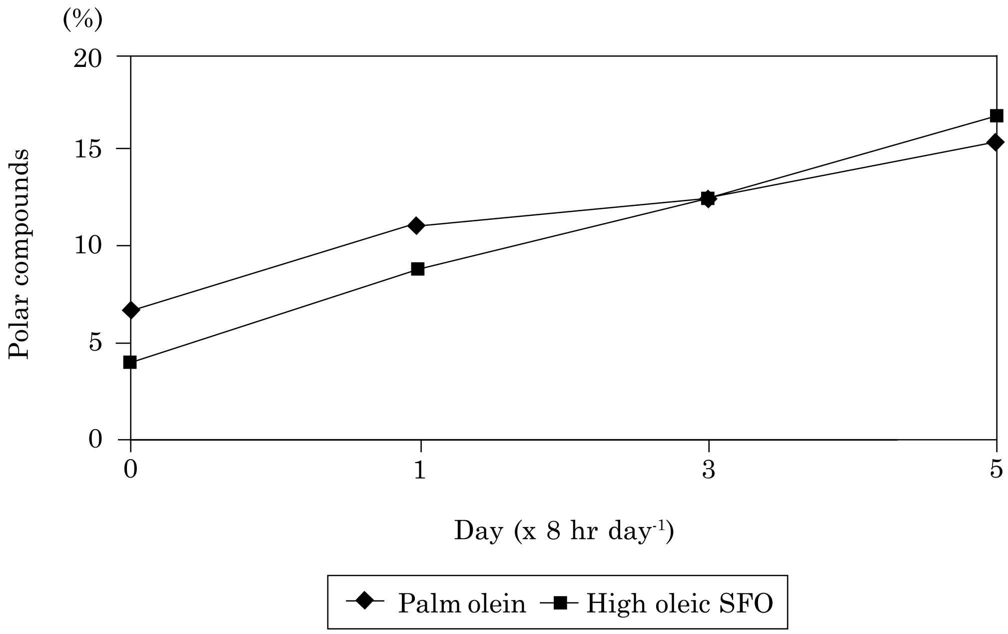

Figure 6. Polar compounds (%).

considered acceptable as many countries had set a maximum acceptable levels of 10% and 25% for polymer and polar compound contents respectively (Firestone *et al.,* 1991).

CONCLUSION

In general, both palm olein and high oleic sunflower oil are comparable in frying performance. Palm olein is more stable than high oleic sunflower oil with regards to changes in fatty acid composition and drop in linoleic acid to palmitic acid ratio. Palm olein also has better oxidative stability indicated by longer induction period. High oleic sunflower oil is slightly more stable in terms of hydrolytic stability as observed from lower rate of increase in FFA. In parallel to the increase in FFA, decrease in smoke point was relatively faster in palm olein. As frying progressed, colour increased relatively faster in palm olein. The rate of increase in polar compounds content was relatively higher in high oleic sunflower oil than that of palm olein.

This study confirmed earlier work in Europe (Sebedio *et al.*, 1996) where it was observed that the frying performance of both palm olein and the high oleic sunflower oil was comparable during the frying of potato crisps under an industrial frying experiment. Factors such as price, availability, nutritional issues, GMO *vs.* non-GMO and other technical considerations will ultimately influence the final decision of the preferred oil.

ACKNOWLEDGEMENT

The authors would like to thank Borden Food Products, Malaysia for kindly supplying the raw potato slices, the Director-General of MPOB for permission to publish this paper and the staff of the Product Development and Advisory Services Division for their kind assistance.

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