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Frying Performance of Palm-Based Solid Frying Shortening

[1]M.N. Omar, [2]M.N. Nor-Nazuha, [3]M.N. Nor-Dalilah and [4]M.M. Sahri
[1]Kulliyyah of Science, International Islamic University Malaysia,
Indera Mahkota 25200, Kuantan, Pahang, Malaysia
[2]Faculty of Education, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia
[3]Faculty of Information Technology, Multimedia University, Jalan Multimedia 63100 Cyberjaya, Malaysia
[4]Malaysian Palm Oil Board, Persiaran Institusi, 43650 Bandar, Baru Bangi, Selangor, Malaysia

Abstract: In order to evaluate the frying performance of palm-based solid frying shortening against standard olein, the fresh potato chips were fried in both frying media using an open fryer. After frying the chips for 40 h in an open batch fryer, it was found that the frying quality of palm-based solid frying shortening was better than standard palm olein in terms of Free Fatty Acid (FFA) values, Total Polar Content (TPC) and Total Polymeric Material (TPM). Solid shortening gave FFA, TPC and TPM values of 0.7, 15.3 and 2.67%, respectively, whilst standard palm olein gave values for FFA, TPC and TPM of 1.2, 19.6 and 3.10%, respectively. In terms of sensory mean scores, sensory panelists preferred the color of potato chips fried in solid shortening on the first day of frying, while on the third and fifth day of frying there were no significant differences ($p<0.05$) in the sensory scores of fried products in both frying mediums. However, on the fifth day of frying, panelists gave higher scores in terms of taste, flavor and crispness for potato chips fried in solid shortening. These findings show that the palm-based solid shortening is better than palm olein when used for deep fat frying in terms of FFA values, total polar content and total polymeric material, especially for starch-based products such as potato chips. The result also shows that, in terms of sensory mean scores, after frying for 40 h, the sensory panelists gave higher scores in terms of taste, flavor and crispiness for potato chips fried in palm-based solid shortening.

Key words: Palm-based, solid shortening, frying quality, total polar content, total polymeric materials

INTRODUCTION

Solid vegetable fat/shortening is produced to substitute solid animal fat especially lard and butter (O'Brien, 2004; Wai-Lin, 2002). Shortening is defined as a semisolid plastic material made wholly from fats and oils for use in cooking, baking and frying (O'Brien, 2004). It is so called because it promotes a short or crumbly texture. The term shortening can be used more broadly to apply to any fat that is used in baking and which is solid at room temperature, such as butter, lard, or margarine. In recipes, it refers to a hydrogenated vegetable oil that is `solid at room temperature`. Shortening has a higher smoke point than butter and margarine and has 100% fat content, compared to about 80% for butter and margarine (Wai-Lin, 2002).

The history of shortening started in North America in the 1890s when cottonseed oil was converted to solid fractions to replace lard (O'Brien, 2004). The shortening was then exported to Europe and the West Indies. Soybean oil was not a major ingredient in solid shortening until the late 1930s. Now, partially hydrogenated cottonseed oil and soybean oil are used to produce solid vegetable shortening in the USA. These solid shortenings have several drawbacks as they contain higher amounts of trans fatty acid (up to 40%) (List *et al*., 2007). In contrast, palm-based solid shortening has many advantages as it contains no trans fatty acids (Sundram, 2009).

Extensive studies have been conducted on the physical properties of palm-based shortenings (Idris *et al*., 1989; Nor-Aini *et al*., 1995). There are many types of solid fats/shortenings which are tailor-made for specific applications (O'Brien, 2004). The most common type is the multi-purpose solid cooking fat used for frying. This solid cooking fat/shortening is also used in cakes, biscuits, cream fillings, pastries and bread. Frying is a technique widely employed by both the food industry and household consumers. Fats and oils have unique properties that add to a flavor and mouthfeel most

Corresponding Author: Muhammad Nor Omar, Kulliyyah of Science, International Islamic University Malaysia,
Indera Mahkota 25200, Kuantan, Pahang, Malaysia

desirable in overall food palatability. Although, palm olein has been regarded as a superior frying medium locally and internationally, some fast food restaurants in Vietnam and Cambodia prefer to use solid fat, especially lard in their frying. Selection of a frying medium is influenced by a number of factors including the product fried, type of fryer, shelf-life requirement, flavor and eating characteristics of the product.

The main aim of the present study is to evaluate the frying performance of palm-based solid frying fat against standard olein using an open batch fryer. Besides that, assessment of the sensory qualities of products fried in solid shortening will also be carried out in order to compare their sensory qualities to products subjected to normal frying medium, in particular palm olein.

MATERIALS AND METHODS

Materials: Frozen potato chips were purchased in September 2009 from a local outlet. Standard palm olein was obtained from a local supermarket while palm-based solid shortening was obtained from Malaysian Palm Oil Board (MPOB) in mid September 2009.

Experimental: The experiment was carried out using a Frymaster open fryer according to previously reported methods (Omar *et al*., 2007). Standard palm olein and palm-based solid shortening were used to fry potato chips for 3.5 min at 180+2°C. An intermittent frying experiment was carried out for 8 h per day over five consecutive days. Forteen batches of potato chips, with every batch weighing approximately 300 g, were fried daily with an interval of 30 min between batches. After filtering, the frying oil/shortening in the fryer was topped up with about 20% of fresh oil/shortening at the end of each day. For the analysis of the physicochemical parameters, an oil sample of 100 mL was taken at the end of each day of frying. The samples were cooled, purged with nitrogen and kept at -18°C before analyses.

Fat analysis

GC analysis: The oil sample was methylated using a boron trifluoride methanolic sodium hydroxide solution. The oil was then analysed via on-column GC technique using Agilent 6890N gas chromatograph (Agilent, Avondale, USA) equipped with a flame ionization detector (FID). An HP-5 non-polar capillary column (50 m x 0.12 x 0.5 μm, SGE, Australia) was used and the temperature was initially kept at 50°C for 2 min and then programmed at 5°C min^{-1} to 250°C. The injector and detector temperatures were 220 and 250°C, respectively and He gas was used as carrier gas with a flow rate of 1.2 mL min^{-1}.

HPLC analysis: HPLC analysis was carried out using a Waters HPLC (Waters Associates, Milford, MA) equipped with a Rheodyne 7725 injector (10 mL sample loop), Waters 510 HPLC pump (Waters Associates), 100°A Ultrastyragel column (Waters Associates) and a refractive index detector (Waters Associates).

Oil content: Total oil content of ground potato chips was determined by Soxhlet extraction. The oil was extracted using a Soxtec 2050 extractor system (Foss Analytical AB, Hoganas, Sweden). 1.5 g of potato chips sample was extracted for 2 h using n-hexane as a solvent.

Free fatty acid, total polar content and total polymeric materials: Free Fatty Acid (FFA) value was determined according to the MPOB Test Method (2004). The Total Polar Content (TPC) and Total Polymeric Material (TPM) were determined according to the methods previously reported (Dobarganes *et al*., 2000; Dobarganes and Márquez-Ruiz, 2007).

Sensory evaluation For sensory evaluation, sufficient samples of freshly fried potato chips were taken on days 1, 3 and 5 of frying and served to trained panelists within 10 min after being taken out of the fryer. A nine-point hedonic scale was used by the panel members to judge their perception, where 9 = extremely good and 1 = extremely bad. The sensory score data was analyzed statistically by using computer program SPSS software (version 11.5 for Windows; SPSS Inc., Chicago, IL, USA).

RESULT AND DISCUSSION

Frying performance of standard olein and palm-based solid frying shortening: Table 1 shows the fatty acid compositions of palm olein and palm-based solid shortening before frying. It was found that palmitic acid (C16: 0) content of solid shortening was higher than of palm olein while oleic acid (C18: 1) content in palm olein was higher than in solid shortening. The C16: 0 content could contribute to the frying quality of frying medium since saturated fatty acid is stable towards oxidation (Omar *et al*., 2007).

Table 1: Fatty acid composition of palm olein and palm-based solid shortening

Frying media	Fatty acid (wt %) C12:0	C14:0	C16:0	C18:0	C18:1	C18:2	C18:3
Palm olein	0.20	1.10	40.90	4.20	41.5	11.6	0.3
Shortening	0.42	1.92	49.55	4.45	37.6	6.01	0.1

Figure 1 shows the FFA values of used palm olein and solid shortening after frying. It was found that there were significant differences between FFA values of olein and solid shortening on the first and fifth day of frying. FFA values of olein increased significantly at all frying periods compared to FFA values of used solid shortening. However, the FFA values of both frying mediums studied were below the maximum discard point of 2-2.5% (Ismail *et al*., 2003). In terms of Total Polar Contents (TPC), there were significant differences between TPC of used olein and solid shortening especially on the third day of frying (Fig. 2). The TPC content of olein increased significantly from the first to fifth day compared to the TPC content of used solid shortening. However, the Total Polymeric Materials (TPM) also showed a different trend. There were no significant differences from the first to fifth day of frying between TPM of used palm olein and solid shortening (Fig. 3). It was also found that the TPCs and TPMs of both oils were below the discard points of 25-27% for TPC and 10-16% for TPM (Ismail *et al*., 2003). The results also were in contrast with results obtained by Razali (2005) whereby the frying quality of palm-based liquid shortening was far better than palm olein when used for frying chicken. These might be due to the different products and shortenings used for frying. The present study used potato chips fried in solid shortening while the latter used chicken parts and liquid shortening.

After the fifth day of frying, solid shortening gave Total Polar Content (TPC) and total polymeric material (TPM) values of 15.3 and 2.67%, respectively, whilst standard olein gave TPC and TPM values of 19.6 and 3.10%, respectively. It was found that the frying quality of solid frying shortening was better than standard olein in terms of FFA values and total polar contents.

Sensory evaluation: In terms of sensory scores, on the first day (Fig. 4), sensory panelists preferred the colour of potato chips fried in solid shortening while on the third and fifth day of frying (Fig. 5, 6) there were no significant differences ($p<0.05$) on the sensory scores of

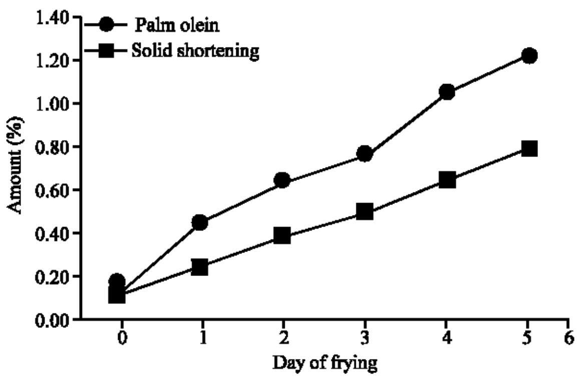

Fig. 1: FFA values of used olein and solid shortening using open fryer

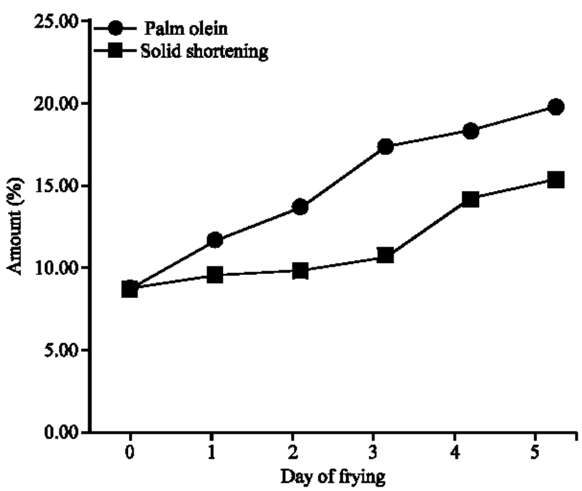

Fig. 2: Total polar contents of used olein and solid shortening using open fryer

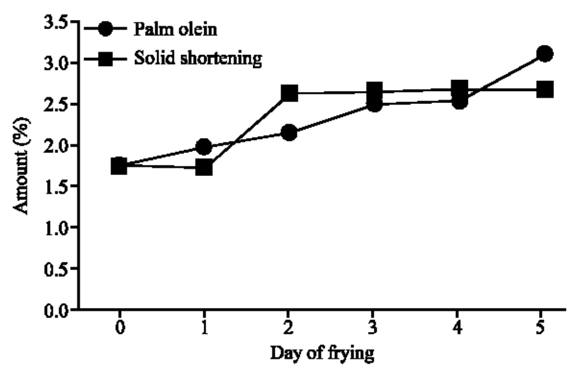

Fig. 3: Total polymeric materials of used olein and solid shortening using open fryer

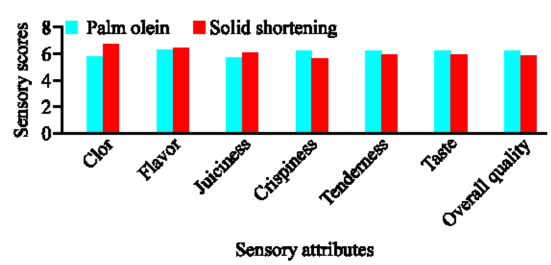

Fig. 4: Mean sensory score of potato chips fried in olein and solid shortening (day 1)

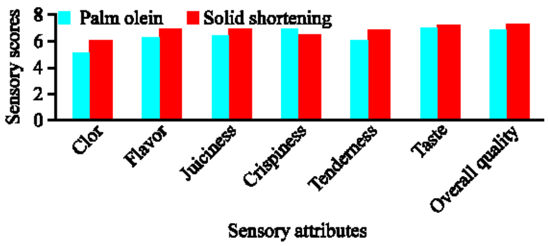

Fig. 5: Mean sensory score of potato chips fried in olein and solid shortening (day 3)

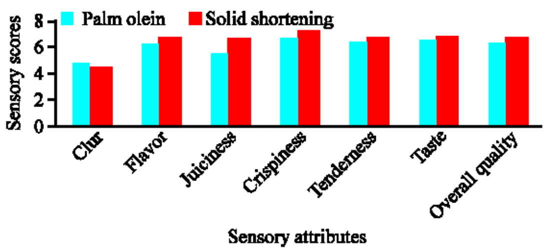

Fig. 6: Mean sensory score of potato chips fried in olein and solid shortening (day 5)

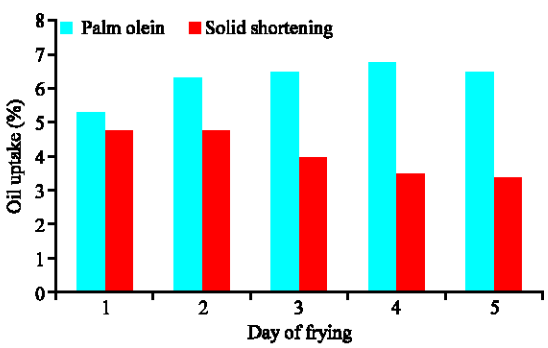

Fig. 7: Oil uptake by potato chips fried in palm olein and solid shortening

fried products in both frying mediums. However, the sensory panelists gave higher scores in terms of taste, flavour and crispness for potato chips fried in solid shortening on the fifth day of frying.

Oil uptake: Figure 7 shows the variation of the oil uptake by potato chips for the increasing frying times. The oil uptake pattern shows a uniform absorption of oil by the chips fried in both frying media. However, the oil absorbed by the chips fried in solid shortening was slightly lower than in palm olein. The decreasing amount of oil absorbed by the chips fried in the shortening was very significant ($p<0.05$) when frying was prolonged up to 5th day of frying. The lower oil uptake could contribute to the sensory quality of fried potato.

CONCLUSION

Palm-based solid shortening is better than palm olein when used for deep fat frying in terms of FFA values, total polar content and total polymeric material, especially for starch-based products such as potato chips. In terms of sensory mean scores, after frying for 40 h, the sensory panelists gave higher scores in terms of taste, flavour and crispness for potato chips fried in palm-based solid shortening.

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