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Composition and Thermal Analysis of Lipids from Pre-fried Chicken Nuggets

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Abstract Composition and thermal profiles of the endogenous lipids of ten commercial chicken nuggets brands (NPO, ACO, AFO, APO, ASO, AMO, ARO, JOD, SMO, and SOD) were compared with those of the lipids of chicken nuggets pre-fried in lard (ALD) and palm olein (AOO) to determine the type of oil used for pre-frying of the product. The stearic acid content of the commercial brands were similar to that of the sample pre-fried in palm olein, but significantly ($p < 0.05$) lower than that of the sample pre-fried in lard. The triacylglycerol (TAG) profiles of the commercial brands were similar to that of the sample pre-fried in palm olein, but distinctly different from the sample pre-fried in lard according to the dissimilarities in the contents of TAG molecules namely, PLL, POS, and PPO. Based on thermal analysis, the commercial brands of chicken nuggets could be divided into three distinguishable subgroups namely, Group-A: NPO; Group-B: ACO, AFO, APO, ASO; Group-C: AMO, ARO, JOD, SMO, SOD. While brands under group-B showed close similarity to AOO, none show any similarity to sample ALD. As any of the samples did not possess characteristics of the sample pre-fried in lard, the commercial brands of chicken nuggets of this study are recommendable for consumers whose religious restriction prevents the use of lard in food.

Keywords Chicken nuggets · Differential scanning calorimetry · Frying oil · Lard detection · Palm olein · Thermal analysis

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Introduction

The chicken nuggets is one of the consumer products preferred as a fast food all over the world. It is made of chicken meat, vegetable protein, gum and a fair proportion of chicken skin. After formulation, it is submerged in a frying medium to pre-fry before being packed into polyethylene bags. The choice of the frying medium used for chicken nuggets may vary depending on the cost as well as the preference of the food manufacturer. Although vegetable-based oils and shortening are preferred by consumers, there is a possibility for using animal fats or other sub-branded oil products as the frying medium for chicken nuggets [1]. In the past, animal fats such as lard and tallow were used for the frying of a variety of consumer products [2]. The odor characteristic of lard is still preferred in the Chinese food culture. For instance, lard is the preferred shortening in Chinese Moon Cake preparation while the adipose tissues of the swine is sold in wet-markets to customers who want to make use of it as frying medium for shallow frying of vegetables. Therefore, the type of ingredients in food products is a matter of concern for consumers. A recent survey showed that as much as ten different brands of chicken nuggets are available in superstores for sale, but the type of oil used for pre-frying was not specified by the manufacturers. Due to trade competition, speculations are very common concerning the type of fat used as ingredient in consumer products. In such instances, food control authorities are compelled to cross-check the suspected products through chemical analyses. However, the availability of data on the characteristic properties for identification of the lipid component present in pre-fried chicken nuggets is scanty. In a previous study, Devineni et al. [3] provided the fatty acid composition of the oil derived from a type of chicken

nuggets. However, this report did not provide adequate details of the TAG composition and thermal profiles of the lipids. In fact, these data are also essential to establish the identity of oils present in chicken nuggets. Hence, the objective of this study was to characterize the lipid components derived from ten brands of chicken nuggets commercially available in Malaysia by using GLC, HPLC, and DSC. In this, lipids derived from chicken nuggets pre-fried in palm olein and lard were used as references to interpret the lipid profiles of the commercial chicken nuggets samples.

Materials and Methods

Materials

Ten different brands of commercial chicken nuggets identified by their sample code (SOD, SMO, AMO, JOD, ACO, AFO, ARO, APO, ASO, and NPO) were purchased from superstores in the periphery of Serdang, Malaysia. Samples of chicken nuggets pre-fried in lard (ALD) and palm olein (AOO) were used as references. Lard was extracted using adipose tissues of swine collected from local slaughter houses according to the method reported previously by Marikkar et al. [4]. A sample of palm olein was obtained from Lam Soon (M) Berhad. All the chemicals used in this study were either analytical or HPLC grade unless otherwise specified.

Preparation of Chicken Nuggets

Samples of chicken nuggets pre-fried in lard and palm olein were prepared using chicken meat devoid of bones and extraneous fat in accordance with the procedure reported by Perlo et al. [5]. A minced sample of chicken meat (65%) was mixed with a portion of chicken skin (6.5%) and other required ingredients (pepper, salt, corn starch, and garlic powder) (28.5%) and ground thoroughly using a electrically-operated blender. The mixture was then extended into a thin flat layer of 10 mm thickness and kept frozen at −20 °C for 24 h prior to shaping into circles using a disc of 10 mm diameter. The pieces were breaded before being pre-fried in either lard or palm olein at 180 °C for 10 s. The pre-fried samples were subsequently transferred into a freezer for storage.

Fat Extraction from Chicken Nuggets

Samples of chicken nuggets oven-dried at 105 °C were minced into pieces and finely ground using a blender. Fat extraction was carried out in petroleum ether (Boiling Point: 40−60 °C) using Soxhlet extraction procedure as described in AOAC Method 960.39 [6].

GLC Analysis of Fatty Acid Methyl Esters

Fatty acid methyl esters (FAME) were prepared by dissolving a 50-mg portion of oil in 0.8 ml of hexane and adding a 0.2-ml portion of 1 M solution of sodium methoxide [7]. The top hexane layer was injected on an Agilent 6890N gas chromatograph (Agilent Technologies, Singapore) equipped with a polar capillary column RTX-5 (0.32 mm internal diameter, 30 m length and 0.25 μm film thickness; Restex Corp., Bellefonte, PA) and a Flame Ionization Detector (FID). Split injection was conducted with a split ratio of 58:1, nitrogen was used as a carrier gas at a flow-rate of 1.00 ml/min. The temperature of the column was 50 °C (for 1 min), and programmed to increase to 200 °C at 8 °C /min. The temperatures of the injector and detector were maintained at 200 °C [8].

HPLC Analysis of Triacylglycerol Composition

The system used was a Waters Model 510 liquid chromatograph equipped with a differential refractometer Model 410 as the detector (Waters Associates, Milford, MA). The analysis of TAG was performed on a Merck LiChrospher RP-18 Column packed with a particle size of 5 μm (12.5 cm × 4 mm i.d., Merck, Darmstadt, Germany). The mobile phase was a mixture of acetone–acetonitrile (63.5:36.5) and the flow rate was 1 ml/min at 30 °C. The injector volume was 10 μl of 5% (w/w) oil in chloroform. Each sample was chromatographed two times, and the data were reported as percentage areas [8].

Thermal Analysis by DSC

For thermal analysis, a Mettler-Toledo DSC, Model 823 (Mettler-Toledo GmbH), equipped with the STAR^e thermal analysis system was used. Nitrogen (99.9% purity) was used as the purge gas at a rate of ∼20 ml/min. Approximately 6–8 mg of melted sample was placed in a standard DSC aluminum pan and then hermetically sealed. An empty and hermetically sealed DSC aluminum pan was used as a reference. In order to obtain cooling profiles, the oil samples were subjected to the following temperature program: 70 °C isotherm for 1 min, cooled at 5 °C/min to −70 °C [8].

Statistical Analysis

All analyses were carried out in duplicate and the results were expressed as mean values ± standard deviation. Data

were statistically analyzed by one-way analysis of variance (ANOVA) using MINITAB (version 14) statistical package at 0.05 probability level.

Results and Discussion

Fatty Acid Distributional Patterns of Lipids from Chicken Nugget Samples

Fatty acid compositions of the lipids extracted from commercial brands of chicken nuggets are compared with those of the lipids from chicken nuggets pre-fried in lard (ALD) and palm olein (AOO) as shown in Table 1. Most of the commercial brands are found to contain palmitic (C16:0), oleic (C18:1), and linoleic (C18:2) as major fatty acids. All of them except SMO, had oleic (39.81–43.41%) as the most dominant fatty acid followed by palmitic (31.37–41.33%), and linoleic (10.52–14.54%) acids. In the case of SMO, palmitic was the most dominant fatty acid (41.33%) followed by oleic (39.81%) and linoleic (10.99%) acids. The overall fatty acid distributional patterns of these commercial samples are comparably similar to that of AOO. For instance, the proportions of palmitic (33.65%), oleic (43.09%), linoleic (13.93%) and stearic (4.71%) acids of AOO are found to fall within the ranges of these fatty acids possessed by the commercial brands. On the other hand, ALD is also found to have palmitic (24.52%), oleic (35.47%), and linoleic (20.11%) as major fatty acids with oleic being the most dominant. However, considerable differences existing between the commercial brands and ALD in the proportions of stearic and linoleic fatty acids make them to be distinctly different. Particularly, the difference in the content of stearic acid is most significant as the concentration of this fatty acid in ALD is more than two times that of the proportion found in any of the commercial brands. This could be due to the fact that lard, which was used as the pre-frying medium for the preparation of ALD, was also found to have a higher proportion of stearic acid (Table 1). According to previous studies, the stearic acid content of lard was much higher (13–16%) than that of palm olein [9, 10]. Hence, the stearic acid content could be taken as an effective discriminating parameter to distinguish the commercial samples from ALD.

TAG Distributional Profiles of Lipids from Chicken Nugget Samples

TAG profiles of lipids extracted from the ten commercial samples of chicken nuggets are presented in Fig. 1a while those lipids extracted from chicken nuggets pre-fried in lard and palm olein are presented in Fig. 1b. The TAG

Table 1 Fatty acid (FA) compositions of lipids from coded samples of commercial brands and chicken nuggets pre-fried in lard, and palm olein

FA	Palm olein	ACO	AFO	ALD	AMO	AOO	APO	ASO	JOD	NPO	SOD	ARO	SMO	Lard
C12:0	0.26 ± 0.00h	0.29 ± 0.00g	0.33 ± 0.00e	0.4 ± 0.00c	0.37 ± 0.00d	0.18 ± 0.0k	0.37 ± 0.00d	0.83 ±0.01a	0.75 ± 0.00b	0.25 ± 0.00i	0.23 ± 0.00j	0.23 ± 0.00j	0.30 ± 0.00f	0.07 ± 0.00l
C14:0	0.98 ± 0.00h	0.92 ± 0.00j	0.92 ± 0.00j	1.86 ± 0.00a	0.99 ± 0.00g	0.92 ± 0.0j	1.01 ± 0.00f	1.33 ± 0.01b	1.18 ± 0.00c	0.94 ± 0.00i	0.95 ± 0.01i	1.05 ± 0.00e	1.08 ± 0.00d	1.34 ± 0.05b
C16:0	38.21 ± 0.02c	33.99 ± 0.00i	31.88 ± 0.00k	24.52 ± 0.01m	34.76 ± 0.01h	33.65 ± 0.02j	36.36 ± 0.00e	36.12 ± 0.06f	31.37 ± 0.01l	37.18 ± 0.00d	35.90 ± 0.06g	40.40 ± 0.04b	41.33 ± 0.04a	24.08 ± 0.55n
C16:1	0.19 ± 0.00n	1.95 ± 0.00f	3.40 ± 0.17b	2.7 ± 0.00d	2.94 ± 0.00c	1.59 ± 0.0h	0.98 ± 0.02i	0.83 ± 0.00j	3.57 ± 0.00a	0.61 ± 0.00l	1.77 ± 0.01g	0.48 ± 0.07m	0.75 ± 0.00k	2.08 ± 0.05e
C18:0	4.21 ± 0.00k	4.56 ± 0.00g	4.44 ± 0.00h	10.49 ± 0.00b	4.57 ± 0.01f	4.71 ± 0.01e	4.36 ± 0.01j	4.40 ± 0.01i	4.75 ± 0.00d	4.22 ± 0.00k	5.07 ± 0.01c	4.40 ± 0.00i	4.39 ± 0.01i	12.34 ± 0.17a
C18:1	44.01 ± 0.01a	42.14 ± 0.00e	42.24 ± 0.08e	35.47 ± 0.03i	41.20 ± 0.00g	43.09 ± 0.04c	42.49 ± 0.01d	41.69 ± 0.06f	42.46 ± 0.05d	43.41 ± 0.00b	42.17 ± 0.08e	42.15 ± 0.03e	39.81 ±0.02h	41.00 ± 1.14g, e, f
C18:2	11.45 ± 0.01k	14.29 ± 0.00d	14.54 ± 0.12c	20.11 ± 0.10a	13.30 ± 0.00g	13.93 ± 0.01e	12.89 ± 0.01h	13.24 ± 0.01g	13.76 ± 0.00f	12.54 ± 0.00i	12.24 ± 0.01j	10.52 ± 0.01m	10.99 ± 0.01l	16.78 ± 0.38b
Others	0.70 ± 0.02l	1.85 ± 0.01f	2.25 ± 0.03c	4.44 ± 0.04a	1.87 ± 0.00f	1.92 ± 0.03e	1.61 ± 0.03h	1.56 ± 0.01h	2.15 ± 0.03d	0.85 ± 0.00j	1.67 ± 0.00g	0.77 ± 0.00k	1.36±0.08i	2.29 ± 0.02b

Each value in the table represents the mean ± standard deviation of duplicate analyses and means within each row bearing different alphabets are significantly ($p < 0.05$) different

AOO Chicken nuggets pre-fried in palm olein, *ALD* Chicken nuggets pre-fried in lard

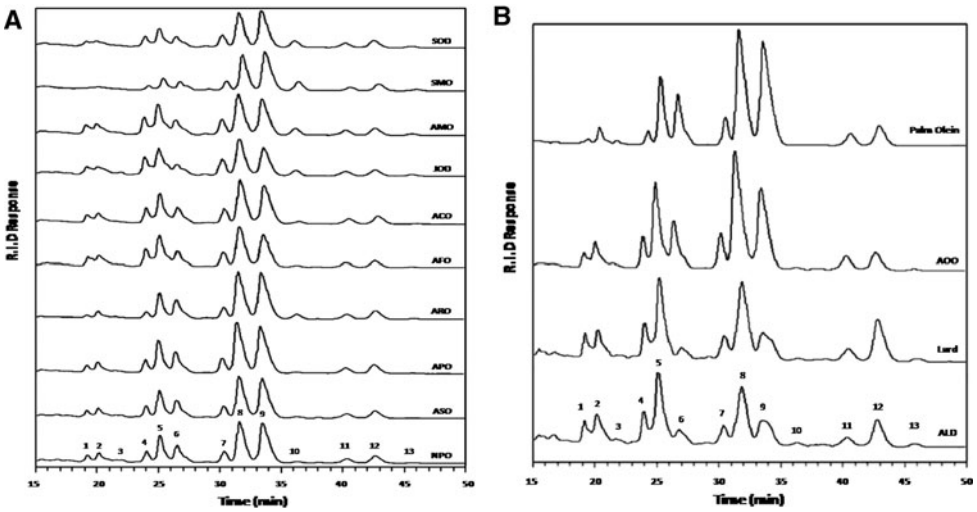

Fig. 1 **a** Triacylglycerol profiles of lipids from ten coded samples of commercial chicken nuggets, and **b** Triacylglycerol profiles of palm olein, lard and lipids extracted from chicken nuggets pre-fried in lard (*ALD*) and palm olein (*AOO*). Triacylglycerolpeak assingment as given in Table 2

peaks of the commercial brands as well as the two reference samples were identified as 1: MMM, 2: PLL, 3: MPL, 4: OOL, 5: PLO, 6: PPL, 7: OOO, 8: OOP, 9: OOS, 10: POS, 11: PPO, 12: PPP, and 13: PPS (M, myristic; L, linoleic; P, palmitic; O, oleic; S, stearic) based on the TAG profiles of palm olein and lard as reported in the Ref. [11]. The TAG profiles of most of the commercial brands are found to have same TAG molecules, of which OOP, PPO, PLO and PPL are present as the major TAG species. The quantitative data presented in Table 2 shows the differences among them with respect to the proportional distribution of various TAG species. Of these differences, the variation in the content of PPP is most significant. While samples SOD, SMO, AMO, JOD, and ARO had relatively higher proportion of PPP (2.48–7.11%), samples ACO, AFO, APO, ASO, and NPO samples had significantly lower proportions of PPP (0–0.95%) (Table 2).

According to the overlay presented in Fig. 1b, the TAG profiles of AOO and palm olein were found to be similar to the commercial brands since they are also possessed with OOP, PPO, PLO and PPL as the major TAG molecular species. However, the exception is the fact that the occurrence of tripalmitin (PPP) in AOO and palm olein is too negligible to be detected. According to previous studies, in most of the commonly found samples of palm olein, PPP was detected only in very small amounts [12, 13]. On the other hand, TAG profiles of ALD and lard are found to possess PLO, OOP, PPO, POS, and PLL as the major TAG molecules (Fig. 1b). Due to the differences in the proportional distribution of these TAG molecules, ALD and lard display considerable deviations from most of the commercial brands (Table 2). While all commercial brands have less than 6.1% of POS (peak-12), the proportion of this TAG species in ALD is as high as 9.87%. Likewise, the proportion of PLL (peak-4) in ALD is 8.55%, which is more than 73% of the proportion found in any of the commercial brand. More significantly, the proportion of PPO (peak-9) in ALD is found to be much lower than those of any other commercial brand (Table 2). These could be probably due to the fact that pure lard, which was used as frying medium for ALD, was also found to have higher proportions of POS and PLL and lower amount of PPO (Table 2). The TAG proportional distribution of lard used in this study was also agreeable with the previous data reported in the Ref. [11]. Hence, the dissimilarities in the contents of PLL, POS and POO could be considered as effective discriminating factors to distinguish the commercial samples from ALD.

DSC Cooling Profiles of Lipids from Chicken Nugget Samples

DSC thermal profiles of lipids extracted from the ten commercial samples of chicken nuggets are presented in Fig. 2a while those of lipids extracted from chicken nuggets pre-fried in lard and palm olein are presented in Fig. 2b. Based on the characteristic differences in the profiles of the samples, it may be possible to categorize the commercial brands into three subgroups namely, A, B, and C. According to the thermal characteristic data, NPO has its major thermal transition at −1.63 °C and a minor transition at −52.68 °C. The non existence of any distinctly identifiable high-melting thermal transition above 0 °C in the DSC curve of NPO may place it into the first subcategory identified as group-A. Samples AFO, APO, ASO, and ACO may be put together as the second subcategory identified as Group-B for having similar features in their thermal profiles. Having a broad low-melting transition (0 to −4 °C) which is accompanied by a sharp minor thermal transition appearing in the range of −51.0 to

Table 2 Triacylglycerol (TAG) composition of lipids from coded samples of commercial brands, and chicken nuggets pre-fried in lard, and palm olein

TAG	Palm olein	SMO	ARO	SOD	NPO	APO	ASO	ACO	AMO	AOO	AFO	JOD	ALD	Lard
1 (MMM)	0.44 ± 0.04i	0.32 ± 0.09i	0.75 ± 0.03h	1.43 ± 0.06g	1.49 ± 0.03g	1.99 ± 0.00e	2.26 ± 0.16d	2.85 ± 0.02c	3.44 ± 0.01c	2.03 ± 0.01d	3.11 ± 0.96c	1.93 ± 0.01f	4.62 ± 0.02a	4.20 ± 0.07b
2 (PLL)	2.43 ± 0.10h	–	2.54 ±0.03h	–	3.28 ± 0.04g	3.48 ± 0.03g	4.03 ± 0.64f	3.87 ± 0.02f	4.24 ± 0.02e	4.32 ± 0.03d	4.94 ± 0.04c	0.75 ± 0.02i	8.55 ± 0.00a	6.10 ± 0.05b
3 (MPL)	0.29 ± 0.06c	–	0.24 ± 0.02c	–	0.27 ± 0.01c	0.19 ± 0.01d	0.39 ± 0.41b	–	–	0.33 ± 0.01b	–	0.45 ± 0.00b	1.10 ± 0.00a	0.08 ± 0.001e
4 (OOL)	1.91 ± 0.02h	1.89 ± 0.23h	2.24 ± 0.02g	5.31 ± 0.29c	3.04 ± 0.02f	3.96 ± 0.03e	4.25 ± 0.08d	5.36 ± 0.05c	6.03 ± 0.23b	4.08 ± 0.02d	6.41 ± 0.11b	8.34 ± 1.25a	6.75 ± 0.10b	6.63 ± 0.05b
5 (PLO)	12.12 ± 0.00h	7.00 ± 1.29k	11.38 ± 0.03j	11.91 ± 0.17i	12.64 ± 0.03g	13.42 ± 0.05f	13.33 ± 0.18f	15.02 ± 0.05e	15.35 ± 0.03e	16.42 ± 0.09d	17.70 ± 0.24c	16.62 ± 0.24d	22.57 ± 0.21a	20.91 ± 0.26b
6 (PPL)	10.81 ± 0.02a	4.69 ± 2.95c	9.97 ± 0.01a	7.36 ± 0.02b	9.90 ± 0.01a	9.65 ± 0.07a	9.90 ± 0.1a	8.65 ± 0.05b	8.28 ± 0.04b	9.63 ± 0.03a	8.81 ± 0.16b	7.66 ± 0.22b	4.81 ± 0.00c	2.89 ± 0.01d
7 (OOO)	4.48 ± 0.01g	5.53 ± 0.34e	4.66 ± 0.02g	6.71 ± 0.06b	5.00 ± 0.01f	5.18 ± 0.04e	5.02 ± 0.07f	6.08 ± 0.07d	6.47 ± 0.06c	5.62 ± 0.01e	6.48 ± 0.03c	8.33 ± 0.10a	4.57 ± 0.07g	5.16 ± 0.32f
8 (OOP)	29.21 ± 0.20a	27.88 ± 1.46c	26.83 ± 0.03d	24.66 ± 0.01f	27.47 ± 0.00c	26.30 ± 0.04d	25.29 ± 0.34e	25.16 ± 0.03e	23.08 ± 0.07h,g	28.66 ± 0.03b	23.82 ± 0.25g	24.44 ± 0.27f	20.70 ± 0.06i	24.66 ± 0.16f, e, g
9 (PPO)	30.07 ±0.08b	35.69 ± 1.85a	30.95 ± 0.00b	28.92 ± 0.05c	28.79 ± 0.03c	27.74 ± 0.06d	27.55 ± 0.30d	24.50 ± 0.03e	22.18 ± 0.05f	21.18 ± 0.06f	21.10 ± 0.20f	20.01 ± 0.30g	11.99 ± 0.05i	11.12 ± 0.01i
10 (PPP)	–	7.11 ± 0.43a	2.48 ± 0.01d	4.17 ± 0.02b	–	0.22 ± 0.01g	0.58 ± 0.08f	0.95 ± 0.01e	3.37 ± 0.03c	0.16 ± 0.13g	0.68 ± 0.03f	3.14 ± 0.00c	0.70 ± 0.03f	0.27 ± 0.03 g
11 (OOS)	2.90 ± 0.10b	2.73 ± 0.10c	2.54 ± 0.10	3.10±0.03b	2.99 ± 0.06b	2.82 ± 0.11c	2.60 ± 0.04c	2.82 ± 0.04c	2.57 ± 0.04c	3.17 ± 0.01b	2.69 ± 0.05c	3.12 ± 0.00b	3.05 ± 0.08b	3.78 ± 0.00a
12 (POS)	5.34 ± 0.05e	6.13 ± 0.31c	5.24 ± 0.01f	5.71 ± 0.03d	5.14 ± 0.02f	5.06 ± 0.07f	4.80 ± 0.11g	4.73±0.00g	4.33 ± 0.08h	4.38 ± 0.03h	4.16 ± 0.03i	4.45 ± 0.1 h	9.87 ± 0.08b	13.52 ± 0.09a
13 (PPS)	–	1.05 ± 0.07a	0.17 ± 0.00c	0.72 ± 0.08b	–	0.22 ± 0.01c	–	–	0.66 ± 0.01b	–	0.12 ± 0.16c	0.77 ± 0.02b	0.71 ± 0.04b	0.68 ± 0.00b

Each value in the table represents the mean ± standard deviation of duplicate analyses and means within each row bearing different alphabets are significantly ($p < 0.05$) different

AOO Chicken nuggets pre-fried in palm olein, *ALD* Chicken nuggets pre-fried in lard, *OOO* trioleoyl glycerol, *OOL* dioleoyl-3-linoleoyl glycerol, *PLO* palmitoyl-linoleoyl-oleoyl glycerol, *PLL* dilinoleoyl-1-palmitoyl glycerol, *OOP* dioleoyl-3-palmitoyl glycerol, *OOS* dioleoyl-3-stearoyl glycerol, *MPL* myristoyl-palmitoyl-linoleoyl glycerol, *PPL* dipalmitoyl-1-linoleoyl glycerol, *PPO* dipalmitoyl-3-oleoyl glycerol, *POS* palmitoyl-oleoyl-stearoyl glycerol; *MMM* trimyristoyl glycerol, *PPP* tripalmitoyl glycerol, *PPS* dipalmitoyl-3-stearoyl glycerol

−53.0 °C is a common feature among the samples represented by this group. These samples possessing a minor high-melting thermal transition over the range of 0–4 °C make them to be distinguishable from Group-A. Samples SMO, ARO, AMO, JOD, and SOD forms a separate subcategory identified as group-C. All samples under group-C are found to have broad low-melting transitions, which is accompanied by a minor low-melting transition. The presence of a stronger high-melting transition in the temperature region of 8–12 °C would give a distinct identity for this subgroup.

The overlay of DSC curves presented in Fig. 2b compares the thermal behavior of the lipids extracted from chicken nuggets pre-fried in lard and palm olein with those of the respective frying media. AOO is found to possess a broad low-melting transition at −4.7 °C, which is accompanied by a sharp minor low-melting thermal transition at −49.0 °C. In addition to these, a tiny high-melting transition is also found to be seen at 1.0 °C. These features make it to be different from the DSC profile of palm olein. A comparison with commercial samples may show that the DSC profile of AOO is closely related to those of the commercial brands represented by Group-B (AFO, APO, ASO, and ACO). It is mainly because the samples in this group and AOO are found to have similar pattern in their thermal profiles. On the other hand, ALD is found to have four distinctly identifiable exothermic thermal transitions with peak maxima at 8.63, −2.17, −24.44 and −43.3 °C. The sharp minor thermal transition at 8.63 °C could be considered as the higher melting transition while the rest could be assumed as belonging to the lower melting region. Unlike the DSC profiles of the commercial brands and AOO, the profile of ALD did not display any broad thermal transition in the lower temperature region. This feature could be useful to make a clear difference between ALD and the commercial brands of chicken nuggets.

Conclusions

This study demonstrated the ways of differentiating commercial brands of chicken nuggets from chicken nuggets pre-fried in lard using GLC, HPLC, and DSC as analytical tools. The stearic acid content coming from fatty acid data and the proportional differences seen in the TAG molecular species such as PLL, POS and PPO could be useful as effective discriminating parameters. According to thermal analysis, all commercial brands possessing a broad thermal transition in the lower melting region is a significant feature, which is not found in chicken nuggets pre-fried in lard. The information obtained from this study could be used as a reference to establish procedures to cross-check

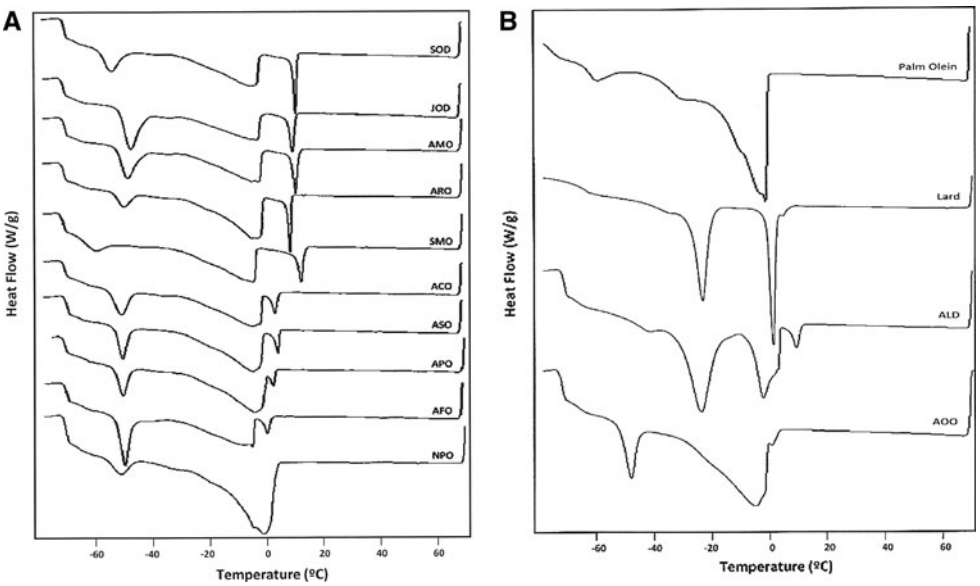

Fig. 2 **a** DSC cooling profiles of lipids extracted from ten coded samples of commercial chicken nuggets, and **b** DSC cooling profiles of palm olein, lard and lipids extracted from chicken nuggets pre-fried in lard (*ALD*) and palm olein (*AOO*)

the source origin of the frying media used in commercial brands of chicken nuggets.

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