DETECTION AND EVALUATION OF LARD ADULTERATION IN PURE GOAT AND MUTTON TALLOWS

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ABSTRACT

This investigation was carried out in an attempt to find out a reliable simplified specific method to be recommended for quality control laboratories for the detection and evaluation of lard adulteration in pure goat and mutton tallows as well as in other fat mixtures.

The solidification curves of pure lard, goat and mutton tallows as well as goat and mutton tallow mixtures including 3;6; 9;12 and 15% of added lard has been studied by Differential Scanning Calorimetry (DSC).

Fatty acid composition of B-monoglycerides (B-MG) and triglycerides (TG) of lard; goat and mutton tallows was determined by applying GLC technique.

The DSC data indicated the existence of rather marked specific differences, between the solidification properties of lard, goat and mutton tallows. Likewise, GLC data revealed remarkable variations in the fatty acid composition in triglycerides and B-monoglycerides fractions in lard, goat and mutton tallows. However, lard is uniquely characterized by the presence of high percentage of saturated fatty acids especially palmitic acid at the B-monoglycerides.

Furthermore, using additional certain calculation factors namely; palmitic acid enrichment factor, unsaturation ratio, total C_{16}/total C_{18} fatty acids and saturated/unsaturated fatty acids in B-monoglycerides could be recommended as a helpful guide in detecting lard in pure goat and mutton tallows as well as in other fat mixtures.

INTRODUCTION

The consumption of pork and its by-products is prohibited in Egypt and other Islamic countries due to religious concepts. Therefore, nowdays, great attention is paid to find out more definite and modern chemical methods for detection of lard in fat and oil products and other food-stuffs.

The difference between the solidification properties of lard and other animal tallows is quite obvious. The possibilities of detection of animal tallow in lard by determination of the crystallization properties through differential thermal analysis and especially Differential Scanning Calorimetry (DSC) have been outlined by Huyghbaert et al. (1972).

Bracco et al. (1976) pointed out that the mixture of lard and other animal fats could be distinguished by differential calorimetry cooling curves, since temperature and solidification peak area were specific for each type of fat and directly related to the proportion of each type in a mixture. The DSC method has been compared with the GLC fatty acids determination, based upon the prevelant specific differences in minor fatty acids. Although the GLC method has a higher sensitivity than the DSC method, the latter may serve to some extent as a sound confirmation of the former.

Amer et al. (1972) set a comparison between the glyceride structure of lard and other fats. They mentioned that lard glycerides were characterized by the presnece of high percnetage of saturated fatty acids at the 2-position mainly palmitic acid. The authors herein used this phenomenon for the detection of lard in other animal fats, namely: goat and mutton tallows.

MATERIALS AND METHODS

1- Materials:

All samples under study were obtained from Assiut slaughter house immediately after slaughtering.

Goat tallow was trimmed free from lean meat of male animals. While, mutton tallow was taken from the tail.

Crude lard was procured from Assiut local market. Lard was withdrawn from pork outer back fat of male pig animals.

Goat and mutton tallows were deliberately adulterated in the laboratory with added lard using the following adulteration percentages: 3;6;9;12 and 15% (w/w).

2- Analytical methods:

Fat extraction: Fat was extracted from fatty tissues as described by Folch et al. (1957).

Preparation of triglycerides: The triglycerides were separated from total fat by adopting the method of Dister and Baur (1965).

Preparation of B-monoglycerides: Enzymatic preparation of B-monoglycerides from triglycerides by pancreatic lipase was performed as described by Rossell et al. (1978).

Preparation of methyl esters of fatty acids: The methyl esters of fatty acids were prepared from total lipids; triglycerides and B-monoglycerides using the method described by Rossell et al. (1983).

Gas liquid chromatography of methyl esters of fatty acids: The methyl esters of fatty acids were separated using a PYE unicam (GCD) gas liquid chromatography apparatus.

Factors calculation: Certain factors were calculated as outlined by Rashwan (1986). The following equations were used:

(1) Palmitic acid enrichment factor:

$$\frac{\text{\% palmitic acid in B-monoglyceride}}{\text{\% palmitic acid in triglyceride}}$$

(2) Unsaturation ratio:

$$\frac{\text{\% unsaturated fatty acids in B-monoglyceride}}{\text{\% unsaturated fatty acids in triglyceride}}$$

(3) a. $$\frac{\text{\% total } C_{16} \text{ fatty acids in B-monoglyceride}}{\text{\% total } C_{18} \text{ fatty acids in B-monoglyceride}}$$

b. $$\frac{\text{\% saturated fatty acids in B-monoglyceride}}{\text{\% unsaturated fatty acids in B-monoglyceride}}$$

Differential scanning calorimetry (DSC) analysis: Analyses were made using a Perkin Elmer DSC-apparatus, according to the method described by Lambelet (1983).

RESULTS AND DISCUSSION

The data of the mean values of the fatty acid composition of lard; Goat and Mutton tallows are represented in Table (1). The data showed that the quantitative fatty acid composition markedly varied in lard than that for goat and mutton tallows. It is apparent from the data that the linoleic acid ($C_{18:2}$) component in lard; goat and mutton tallows amounted to 10.76%, 3.63% and 2.60%, Table (1): Mean values of fatty acid composition of lard, goat and mutton tallows (% of the total).

Tallow	% of fatty acid content								
	$C_{14:0}$	$C_{16:0}$	$C_{16:1}$	$C_{17:0}$	$C_{18:0}$	$C_{18:1}$	$C_{18:2}$	$C_{18:3}$	$C_{18:0}/C_{18:2}$
Lard	1.92	27.34	4.26	0.79	12.39	41.03	10.76	1.32	1.15
Goat	3.50	25.40	2.60	0.16	15.96	44.90	3.63	1.60	4.40
Mutton	4.26	24.91	3.18	0.29	16.81	46.10	2.60	1.10	6.47

respectively. However, the stearic acid ($C_{18:0}$) component was lower in lard (12.39%) than that in goat and mutton tallows (15.96% and 16.81%), respectively). An alternative check-up adulteration of goat and mutton tallows with lard is set-up from the $C_{18:0}/C_{18:2}$ ratio. The latter ratio accounted to 1.15; 4.40 and 6.47 in lard, goat and mutton tallows, respectively. These results are in good agreement with those reported by Kim and Kim (1982) and Nour El-Din et al. (1984).

On the other hand the data outlined in tables 2 and 3 revealed that palmitic acid enrichment factor was 2.29; 0.31 and 0.16 in lard, goat tallow and mutton tallow, respectively. This could be mostly attributable to the rather low content of palmitic acid in B-monoglyceride and its high content in triglyceride of goat and mutton tallows. On contrary, the palmitic acid was rather high in the former than in the latter fractions of lard (Abou-Arab, 1980; Nour El-Din et al. 1984 and Rashwan 1986). Needless to say that as the lard percentage increased the palmitic acid enrichment factor was elevated. This might be essentially due to the fact that 90% of the total palmitic acid in lard is available in the B-position (Bracco et al. 1976).

Tables (4 and 5) represent the data of unsaturation ratio of lard; goat and mutton tallows.

Table (2): Palmitic acid enrichment factor for lard; goat tallow and lard-goat tallow mixtures.

Origin		Palmitic acid in B-MG	Palmitic acid in TG	Factor
Lard		59.82	26.11	2.29
Goat tallow		6.81	21.71	0.31
% Added lard in goat tallow (w/w)	3%	6.96	21.90	0.32
	6%	8.07	22.04	0.37
	9%	10.31	22.68	0.45
	12%	12.18	22.81	0.53
	15%	13.64	22.97	0.59

Table (3) Palmitic acid enrichment factor for lard; mutton tallow and lard-mutton tallow mixtures.

Origin		Palmitic acid in B-MG	Palmitic acid in TG	Factor
Lard		59.82	26.11	2.29
Mutton tallow		4.21	25.96	0.16
% Added lard in mutton tallow (w/w)	3%	4.46	25.98	0.17
	6%	5.97	26.09	0.23
	9%	7.08	26.45	0.27
	12%	8.81	26.73	0.33
	15%	11.43	26.84	0.43

Data revealed that this ratio was rather low in lard (0.45) than that in goat and mutton tallows (1.29 and 1.44, Table (4): Unsaturation ratio for lard, goat tallow and lard-goat tallow mixtures.

Source of fat		Unsaturated F.A. in TG.	Unsaturated F.A. in B-MG	Ratio
Lard		57.30	25.98	0.45
Goat tallow		63.75	82.29	1.29
Added lard in goat tallow (w/w)	3%	63.18	80.24	1.27
	6%	62.93	75.52	1.20
	9%	62.04	69.48	1.12
	12%	60.89	65.76	1.08
	15%	59.72	63.30	1.06

Table (5): Unsaturation ratio for lard, mutton tallow and lard-mutton tallow mixtures.

Source of fat		Unsaturated F.A. in TG	Unsaturated F.A. in B-MG	Ratio
Lard		57.30	25.98	0.45
Mutton tallow		61.43	88.41	1.44
Added lard in mutton tallow (w/w)	3%	61.12	85.57	1.40
	6%	61.01	84.19	1.38
	9%	60.34	79.05	1.31
	12%	59.17	73.37	1.24
	15%	58.34	70.59	1.21

respectively). Such discrepancies could be attributed to high content of unsaturated fatty acids in B-monoglycerides and its low content in triglycerides fractions in goat and mutton tallows. However, lard recorded an opposite trend. These data are in close agreement with Abou-Arab (1980); Bayoumy (1982) and Youssef et al. (1986) findings.

Such results showed that the unsaturation ratio for certain mixtures of lard, goat tallow and mutton tallow gradually decreased as lard percentage was increased.

Tables (6 and 7) indicate the total C_{16}/total C_{18} fatty acids and the saturated/unsaturated fatty acids for lard; goat tallow and mutton tallow in B-monoglyceride.

The data revealed that the total C_{16}/total C_{18} fatty acids ratio in lard was considerably high (2.29); while, it was comparatively extremely low in goat and mutton tallows (0.17 and 0.11, respectively). Therefore, the addition of lard to goat and mutton tallows resulted in a rather slight increment in the C_{16}/C_{18} fatty acids ratio.

On the other hand, saturated/unsaturated fatty acids ratios in B-monoglyceride accounted to 2.78; 0.21 and 0.13 in lard; goat tallow and mutton tallow, respectively. This might be mostly due to the rather high content of saturated fatty acids and low content of unsaturated fatty acids in B-monoglyceride in lard, as well as their opposite trend in goat and mutton tallows. Such data coincide with those previously reported by Abdel-Fattah,(1970 and 1974); Nour El-Din et al. (1984) and Rashwan (1986).

Moreover, the data revealed that the saturated/unsaturated fatty acids ratio increased as the lard percentage was elevated.

Fig. (1) represents the solidification curve of lard; goat and mutton tallows. Such curve shows that the melting diagrams of pure goat tallow is apparently different from the other two fats. Melting diagram of goat tallow shows a big endothermic peak located at 50°C.

Analysis of mutton tallow samples revealed that it contained an even more amounts of high-

Fig. (1) : The Solidification Curves of (A) lard, (B) goat and (c) mutton tallow.

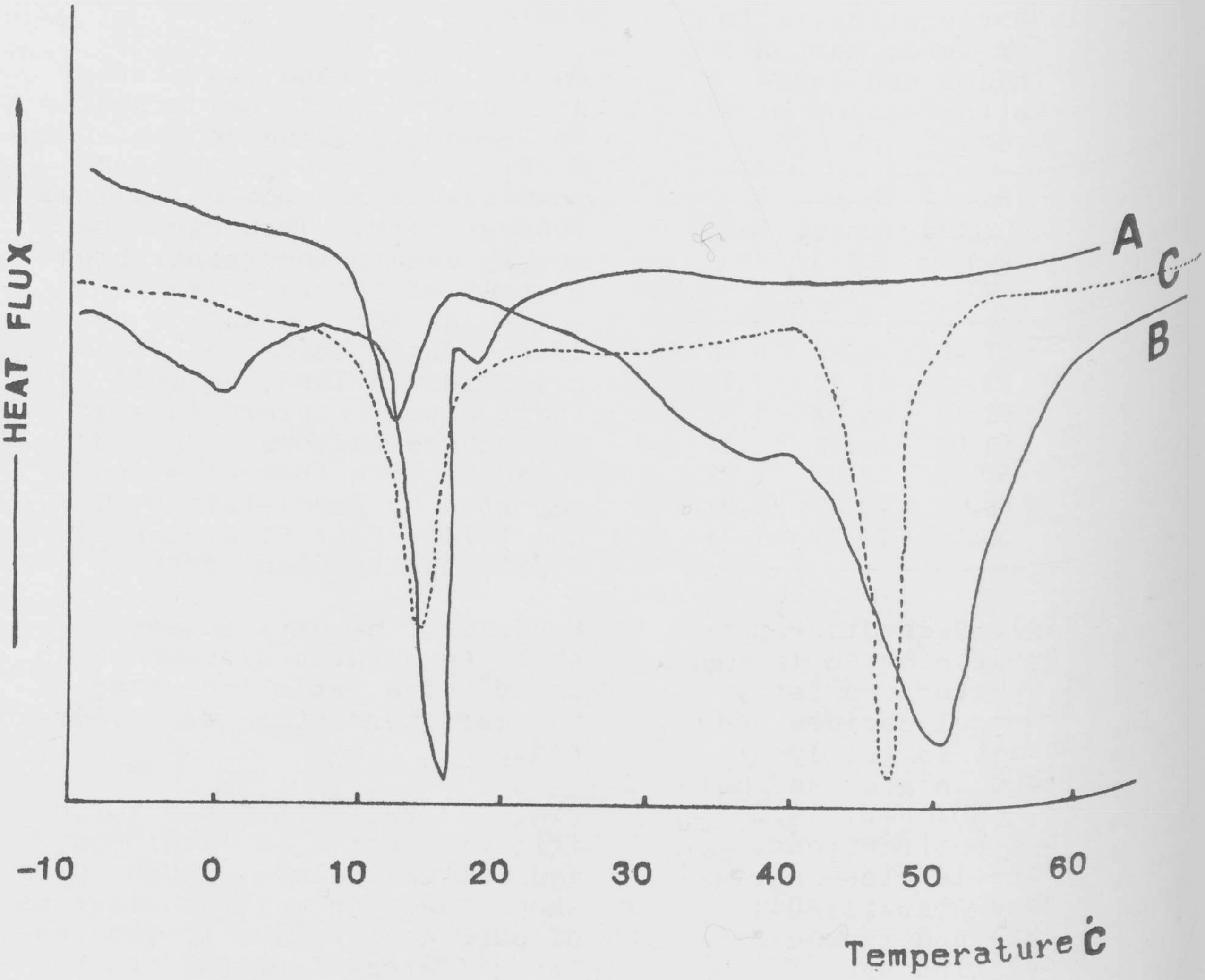

Table (6): Total C_{16}/total C_{18} fatty acids and saturated/unsaturated fatty acids ratios in B-monoglycerides of lard; goat tallow and lard-goat tallow mixtures.

Fatty acids	Lard	Goat tallow	% Lard in Goat tallow (w/w)				
			3	6	9	12	15
% total C_{16}	64.73	12.90	13.72	14.68	16.93	18.81	20.14
% total C_{18}	28.30	77.87	76.22	69.90	58.38	49.50	44.76
C_{16}/C_{18}	2.29	0.17	0.18	0.21	0.29	0.38	0.45
SFA	72.28	17.57	17.93	19.51	20.73	23.11	24.70
USFA	25.98	82.29	77.96	72.26	66.87	59.26	53.70
SFA/USFA	2.78	0.21	0.23	0.27	0.31	0.39	0.46

Table (7): Total C_{16}/total C_{18} fatty acids and saturated/unsaturated fatty acids ratios in B-monoglycerides of lard; mutton tallow and lard-mutton tallow mixtures.

Fatty acids	Lard	Mutton tallow	% lard in mutton tallow (w/w)				
			3	6	9	12	15
% total C_{16}	64.72	9.02	9.81	10.76	12.45	14.06	15.93
% total C_{18}	28.30	84.41	75.46	67.25	59.29	52.07	45.51
C_{16}/C_{18}	2.29	0.11	0.13	0.16	0.21	0.27	0.35
SFA	72.28	11.80	12.13	13.41	14.52	16.47	17.86
USFA	25.98	88.41	80.87	70.58	63.13	56.79	54.12
SFA/USFA	2.78	0.13	0.15	0.19	0.23	0.29	0.33

melting glycerides than that in lard samples. Since, the DSC curve presented a well-separated minimum at a high temperature, therefore lard seemed easily detectable in mutton tallow

Table (8) Results of the determination of the DSC solidifying curve of fat samples.

Fat origin	M_1 °C	M_2 °C	$\Delta M = M_1 - M_2$	M_2/M_1
Lard	19	15	4	0.79
Goat tallow	50	10	40	0.20
Mutton tallow	47	11	36	0.23

The results of the DSC solidification curves of lard; goat tallow and mutton tallow are shown in Table (8). Such data showed temperature values of exothermal effects, as well as the ΔM values ($\Delta M = M_1 - M_2$) and the M_2/M_1 ratio. It is evident from such data that there exists a remarkable difference from the solidification curves of tallows. It could be noticed that ΔM was < 5.0 in lard; while it was >5.0 in both goat and mutton tallows.

The M_2/M_1 ratio shows higher value for lard (0.79) than that of goat and mutton tallows (0.20 and 0.23, respectively). This ratio might be certainly considered as a reliable parameter for the detection of lard in goat and mutton tallows.

These data coincide with previously reported by Huyghebaert et al. (1972); Lambelet,(1983) and Rashwan (1986).

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