DETECTION AND EVALUATION OF LARD ADULTERATION IN PURE BUFFALO AND COW BUTTER

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SUMMARY

This investigation was carried out in an attempt to assess the most reliable methods for detection and evaluation of lard adulteration in pure buffalo and cow butters.

The results showed that the quantitative fatty acid composition varied markedly in lard than that in pure buffalo and cow butters. In general, it is clear that lard contained more unsaturated fatty acids (57.851%) than pure buffalo and cow butters (24.434% and 24.603%, respectively). The linoleic acid ($C_{18:2}$) component in lard; buffalo butter and cow butter was found to be 10.67%; 2.578% and 2.895%, respectively. Meanwhile, the stearic acid ($C_{18:0}$) component was noticeably lower in lard (11.231%) than that in buffalo butter and cow butter (19.159% and 18.862%, respectively).

Furthermore, the data revealed that palmitic acid enrichment factor could be successfully used as a helpful guide in detecting lard in pure buffalo and cow butters, as it was elevated as lard percentage was increased; unsaturation ratio; total C_{16}/total C_{18} fatty acids; saturated/unsaturated fatty acids and USU/SUS ratio could be recommended as a reliable criteria for lard contamination in buffalo and cow butters.

INTRODUCTION

Fats and oils have always played an essential role in human nutrition. Sources of dietary fat have been changing continuously during the past two decades (FAO, 1978). Owing to the high price of butter, unethical suppliers always adulterate butter with other lipids which are similar in structure and less expensive (Farag, et al. 1982).

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.

The differences in the melting diagrams and crystallization patterns of various lipids, as determined by differential thermal analysis, provide a basis for the determination of adulteration in cow or buffalo ghee (Lambelet, (1983). Such adulteration causes a significant change in the concentrations of certain fatty acids (Tsatsaronis et al. 1972, and Farag et al. 1980). Adulteration can be detected by the changed ratios of some fatty acids in the total lipid extracts (Carisano et al. 1976, and Farag et al. 1980). However, up to the authors knowledge the application of specific ratios and calculating factors based on fatty acid composition in triglycerides and B-monoglycerides in butter manufacture is lacking in the literature. Therefore, this investigation was carried out to fill this gap.

MATERIALS AND METHODS

1. Lipid materials:
Pure buffalo and cow butters were obtained from Dairy Scince Department, Faculty of Agriculture, Assiut University. Crude lard was purchased from Assiut local market. Lard was withdrawn from pork outer back fat of male animals. Buffalo and cow butters were deliberately adulterated in the laboratory with above-mentioned lard to give the following adulteration percentages: 3; 6; 9; 12 and 15% (W/W).

2. Analytical methods:

2.1. Fat extraction: Fat was extracted from fatty tissues as described by Folch et al. (1957) applying Ways et al. (1964) modifications.

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

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

2.4. Preparation of methyl esters of fatty acids. The methyl esters of fatty acids were prepared from total lipids; triglycerides and B-monoglycerides using 5 ml. 3% H_2SO_4 in absolute methanol and 2 ml. benzene as mentioned by Rossell et al. (1983).

2.5. 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 with S 8 autosampler.

2.6. Factors calculation: The palmitic acid enrichment factor; the unsaturation ratio and other ratios based on the fatty acid composition of triglycerides and B-monoglycerides were calculated as outlined by Rashwan (1986). The following equations were used respectively:

(1) Palmitic acid enrichment factor:

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

(2) Unsaturation ratio:

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

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

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

2.7. Statistical method for calculating the glycerides pattern: Vander Wal method (1960) was used for calculating the glycerides pattern.

RESULTS AND DISCUSSION

The GLC analysis of the methyl esters of fatty acids of lard, buffalo butter and cow butter are given in Table (1). The data revealed that the quantitative fatty acid composition varied markedly in lard than that in pure buffalo and cow butters. In general, it is obvious that lard contained more unsaturated fatty acids (57.851%) than pure buffalo and cow butters (24.434% and 24.603%, respectively). The linoleic acid ($C_{18:2}$) component in lard, buffalo butter and cow butter was found to be 10.678%; 2.578% and 2.895%, respectively. Meanwhile, the stearic acid ($C_{18:0}$) component was noticeably lower in lard (11.231%) than that in buffalo and cow butters (19.159% and 18.862%, respectively). An alternative check-up of the adulteration of buffalo and cow butters with lard is made from the $C_{18:0}/C_{18:2}$ and the total saturated/total unsaturated fatty acids ratios. The latters were (1.05; 7.43 and 6.52); (0.69; 2.55 and 2.35) in

Table 1. Mean values of fatty acid composition of lard, buffalo butter and cow butter (% of the total).

Tallow	% of fatty acid content																		
	$C_{4:0}$	$C_{6:0}$	$C_{8:0}$	$C_{10:0}$	$C_{12:0}$	$C_{14:0}$	$C_{14:1}$	$C_{14:2}$	$C_{15:0}$	$C_{16:0}$	$C_{16:1}$	$C_{17:0}$	$C_{18:0}$	$C_{18:1}$	$C_{18:2}$	$C_{18:3}$	$\frac{C_{18:0}}{C_{18:2}}$	TS*	TU**	TS/TU
Lard	0.000	0.000	0.161	0.032	0.681	1.624	0.131	0.021	0.120	25.613	3.992	0.451	11.231	40.165	10.678	2.364	1.05	39.913	57.851	0.69
Buffalo butter	0.485	0.593	2.034	1.556	1.937	8.242	2.517	0.000	2.132	24.297	3.187	1.369	19.159	16.152	2.578	0.000	7.43	62.304	24.434	2.55
Cow butter	0.355	0.931	3.035	2.294	1.917	6.625	2.097	0.000	1.345	21.176	5.706	0.731	18.362	12.815	2.895	0.000	6.52	57.871	24.603	2.35

* total saturated fatty acids.

**total unsaturated fatty acids.

lard; buffalo and cow butters, respectively. These results are in good agreement with those reported by Farag et al. (1980) and Youssef et al. (1986 a). Moreover, table (2) revealed that the palmitic acid enrichment factor was 2.34, 1.20 and 1.09 in lard, buffalo and cow butters, respectively. This may be due to the fact that B-monglycerides of lard are specifically occupied with saturated fatty acids mainly palmitic acid (Nour El-Din et al. 1984 and Youssef et al. 1986 b)

Results given in Tables (3 and 4) indicated that the unsaturation ratio was noticeably lower in lard (0.39) than that in buffalo and cow butters (0.84 and 1.29, respectively). Meanwhile, the total C_{16} fatty acids/total C_{18} fatty acids in B-monoglycerides was considerably high in lard (2.57), while it was 1.04 and 0.57 in buffalo and cow butters, respectively. This may be due to high content of saturated fatty acids and low content of unsaturated fatty acids in B-position in lard, while buffalo and cow butters recorded an opposite trend. Such data coincide with with those previously reported by Bracco et al. (1976); El-Dashlouty (1978); Nour El-Din et al. (1984) and Youssef et al. (1986 b).

It is note-worthy that the USU/SUS ratios (Table 5) was higher in lard than that in buffalo and cow butters being 23.31, 0.28 and 1.62, respectively.

Furthermore, the data given in Tables (6 and 7) revealed that palmitic acid enrichment factor could be successfully used as a helpful guide in detecting lard in pure buffalo and cow butters, as it was elevated as lard percentage was increased. This may be due to the fact that 90% of the total palmitic acid in lard was in the B-position (Bracco et al. 1976; Abou-Arab 1980 and Rashwan 1986).

Regarding to the unsaturation ratio, it could be noticed from tables (8 and 9) that there was gradual decrease in this ratio with the increment of lard percentage to buffalo or cow butter contents.

Table 2. Palmitic acid enrichment factor for lard; buffalo butter and cow butter.

Sample	Palmitic acid in B.MG.	Palmitic acid in T.G.	Factor
Lard	58.63	25.07	2.34
Buffalo butter	28.46	23.77	1.20
Cow butter	25.34	23.24	1.09

Table 3. Unsaturation ratio of lard; buffalo butter and cow butter.

Source of fat	Lard	Buffalo butter	Cow butter
% unsaturated fatty acids in T.G.	56.47	24.14	18.90
% unsaturated fatty acids in B.MG.	21.75	20.16	24.31
Ratio	0.39	0.84	1.29

Table 4. Total C_{16}/C_{18} fatty acids ratio and S.F.A./U.S.F.A. for lard; buffalo butter and cow butter.

Fatty acids	Lard	Buffalo butter	Cow butter
% Total C_{16} fatty acids	62.83	28.46	25.34
% Total C_{18} fatty acids	24.48	27.49	44.17
C_{16}/C_{18}	2.57	1.04	0.57
% saturated fatty acids	71.55	51.85	59.69
% unsaturated fatty acids	21.75	20.16	24.31
S.F.A./U.S.F.A. ratio	3.29	2.57	2.46

Table 5. The USU/SUS ratio for lard; buffalo butter and cow butter.

Sample	USU/SUS
Lard	23.31
buffalo butter	0.28
cow butter	1.62

Table 6. Palmitic acid enrichment factor for standard mixtures of lard and buffalo butter.

Fat mixture (w/w) Lard %	buffalo butter %	Palmitic acid in B.MG	Palmitic acid in T.G.	Factor
3	97	29.11	22.31	1.30
6	94	31.92	23.04	1.39
9	91	37.09	23.22	1.60
12	88	40.13	23.92	1.68
15	85	42.68	24.37	1.75

Table 7. Palmitic acid enrichment factor for standard mixtures of lard and cow butter.

Fat mixture (w/w) Lard %	buffalo butter %	Palmitic acid in B.MG	Palmitic acid in T.G.	Factor
3	97	26.31	22.76	1.16
6	94	26.92	22.70	1.19
9	91	32.57	23.84	1.37
12	88	33.84	24.06	1.41
15	85	35.76	24.92	1.43

Table 8. The unsaturation ratio of standard mixtures of lard and buffalo butter.

Source of fat	3%	6%	9%	12%	15%
% unsaturated fatty acids in T.G.	26.33	29.22	31.82	34.73	40.71
% unsaturated fatty acids in B-MG.	21.24	22.92	22.70	23.78	24.23
Ratio	0.81	0.78	0.71	0.68	0.60

Table 9. The unsaturation ratio of standard mixtures of lard and cow butter.

Source of fat	3%	6%	9%	12%	15%
% unsaturated fatty acids in T.G.	23.07	23.43	24.51	27.83	28.82
% unsaturated fatty acids in B-MG.	24.38	24.35	24.69	24.01	22.95
Ratio	1.06	1.04	1.01	0.86	0.80

Table 10. Total C_{16}/C_{18} fatty acids ratio and S.F.A./U.S.F.A. for standard mixtures of lard and buffalo butter in B-monoglycerides.

Source of fat	3%	6%	9%	12%	15%
% Total C_{16} fatty acids	29.11	33.27	38.52	42.49	45.39
% Total C_{18} fatty acids	27.84	30.02	30.24	31.03	32.24
C_{16}/C_{18}	1.05	1.11	1.27	1.37	1.41
% saturated fatty acids	54.72	57.72	61.14	64.24	65.81
% unsaturated fatty acids	21.24	22.92	22.70	23.78	24.23
Ratio	2.58	2.60	2.69	2.70	2.72

Table 11. Total C_{16}/C_{18} fatty acids ratio and S.F.A./U.S.F.A. for standard mixtures of lard and cow butter in B-monoglycerides.

Source of fat	3%	6%	9%	12%	15%
% Total C_{16} fatty acids	26.40	27.15	33.16	35.45	38.23
% Total C_{18} fatty	44.03	43.66	43.47	39.97	35.66
C_{16}/C_{18}	0.60	0.62	0.76	0.89	1.07
% saturated fatty acids	62.06	62.25	67.35	65.72	65.40
% unsaturated fatty acids	24.38	24.35	24.69	24.01	22.95
Ratio	2.55	2.56	2.73	2.74	2.85

Furthermore, from the present data it is evident that lard is easly detectable if it is present as contaminant at the rate of 3% or more in buffalo or cow butter.

Moreover, the addition of lard to buffalo or cow butter resulted in a rather slight increase in the C_{16}/C_{18} fatty acids and saturated/unsaturated fatty acids ratios (Tables 10 and 11). This may be due to the relatively high and the markedly low corresponding ratios in lard, buffalo and cow butters, respectively (Rashwan, 1986).

Further, the data given in tables (12 and 13) revealed that the USU/SUS ratio increased as lard percentage was elevated. This may be attributed to the very high values of USU/SUS ratio for lard.

In conclusion, the palmitic acid enrichment factor; unsaturation ratio; total C_{16}/Total C_{18} fatty acids; saturated/unsaturated fatty acids and USU/SUS ratio could be recommended as a reliable criteria for lard contamination in buffalo and cow butters.

Table 12. The USU/SUS ratio for standard mixtures of lard and buffalo butter.

Fat mixtures (w/w)		USU/SUS
Lard %	buffalo butter %	
3	97	0.64
6	94	0.78
9	91	1.45
12	88	1.95
15	85	3.00

Table 13. The USU/SUS ratio for standard mixture of lard and cow butter.

Fat mixtures (w/w)		USU/SUS
Lard %	cow butter %	
3	97	1.87
6	94	2.71
9	91	3.85
12	88	3.91
15	85	4.14

REFERENCES

Abou-Arab, A.A. (1980): Identification of the sort of fats and oils in different foods. M.Sc. Thesis, Food Science Dept., Faculty of Agric., Ain Shams University (1980).

Bracco, U. and Winter, H. (1976). Analytical characterisation of mixed animal fats. Revue Francaise des Corps Grass 23 (2) 87-93. (1976).

Carisano, A.; and Riva, M. (1976). Metodo cromatografica per rivelare le sofisticaziani del burro. Riv. Ital Sostanze Grasse, 53 (8), 297-300 (1976), Italy.

Dister, E., and Baur, F.J. (1965): The determination of mono; di- and triglycerides concentrates by column chromatography. J. Assoc. Offic. Agric. Chemists 48, 2; (444-448), 1965.

El-Dashlouty, A.A. (1978). Studies on the quality of some meat products. Ph.D. Thesis, Faculty of Agric. Ain Shams University, Egypt.

FAO, (1978). Dietary fats and oils in human nutrition. Food and Agriculture Organization of the united nations, and the world health organization. Rome, 1978.

Farag, R.S.; Abd El-Samad, A. and El-Rafey, H.H.A. (1980). Detection of lard and shortening adulteration in pure buffalo and cow ghee. Research Bulletin No. 1283, Faculty of Agric., Ain Shams Univ., 23 pp. (1980), Cairo, Egypt.

Farag, R.S.; Ahmed, F.A.; Shihata, A.A.; Abo-Raya, S.H.; and Abd-alla, A.F. (1982). Use of unsaponifiable matter for detection of ghee adulteration with other fats. J. AOCS, Vol. 59, No.2. (1982).

Folch, J.; Lees M. and Stanley, G.H.S. (1957). J. Biol. Chem., 226, 497 (1957).

Lambelet, P. (1983). Detection of pig and Buffalo body fat in cow and buffalo ghees by Differential Scanning Calorimetry. J. AOCS. Vol. 60, No. 5, (1983).

Nour-El-Din, H.; Soliman, A.; Ashour, F. and Bayoumy, A. (1984). Chemical composition of Pork and mutton in Egypt. Proceedings of the European meeting of meat research workers (1984), 3:29 (149-151).

Rashwan, M.R.A., (1986). Studies on the detection and evaluation of lard in some food products. Ph.D. Thesis, Faculty of Agric., Assiut Univ., Egypt.

Tsatsaronis, G.C. and Boskou, D. (1972). Chem. Chrom., Genike Ekdosis 37, 57.

Rossell, J.B.; Russell, J. and Chidley, L.E. (1978): Glyceride analysis of commercial fats by lipase hydrolysis. J. American Oil Chemists' Society 55, (902-903), 1978.

Rossell, J.B.; King, B. and Downes, M.J. (1983). Detection of adulteration. J. American Oil Chemists' Society. Vol. 60, (333-339), 1983.

Vander Wall, R.J. (1960). Calculation of the distribution of the saturated and unsaturated acylgroups in fats from pancereatic lipase hydrolysis data. J. AOCS, 37, (18-20).

Ways, P. and Hanahan D.J., (1964): J. Lipid Res., 5, 318 (1964).

Youssef, M.K.E.; Omar, M.B.E.. Skulberg, A. and Rashwan, M. (1986 a). Estimation of lard in beef tallow by gas liquid chromatography. 32nd European Congress of Meat Research workers, 1986, Ghent, Belgiam, 24-29 August, 1986.

Youssef, M.K.E.; Omar, M.B.E., Skulberg, A. and Rashwan, M. (1986 b). Lipolysis and fractionation of triglycerides by Argentation-TLC in lard and beef tallow mixtures 32nd European Congress of Meat Research Workers, 1986, Ghent, Belgium, 24-29 August, 1986.