MAJOR FATTY ACID COMPOSITION OF COMMERCIAL SEMI-SWEET BISCUIT

[1]Hasmadi Mamat, [1]Mansoor Abdul Hamid, & [2]Sandra E. Hill

[1]Food Technology & Bioprocess Program, School of Food Science & Nutrition, Universiti Malaysia Sabah, 88400 Kota Kinabalu, Sabah, Malaysia.
[2]Food Sciences Division, School of Biosciences, Sutton Bonington Campus, University of Nottingham, Loughborough, Leicestershire, LE12 5RD, United Kingdom.

ABSTRACT. *Total fat contents, fatty acid composition and percentages of saturated (SFA), mono-unsaturated (MUFA) and poly-unsaturated (PUFA) fatty acid were analyzed in ten commercial semi sweet (rich tea type) biscuits using gas chromatography mass spectrometry (GC/MS). Total fat content determined was slightly different with the fat content declared by the manufacturer. Major fatty acids present were palmitic, oleic and linoleic acids. Stearic and myristic fatty acids were also detected but with lower proportion (below 1.5 %). The results obtained show a great variance in the percentages of fatty acids (g/100 g total fatty acids). From the different brands of semi-sweet biscuit, four of the samples contained a high proportion of saturated fatty acids and six samples contained a high proportion of unsaturated fatty acid.*

KEYWORDS. Rich tea biscuit, fatty acid composition, fat extraction, GC/MS, saturated fatty acid, unsaturated fatty acid.

INTRODUCTION

Shortening is a semi solid fat at room temperature used in nearly all bakery products. Vegetable shortening is an essential ingredient and the largest component after flour and sugar in biscuit production. It's the principle ingredient responsible for tenderness, keeping quality, grain and texture and it adds a rich quality to cookies (O'Brien *et al.*, 2003). Fat interacts with other ingredients to develop and mould texture, mouth feel and overall sensation of smoothness of the product (Giese, 1996; Stauffer, 1998). Fat also influences the rheological properties of cookie dough (Jacob & Leelavathi, 2007).

There are two basic types of fatty acid: saturated and unsaturated (mono-unsaturated and poly-unsaturated). Research shows that high intake of saturated fat contributes to the development of coronary heart disease. A high intake of fat of all types, but particularly saturated fat, can increase the amount of cholesterol produced in the liver, and so the amount in the blood (German & Dillard, 2004). A high level of cholesterol in the blood is associated with increased risk of coronary heart disease (Hu *et al.*, 2001).

Biscuits are one of the major sources of fats in our daily diet (Volatier & Verger, 1999). It was reported that the average amount of fat intake in United Kingdom was 98 g of which37 g were saturated (Office for National Statistics, 2008). Rich tea is a type of circular semi-sweet biscuit very popular in the United Kingdom, where their plain flavour and consistency make them particularly suitable for dunking in tea and coffee. The objectives of this study were to determine the amount of saturated and unsaturated fatty acid and to investigate the major fatty acids present in the commercial semi-sweet biscuit.

MATERIALS AND METHODS

Sampling

Ten samples of commercial semi-sweet biscuit brands commonly available were purchased from various supermarkets in the United Kingdom. They were divided into two main groups based on fat content: normal rich tea biscuits and fat reduced rich tea biscuits. Normal rich tea biscuits were A, B, C, E, F, G and I; while reduced fat rich tea biscuits were D, H and J. The information provided on the packaging indicated that the most utilized fats were refined vegetable oils. Only in two cases did the label report the use of palm (samples B and C) and one case reported the use of hydrogenated oil (sample F) (Table 1). From each brand, several samples were bought which were from different batches and were randomly selected for the experiments performed.

Table 1. List of samples and types of fat used in the biscuit production.

Brand	Type of fat
A	Vegetable oil
B	Vegetable oil (palm, rapeseed)
C	Vegetable oil
D	Vegetable oil
E	Vegetable oil
F	Vegetable oil and hydrogenated oil
G	Vegetable oil
H	Vegetable oil (palm, rapeseed)
I	Vegetable oil
J	Vegetable oil

Fat extraction

A total of 200.0 ± 1.0 mg of sample was weighed into a vial. Then, 500 μL of iso-octane was added to the sample and shaken vigorously with Mini Beader Beater (speed of 48 was used to get optimum fat extraction) for 30 sec. The sample was then centrifuged at 13,000 rpm for 5 minutes. After that, the upper solution was pipetted out into a weighed bottle. Solvent was added to the vial and the extraction repeated twice more. The solvent was removed by drying the upper solution collected using nitrogen gas for 4 hours. The bottle containing lipid was weighed and total lipid content (%) then calculated (Carvalho & Malcata, 2005).

Preparation of fatty acid methyl ester (FAMEs)

Extracted oil was dissolved in chloroform to a concentration of 10 mg/mL (i.e. 0.01g lipid mixed with 1.0 ml chloroform). For every 1.0 ml of sample, 200 μL of trimethylsulfonium hydroxide (TMSH) was added. After waiting for at least 10 min. (to allow the fatty acids to convert to methyl esters), 2.0 μL was injected into the GC/MS.

Determination of fatty acid composition

Fatty acid analysis on GC/MS was performed using a CTS Analytics PAL system auto sampler and a DSQ and TRACE GC Ultra (Thermo Electron Corporation). The sample was injected into the SSL injector (split flow 50 mL min^{-1}) at a temperature of 250 ˚C. Compounds were separated using a polyethylene glycol (BP20 ID 0.22 mm × 25 m) gas chromatography column (Milton Keynes, UK) with 30 mL min-1 nitrogen. Oven temperatures were controlled at 120 ˚C (1 min) then ramped (5 ˚C min^{-1}) to 260 ˚C.

Identification of chromatographic peaks was carried out by comparison of their retention times using appropriate standards of fatty acid methyl esters (Merck, Sigma) (Carvalho & Malcata, 2005).

Statistical analysis

Mean and standard deviation were calculated for each measurement where applicable.

RESULTS AND DISCUSSION

A fatty acid chromatogram for the fat fraction of commercial semi-sweet biscuit is shown in Figure 2 (with peak identification). The chromatogram shows that five types of fatty acids were present; myristic, palmitic, stearic, oleic and linoleic acids. Other fatty acids might be present but at low intensity. Table 1 shows the total fat contents as measured in the laboratory and average fatty acid composition expressed in g/100 g total fatty acids. The measured total fat content ranged from 9.4 – 15.0 % while the total fat content as declared by the manufacturer ranged from 9.9 – 16.8 %. The total fat contents of normal fat rich tea biscuits ranged from 11.9 – 19.0 % while reduced fat rich tea biscuits ranged from 9.4 – 12.3 %.

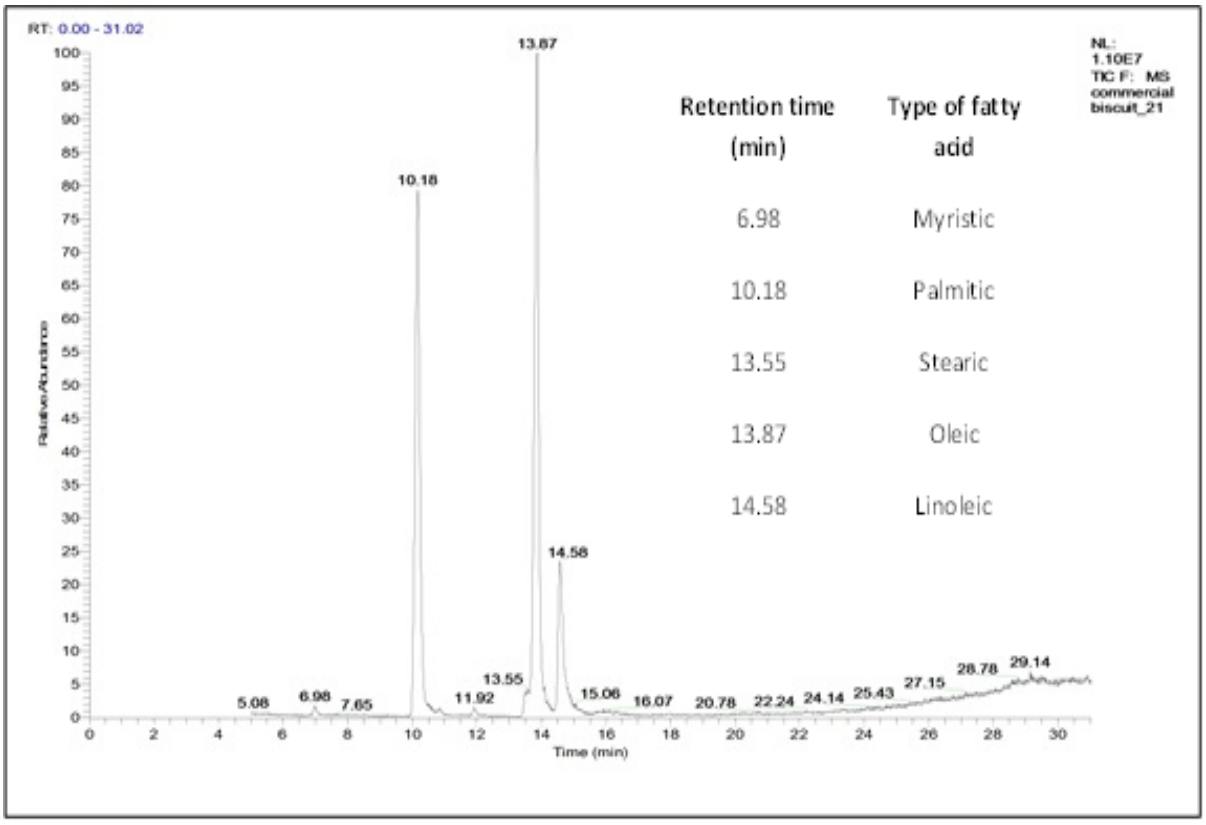

Figure 2. GC/MS chromatogram of fatty acids of the fat fraction of commercial semi-sweet biscuits.

Table 2. Total of fat content and fatty acids composition of commercial semi-sweet biscuit.

Brand/ Oil	Measured[a] (%)	Declared by manufacturer	Myristic[a] C14:0	Palmitic[a] C16:0	Stearic[a] C18:0	Oleic[a] C18:1	Linoleic[a] C18:2
A	14.90 ± 0.20	15.40	0.72± 0.06	43.02± 0.98	0.91± 0.11	45.69± 0.78	9.68± 0.24
B	15.40±0.20	14.00	0.80± 0.08	43.41± 0.50	0.96± 0.11	45.71± 0.24	9.11± 0.31
C	15.80± 0.30	15.50	0.79± 0.11	49.55± 0.54	1.29± 0.11	40.62± 0.23	7.75± 0.54
D	9.70± 0.10	11.20	0.84± 0.07	49.62± 0.26	1.08± 0.07	38.93± 0.18	9.54± 0.31
E	14.10± 0.20	15.70	0.72± 0.04	40.72± 0.94	1.12± 0.16	48.06± 0.19	9.40± 0.55
F	14.50± 0.30	16.80	1.17±0.06	52.60± 0.66	1.00± 0.02	39.21± 0.21	6.04± 0.34
G	14.70± 0.90	13.40	0.87± 0.16	51.03± 0.72	0.89± 0.01	39.80 ± 0.75	7.42± 0.13
H	9.50± 0.00	9.90	0.63± 0.04	42.69± 0.03	1.06± 0.04	43.68± 1.16	11.94± 1.06
I	14.70± 0.20	15.20	0.72± 0.01	44.23± 0.71	0.73± 0.17	46.00± 0.04	8.34± 0.57
J	9.30± 0.80	10.50	0.55± 0.04	41.84± 0.10	0.83± 0.15	46.10± 0.40	10.70± 0.11

[a]Each value is an average of two replications

The most abundant fatty acids present in the commercial semi-sweet biscuit were palmitic, followed by oleic and linoleic acids. Palmitic, oleic and linoleic acids ranged from 40.72 - 52.60, 39.80 – 48.06 and 6.04 – 11.94 %, respectively. Stearic and myristic acids were also present but with lower percentages (below 1.5 %). The high amount of C16: 0 found in sample F (52.60%) was due to the use of hydrogenated oil in the dough, and sample H had a high amount of C18:2 due to the use of rapeseed oil in the dough, as declared on the label by the manufacturer. It is believed that the main source of fat for biscuit production was palm oil with additional rapeseed oil because of the high percentage of palmitic, linoleic and linolenic acid presented as measured in the sample. No linolenic acid was detected in this measurement showing that less rapeseed oil might be used. Caponio *et al.*, (2006) reported that the amount of linolenic acid (C18: 3) was as low as 0.29 % in Italian biscuits.

Palm oil is frequently used in the production of bakery products (Nor Aini & Miskandar, 2007). Palm oil contains an equal amount of unsaturated and saturated fatty acids; this property is unique among vegetable oils and fats. Palm oil contains palmitic acid, the main saturated fatty acid that naturally crystallisesinto β' crystals (Ghotra *et al.*, 2002; Narine & Marangoni, 1999), a small crystal that imparts a smooth texture to the fat. The β' crystals of palm are stable thus extending the shelf life of the finished food with its aerated form and soft texture. It is a stable oil since the level of linoleic acid is low and it has virtually no linolenic acid. This again contributes to the stability of the finished product. Palm oil also has a high melting point and solid fat content while the other liquid oils have to be hydrogenated to meet the requirements and palm oil requires no further modification or chemical processing (Timms, 1985).

Table 3 shows the percentages of saturated, mono-unsaturated and poly-unsaturated fatty acids present in the biscuits. SFA represented 47.64 % of the total, as a mean (range: 42.55 – 51.63 %, SD = 4.51), followed by MUFA, with a mean level of 43.38 % (range: 39.21 45.71 %, SD = 3.41) and PUFA with a mean value of 8.99 % (range: 6.04 – 11.94 %, SD = 1.69). Mario Fernández & Juan, (2000) determined the fatty acid composition of commercial Spanish fast food and snacks by capillary gas chromatography (CGC) using a capillary column and reported that the average of SFA, MUFA and PUFA measured in biscuits were 60.4, 28.9 and 8.9 %, respectively.

Table 3. Total saturated fatty acid (SAFA), mono-unsaturated fatty acid (MUFA) and poly-unsaturated fatty acid (PUFA) present in the commercial semi-sweet biscuits.

Brand	SAFA[a]	MUFA[a]	PUFA[a]
A	44.64± 1.03	45.69± 0.78	9.68± 0.24
B	45.18± 0.43	45.71± 0.24	9.11± 0.31
C	51.63± 0.76	40.62± 0.23	7.75± 0.54
D	51.54± 0.12	38.93± 0.18	9.54± 0.31
E	42.55± 0.74	48.06± 0.19	9.40± 0.55
F	54.77± 0.57	39.21± 0.22	6.04± 0.35
G	52.79± 0.88	39.80± 0.75	7.42± 0.13
H	44.38± 0.11	43.68± 1.16	11.94± 1.06
I	45.68± 0.53	46.00± 0.04	8.34± 0.57
J	43.21± 0.28	46.10± 0.40	10.70± 0.11

[a]Each value is an average of two replications

Figure 2 shows the total amount of saturated and unsaturated fatty acid obtained from commercial semi-sweet biscuits. Results showed that four samples (C, D, F, G) contained a high proportion of saturated fatty acids and six samples (A, B, E, H, I, J) contained a high proportion of unsaturated fatty acid. Mean levels of total saturated and unsaturated fatty acid detected were 47.6 and 51.4 % respectively with the highest amount of saturated fatty acid being 54 % (sample F) and the highest unsaturated fatty acid 57 % (sample E). The biscuits contained a high amount of saturated fat contributed by palm oil and hydrogenated oil, of which palm oil contains about 50% saturated fat.

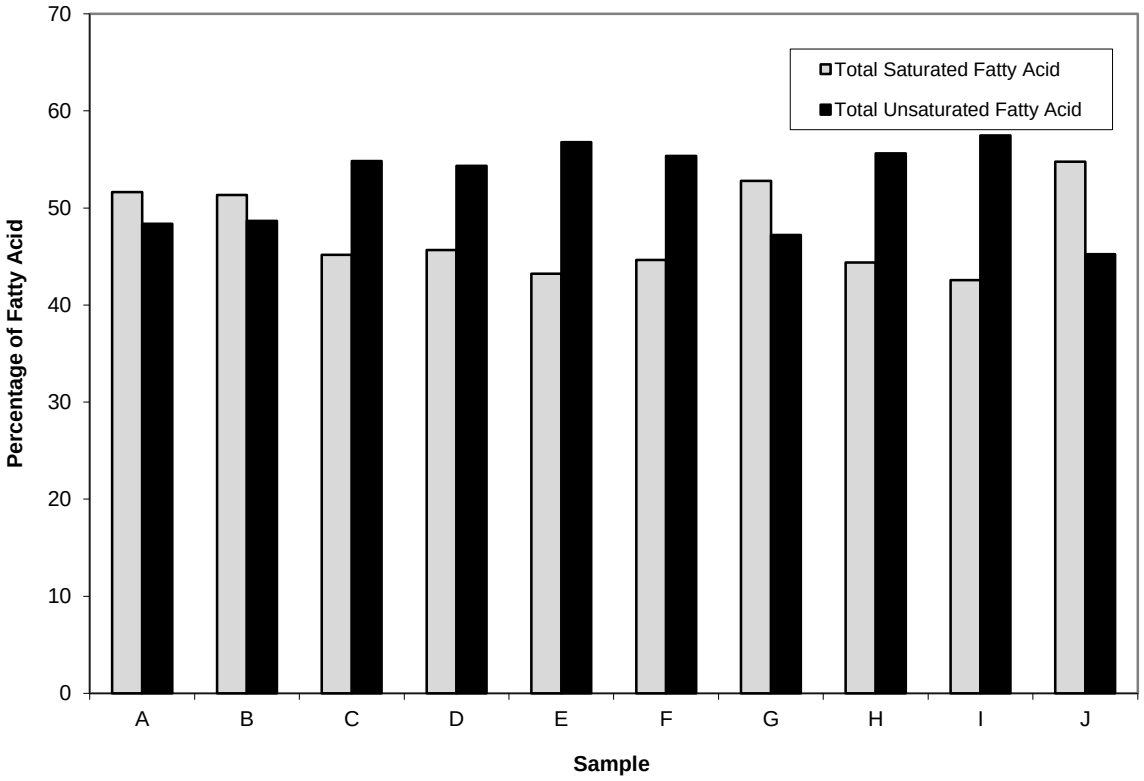

Figure 2. Total of saturated and unsaturated fatty acid present in commercial semi-sweet biscuits.

CONCLUSION

The results in the present study showed that commercial semi-sweet biscuits contain considerable amounts of fat, mainly composed of myristic, palmitic, stearic, oleic and linoleic acids. The major fatty acids were palmitic, oleic and linoleic, while myristic and stearic acids were detected at lower intensity (below 1.5 %). Unsaturated fatty acid (MUFA and PUFA) were the most represented among the fatty acids with values higher than 50% of the total fat.

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