INVESTIGACION

Influence of microwave heating on the stability of processed samn.

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RESUMEN

Influencia del calentamiento en microonda sobre la estabilidad de elaborado de "samn".

Mantequilla fue transformada en samn por calentamiento en microonda y convencional. La calidad del elaborado de samn por los dos métodos fue seguida mediante determinación de los índices de acidez, peróxido y TBA durante un período de seis semanas a 60ºC. La composición en ácidos grasos de muestras de samn fue determinada por técnica cromatográfica gas-líquido. Los datos mostraron que la conversión de mantequilla a samn por calentamiento en microonda fue realizada en aproximadamente una vez y media el tiempo que exige el calentamiento convencional. El calentamiento en microonda, evidentemente, aumentó el desarrollo de la rancidez del samn comparado con el calentamiento convencional.

Los parámetros usados para la medida de la rancidez lipídica indicaron que la causa principal de la rancidez del samn bajo las condiciones presentes es un mecanismo de oxidación.

PALABRAS-CLAVE: Calentamiento convencional - Calentamiento en microonda - Estabilidad - Samn.

SUMMARY

Influence of microwave heating on the stability of processed samn.

Butter was converted to samn by microwave and conventional heating. The quality of the processed samn by the two methods was followed by determining the acid, peroxide and TBA values over a period of six weeks at 60ºC. The fatty acid composition of samn samples was determined by gas-liquid chromatographic technique. The data show that butter conversion to samn by microwave heating was accomplished in about one half of the time that conventional heating requires. Microwave heating obviously increased the development of samn rancidity compared with the conventional heating. The parameters used for measuring lipid rancidity indicated that the main cause of samn rancidity under the present conditions is an oxidation mechanism.

KEY-WORDS: Conventional heating - Microwave heating - Samn - Stability.

1. INTRODUCTION

Microwaves are transmitted through a magnetic field and used as a source of heat. Microwaves are used in the food industry not only for thawing, drying and baking (Rosenberg and Bogl, 1987) but for other applications such as pasteurization and sterilization of many tipes of foods (Dunajski and Stecki, 1971; Ayoub **et al**. 1974; Foley and Buckley 1978; Bogucki 1981; Enami and Ikeda 1982). Moreover, short-time microwave heating of peanuts yielded a 95% reduction of the aflatoxin content without measurable changes in the protein and lipid concentrations (Luter **et al**. 1982). In addition, the microwave energy was sufficient to inactivate the enzymes such as phosphatase during milk pasteurization (Merin and Rosenthal 1984) and alpha amylase of the flour or the dough (Aref **et al.** 1972). Microwave heating of dairy products has been reported for melting of cheese and chocolate blocks or coating (Mohr and Hanne 1981), plastification of curds in the production of certain types of cheese (Bottazzi and Battistotti 1976) and manufacturing of anhydrous milk fat (Mann 1983).

Nowadays microwave ovens are becoming widely used in different countries. Recently, there has been some discussion about the safety of these ovens for food cooking. The objective of the present work was to prepare samn (the common fatty product used for cooking in Egypt) from butter by two methods, i.e., the conventional and microwave heating taking into account the time needed for samn processing by the two methods. One cannot ignore that the microwave heating method would considerably minimize the survival of the associated micro-organisms and consequently increase the shelf-life of lipid materials. Hence, the keeping quality of samn produced by microwave heating was evaluated and compared with that produced by the conventional method.

2. MATERIALS AND METHODS

2.1. Butter

Commercial unsalted butter (Kerry Gold, a product of the Republic of Ireland) was obtained from an Egyptian supermarket.

2.2. Samn processing

Microwave oven used for converting butter into samn was Moulinex electronic Type 823. The frequency

and wattage given for the oven are the power input requirements, not the microwave output. Three 500 ml glass beakers containing ca 250 g butter each was placed on a turn table which slowly rotated the butter samples to obtain uniform heating. Comparative experiment using conventional heating was conducted using gas cooker with stirring (Fahmi 1961). The samn samples obtained by the two methods were transferred into six sterile glass bottles (250 ml) and placed in an incubator adjusted at 60°C ± 1°C to accelerate the auto-oxidation of samn (Thampson 1960). Samples were removed at intervals and subjected to chemical analyses.

2.3. Measurements of samn rancidity

The rancidity of samn was followed by determining the acid peroxide values according to A.O.A.C. (1975) and TBA value as mentioned by Ottolenghi (1959). The measurements of samn rancidity was terminated (6 weeks) when an objectionable odor was obviously noticed. All samples were analysed in triplicate and the mean values were tabulated.

2.4. Standard fatty acids

A set of standard fatty acids of $C_{6:0}$, $C_{7:0}$, $C_{8:0}$, $C_{9:0}$, $C_{10:0}$, $C_{11:0}$, $C_{12:0}$, $C_{13:0}$, $C_{14:0}$, $C_{14:1}$, $C_{15:0}$, $C_{16:0}$, $C_{16:1}$, $C_{17:0}$, $C_{18:0}$, $C_{18:1}$, $C_{18:2}$, $C_{18:3}$ and $C_{20:0}$ with a stated purity of 99% by GLC was purchased from Sigma Chemical Company (St. Louis, MO 63178, U.S.A.).

2.5. Separation and preparation of butter and samn fatty acid methyl esters

Butter and samn samples were saponified with aqueous KOH (20%, w/v) overnight. The unsaponifiables were extracted three times with ether and discarded. The soap solution was acidified with sulfuric acid (20%, v/v) and the liberated fatty acids were extracted three times with ether. The combined ether extract was washed several times with distilled water and dried over anhydrous sodium sulfate. The fatty acids were methylated by diazomethane ethereal solution and the solvent was evaporated off. The methyl esters of the fatty acids were dissolved in chloroform and aliquots of this solution was subjected to gas liquid chromatographic analysis.

2.6. Fractionation and determination of butter and samn fatty acid methyl esters

A GCV Pye Unicam gas liquid chromatograph equipped with dual flame ionization detector and dual channel recorder was used for determining butter and samn fatty acid composition. The fractionation of fatty acid methyl esters was conducted using a coiled glass column (1.5 m x 4 mm O.D.) packed with Diatomite C (100-120 mesh) and coated with 10% Polyethylene glycol adipate (PEGA). The column oven temperature was programmed at 8°C/min from 70°C to 190°C, then isothermally at 190°C for 20 min with nitrogen at 30 ml/min as a carrier gas. The flow rates for hydrogen and air were 33 ml/min and 330 ml/min, respectively. Detector and injector temperatures were 220°C and 300°C, respectively. Peaks identification and quantification were performed by using a PU 4810 computing integrator.

2.7. Statistical analysis

The data for acid, peroxide and TBA values were statistically analysed using the split desing (Snedecor 1976).

3. RESULTS AND DISCUSSION

In the present study, an equal amounts of butter (0.5 kg) were converted to samn by conventional and microwave heating. The time required for samn processing was 23 min and 12 min, respectively. This means that butter conversion to samn was accomplished in about one-half of the time that conventional heating requires.

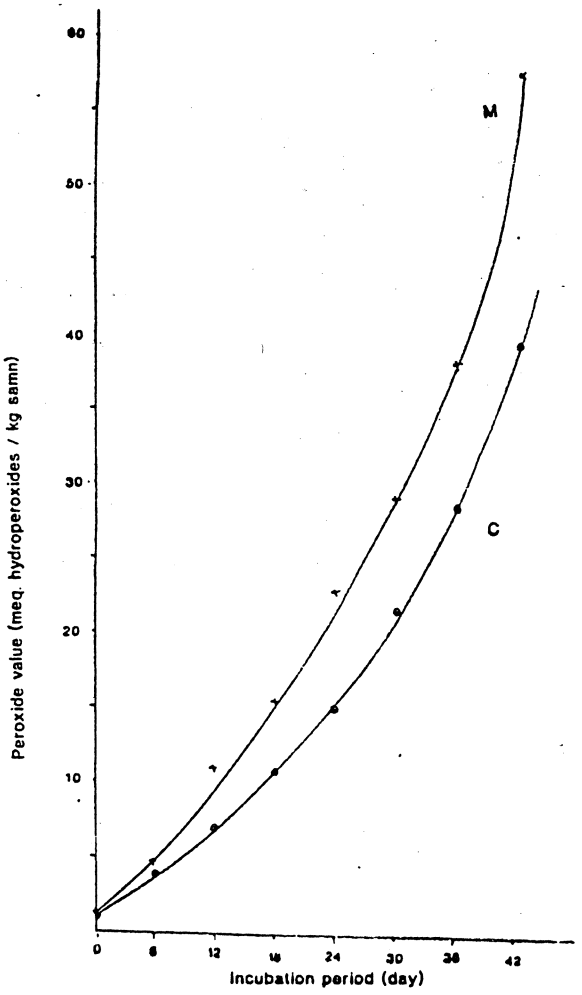

Figure 1
Peroxide values for Samn produced from butter by conventional (C) and microwave (M) heating.

Fig. 1 shows the peroxide value of samn samples incubated at 60°C for 6 weeks. In general, the effect of heating on samn oxidation has shown a feature of an autocatalytic chain reaction. This means that the increase in the rate of hydroperoxide formation with time is typical of an autocatalytic oxidation reaction and the secondary products are necessary to catalyse samn oxidation. The induction periods for samn produced from butter by conventional and microwave heating were 22 and 17 days, respectively. Consequently, the hydroperoxide results reflect the considerable influence of microwave heating on samn.

One would explain the increase of the development of samn rancidity due to application of microwave heating as follows. The major primary reaction in lipid oxidation is known to involve hydroperoxidation of the methylene group adjacent to the unsaturated centres and to occur by a free radical chain process. This reaction can be accelerated by irradiation or by raising the temperature. It is well known that microwave treatment is more energy efficient than conventional heating method (Merin and Rosenthal 1984). Consequently, microwave heating facilitates the abstraction of hydrogen atom from the active methylene

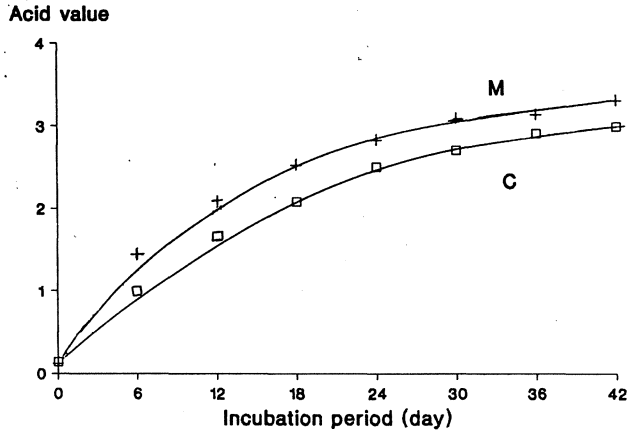

Figure 2
Acid values for Samn produced from butter by conventional (C) and microwave (M) heating.

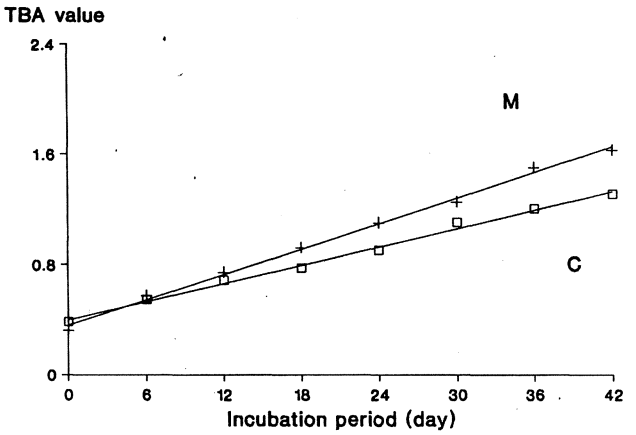

Figure 3
TBA values for Samn produced from butter by conventional (C) and microwave (M) heating.

Table I
Statistical treatment of acid, peroxide and thiobarbituric acid (TBA) values for processed samn.

Parameter	Incubation period (days)							
	Zero	6	12	18	24	30	36	42
			Conventional heating					
Acid value	0.13 a	0.85 b	1.75 bc	2.07 bd	2.49 be	2.69 be	2.89be	2.97 be
Peroxide value	0.50 a	4.00 b	7.00 c	10.80 d	15.00 e	21.90 f	28.90 g	40.00 h
TBA Value	0.38 a	0.54 b	0.68 c	0.77 d	0.90 e	1.10 f	1.20 g	1.30 h
			Microwave heating					
Acid value	0.12 a	1.28 b	2.02 bc	2.52 bd	2.82 be	3.08 be	3.12 be	3.29 be
Peroxide value	0.70 a	4.30 b	11.10 c	15.60 d	23.00 e	29.40 f	38.50g	58.00 h
TBA value	0.32 a	0.57 b	0.74 c	0.92 d	1.10 e	1.25 f	1.50 g	1.62 h

L.S.D. (0.05) values for acid, peroxide and TBA values between various experimental periods irrespective of heating method were 0.28, 1.08 and 0.09, respectively.
Numbers in the row followed by the same letter are not significantly different at p=0.01.

group of the unsaturated fatty acids. The resultant free radical can easily and rapidly react with atmospheric oxygen to produce hydroperoxides. Hence, microwave treatment shortened the induction period and decreased samn stability.

Figs. 2 and 3 show the acid and TBA values for samn obtained from butter by the two methods during incubation. The results of the acid values for both samn samples were very low and gradually increased with storage. However, the acid values of the microwaved samn fall on a smooth curve which lies above converging curve representing the acid values for samn produced by the conventional treatment (Fig. 2). The TBA values in samn, which indicate the formation of the secondary products, were linearly increased with storage in both samn samples.

Table I shows the statistical treatment of acid, peroxide and thiobarbituric acid (TBA) values for processed samn.

In order to compare the secondary oxidation rates of samn produced by the two methods, a TBA value of 0.8 was chosen and the periods required to attain this value were calculated from Fig. 3. This value was achieved after 14 and 18 days for microwave and conventional samn, respectively. Therefore, the secondary oxidation rate for microwaved samn was obviously greater than in conventionally heated samn. It is well established that there are two consecutive reactions in the course of lipid oxidation, i.e., the formation of hydroperoxides and the production of secondary products. The higher TBA values for microwaved samn would be due to the fact that the first reaction occurred much faster than in conventionally heated samn. Looking at the data for peroxide, TBA and acid values, one would emphasize that the main cause of samn rancidity under the experimental conditions is an oxidation mechanism. Generally speaking, the application of microwave ovens for heating and cooking foods and in particular with those rich in lipids should be discontinued since the results of the present work illustrate that the microwave heating enhanced samn oxidation.

Fatty acid composition

This analysis was conducted to see if any changes might take place on the fatty acid patterns of the samn samples processed by microwave and conventional heating. Table II shows the fatty acid composition of butter and processed samn by the two methods immediately and after six weeks. For simplicity, the fatty acid constituents of butter and samn samples were divided into three Categories, i.e., trace (<1%),

Table II
Fatty acid composition (%) of butter and samn obtained by conventional and microwave heating.

Fatty acid	Butter	Incubation Period (week)			
		Zero	6	Zero	6
		Conventional heating		Microwave heating	
8:0	0.5	—	0.1	—	—
10:0	2.4	2.2	2.1	1.9	2.0
12:0	2.9	3.7	3.8	2.8	2.0
14:0	12.4	15.5	16.5	14.9	12.1
15:0	0.6	0.2	0.4	0.6	0.7
15:1	0.8	0.9	0.5	1.1	0.7
16:0	32.7	34.6	34.6	34.8	37.5
16:1	0.2	0.6	0.5	0.6	0.4
17:0	0.6	—	0.1	—	—
18:0	12.1	8.7	8.0	9.1	8.5
18:1	30.2	29.5	30.4	28.6	33.5
18:2	4.6	4.1	3.0	4.5	2.7

minor (<10% – >1%) and major (>10%) components. Butter contained myristic (14:0), palmitic (16:0), stearic (18:0) and oleic (18:1) acids as major substances. The pairs 14:0/18:0 and 16:0/18:1 were nearly present in an equimolar ratio. The acids 10:0, 12:0 and 18:2 occurred as minor components whereas 8:0, 15:0, 15:1, 16:1 and 17:0 were present as trace materials. The data for samn fatty acids obtained by microwave and conventional heating were comparatively the same. This means that the levels of total saturated, unsaturated and volatile fatty acids for butter and samn samples were nearly the same. These results lead one to expect that the two heating methods had no effect on the fatty acid pattern. However, under the GLC experimental conditions of this work, the acids containing hydroperoxide groups either do not emerge from the column due to hydrophilic association of the polar packed material (PEGA) and hydroperoxidic acids (polar substances) or it may emerge from GLC column with the same retention times as with the acids having the same carbon atoms without hydroperoxide groups.

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