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EXAMINATION OF THE CORRELATION OF BUTTER SPREADABILITY AND ITS FAT CONFORMATION BY DSC

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Since the appearance of margarines and spreads on the market, they have been serious competitors with butter. One of the reasons for this was the false nutritional propaganda, but today butterfat has scientifically regained its actual nutritional evaluation. The main disadvantage of butter in comparison to other spreadable tallow is that it does not immediately spread as well when taken out of the refrigerator. One method of obtaining better cold-spreadability is appropriate cream ripening in which a different system known as the corpuscular colloid is created.

Recent examinations were conducted during the winter, when the problem of spreadability of butter is the greatest. Simple cold ripening in accordance with the method used in our earlier EPR studies ripened the cream, and by heat-step ripening, then butter was produced from these materials. By deconvolutional analysis of the DSC curves it was established that butter made from the cream ripened by the heat-step method had three characteristic melting peaks as distinct from the two melting peaks of butter made from cold-ripened cream, and the temperature of the second melting peak for butter from heat-step cream was identical to the characteristic melting temperature for fat particles from earlier EPR spectroscope assays. In sum it can be stated that the DSC method clearly shows both the homogeneous and the particle structure characteristic of butter.

Keywords: *butter, cold-spreadability, DSC, EPR, heat-step ripening*

Introduction

Since the appearance of margarines and spreads on the market, they have been serious competitors with butter. Decades ago this process was significantly promoted by the nutritional propaganda. This based on the lipid theory, according to which the high cholesterol and saturated fatty acid content of animal fats were blamed for causing human arteriosclerosis and the consequent high blood pressure and finally cerebral catastrophe and heart attack [1, 2]. Despite of the fact that the science disproved the lipid-theory, moreover gave back the real nutritional value to the butter contrary to the ‘artificial fat’ margarines [3, 4], in the 1990’s the advertisements still suggested the opposite of this in Hungary [5, 6].

However, the real disadvantage of the butter is its cold hardly spreadable consistency. It is especially true in Hungary, as here mainly fresh (soft) white bread is consumed on which after taking out of the refrigerator margarines can and butter can not be spread easily [7].

In order to improve the spreadability of butter made of cream of a given fatty acid composition basically two methods are available, i.e. the heat-step cream ripening [8–10] and the enrichment with a low melting point milk fat fraction [11–13].

In our experiments we wanted to investigate the liquid/solid fat ratio depending on the temperature [8, 14]. Previously it was measured by EPR spectroscopic method elaborated in our institute [15] now we have followed the melting of butterfat by DSC method [9]. We also looked for further evidences that the texture of butter is determined by its structure (whether it is homogeneous or corpuscular) [14].

Experimental

Materials and methods

Dairy materials and technology

For the experiments cream of winter period was used made from raw milk. It was pasteurized at 96°C, rapidly cooled down to 6°C, then separated to two parts and was ripened by the method of the Hungarian Dairy Research Institute [16] in such a way the ripening of one part resulted in the maximum homogeneous and that of the other part the maximum corpuscular butter structure. The first is called cold ripening and the second is heat-step ripening.

The churning was carried out by the MOHR-type whipper, and in the meantime the current consumption of the device was registered by which the churn-

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ing curves of the cream were recorded. After the churning had been finished the whipper was still operated and consequently the forming of butter grains was carried out and finally 20% water content butter was gained. Then, until the thixotropy was absolutely completed the butters were stored at 4°C for 48 h.

Consistency properties

To determine the consistency properties of butters a penetrometer was used with a normal fat cone [16]. The penetration value (*P*) was measured at 5, 10, 15 and 20°C respectively and the consistency firmness ($F=1000/P$) was determined from it. The consistency firmness was characterized by the curve of temperature-consistency firmness.

DSC measurements

In order to examine the melting and crystallization properties of butter fat measurements were carried out by a Setaram Micro DSC-II scanning calorimeter in the Biophysical Department of University Pécs. Their thermoanalytical group has an excellent skill in the investigation of thermodynamic properties of different biological macromolecules [17–22]. 700–900 mg of butters was measured into a conventional batch vessel. The reference material was ethyl alcohol of quantity identical with the butter's. We were waiting until the thermal equilibrium was reached when the fluctuation of the heat flow was below 0.5 μW. The melting and the crystallization DSC curves were recorded in temperature range of 0–50°C at 0.3 K min^{-1} heating and cooling rates, respectively.

Evaluation of thermal data

Calorimetric enthalpy was calculated using Setaram two-point setting heat flow integration. The complex DSC scans were decomposed into Gaussian functions by a deconvolution program developed in our institute [23].

Results and discussion

Figure 1 shows the churning curve of the two different creams; on Fig. 1a the churning curve of cold ripened and on Fig. 1b that of heat-step ripened cream can be seen.

The four-stage of churning can be well followed on the both curves: foam formation (I), foam settling (II), butter grain formation (III) and cohesion of butter grains (IV). Figure 1 demonstrates well that due to the heat-step ripening the churning time significantly (on average by 20–30%) decreases, and the decrease is characteristic for all the four stages of the churning.

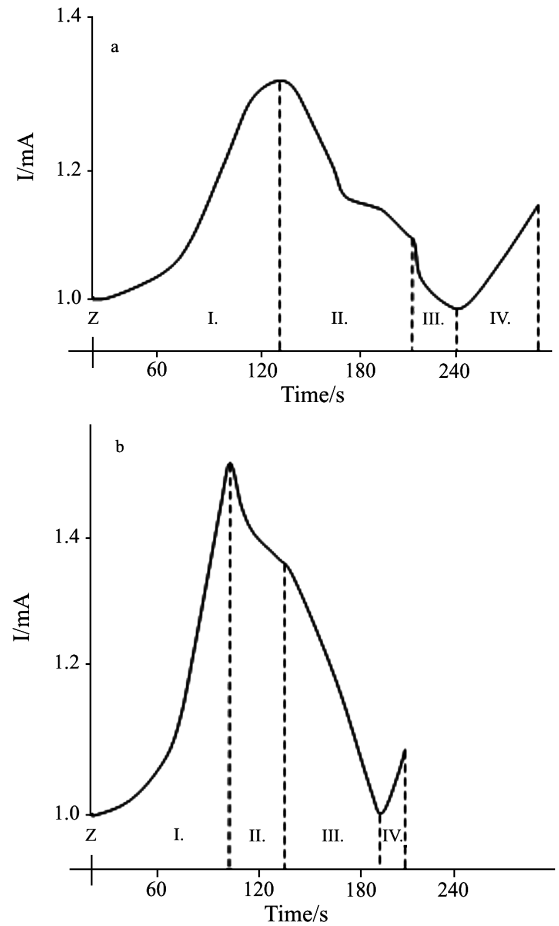

Fig. 1 Churning curves of a – cold ripened and b – heat-step ripened creams

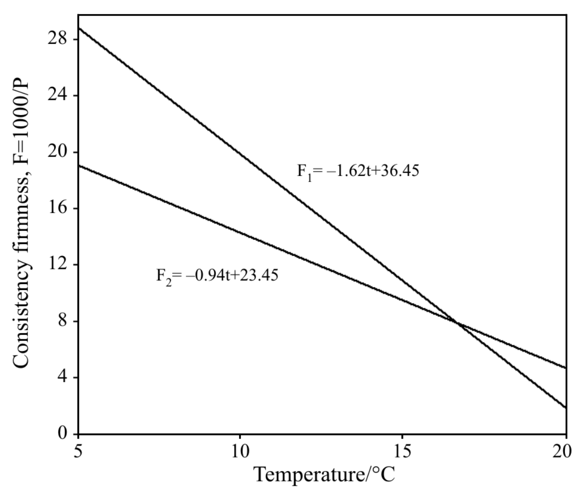

Fig. 2 Consistency firmness of butter made of 1 – cold ripened and 2 – heat-step ripened cream as a function of temperature

Figure 2 shows the change of consistency firmness of butter made of cold ripened (1) and heat-step ripened (2) cream as a function of temperature.

It is obvious in Fig. 2 that at the temperature of refrigerator (5°C) butter made of cold ripened cream

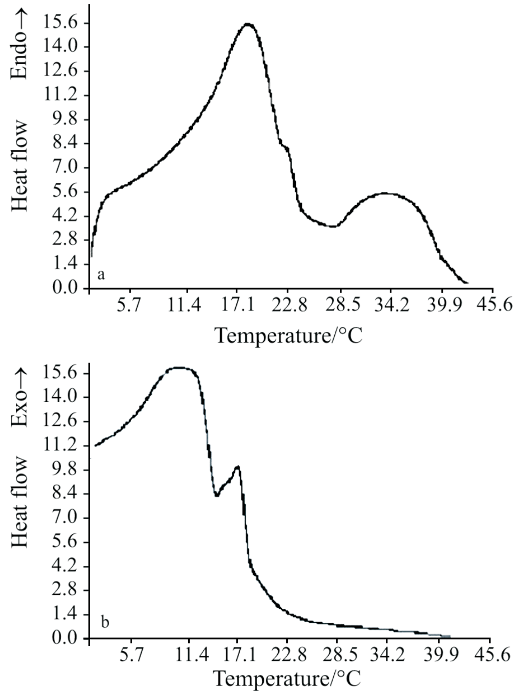

Fig. 3 a – Melting and b – crystallization curves of butter made of cold ripened cream

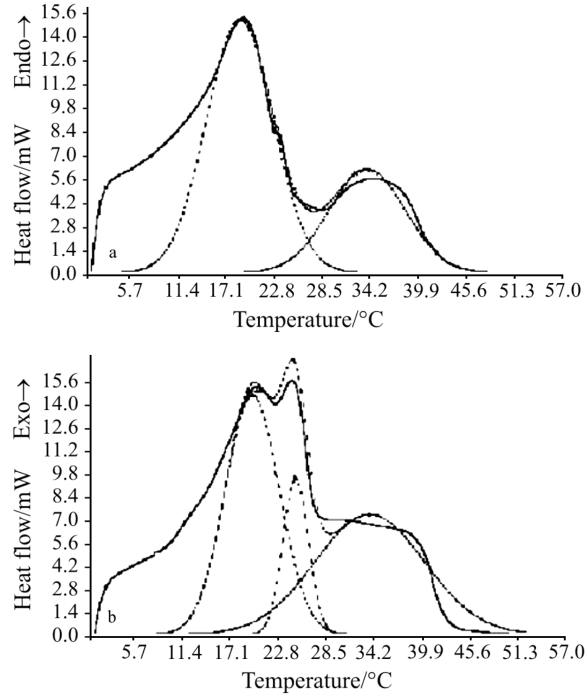

Fig. 5 Deconvoluted melting curves of butters made of a – cold ripened and b – heat-step ripened cream

is much firmer than butter produced from heat-step ripened cream but as a function of temperature it softens much quicker and near to the room temperature (above 17°C) it is already softer than the latter.

In Fig. 3 melting (a) and crystallization (b) DSC curves of butter made of cold ripened cream and in Fig. 4 that of butter made of heat-step ripened cream are shown.

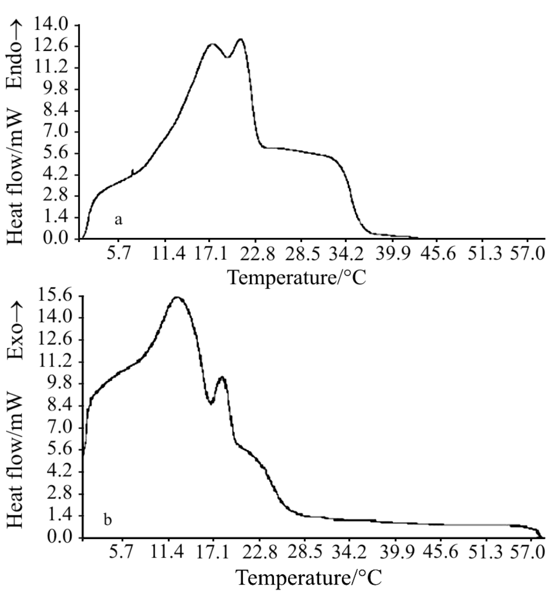

Fig. 4 a – Melting and b – crystallization curves of butter made of heat-step ripened cream

Figures 3 and 4 demonstrate well the difference in melting of fat originating from two different butters. Basically, in both butters a lower and higher melting point fraction can be detected. The difference is in the low melting point fraction, which, in the butter made of heat-step ripened cream could be separated into further two fractions (Fig. 4a), such separation at butter made of cold ripened cream can not be detected so definitely (Fig. 3a). Crystallization curves at both butters show only two separate fractions.

Deconvoluted melting curves of butters made of cold ripened (a) and of heat-step ripened (b) cream are demonstrated in Fig. 5.

It is obvious from the deconvoluted Gauss curves of Fig. 5 that due to heat-step ripening the low melting point fraction separates to two different fractions. At the same time the area ratio of the high melting point fraction increases from 32 to 44%.

Conclusions

Comparing the results of recent DSC measurements with data of our earlier EPR experiments [13–15] it can be stated that the increase of greater extent of liquid fat ratio that could be reached by the indicator material was fallen into the temperature range greater than 25°C for the butter made from heat-step ripened cream compared to the butter made of cold ripened cream either of methods was used. This refers to the fact that butter particles formed during heat-step cream ripening have relatively higher melting point. According to the consistency examinations, the particle structure provides the better spreadability at a low temperature (particles are practically rolling in fat), while at a higher temperature it makes the butter consistency firmer. However, the background of the separation of the low melting point fraction requires further examinations.

Acknowledgements

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