IMPACT OF MILK FAT COMPOSITION ON DIFFUSION AND PERCEPTION OF FLAVOUR COMPOUNDS IN YOGURTS

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Abstract

The aim of the present study was focused on the level of solid milk fat level in flavoured yogurt on their rheological properties, flavour release and diffusion in relation to their sensory properties. Whereas variation of solid fat level slightly influenced texture perception of yogurts, a large effect of solid fat level on flavour release and olfactory perception was highlighted. At 10°C, the odour of yogurt with the highest solid fat fraction (82%) was perceived more intense than yogurts with the lowest solid fat fractions (25% and 70%), in agreement with aroma release (for 10/17 flavour compounds). The diffusion of flavour compounds in the yogurt was slightly affected by the solid fat level. All these results demonstrated that it is not the total fat content that govern flavour release and perception but the uncrystalline or liquid fat content.

Introduction

Fat plays a major role in the determination of texture and flavour of complex food products and its quantitative impact was largely investigated in the past (1). In order to understand the physicochemical mechanisms responsible for olfactory perception during food eating, it seems necessary to take into account, not only the fat content in food, but also its structure and composition. The role of fat composition (animal or vegetable, or equilibrium of liquid-solid phase) on flavour release was previously investigated (2, 3). This last seems to be dependent on the physical state of fat (crystallised or liquid form) in model dairy foods (4, 5).

To our knowledge the study of the influence of solid fat level on a real flavoured product, as yogurt, has been limited in literature, particularly on their sensory impact. In this context, the aim of the present study was focused on the impact of fat composition (solid fat level) on both physicochemical properties (flavour release and diffusion) and sensory properties of yogurts.

Experimental

Product preparation. Three flavoured stirred yogurts (dry matter (22.5%), fat (4%) and proteins (5.4%)) varying in the anhydrous milk fat fraction (solid fat level at 10°C): LMF (Low Milk Fat) presented a solid fat level of 25%, AMF (Anhydrous Milk Fat) a solid fat level of 70% and HMF (High Milk Fat) a solid fat level of 82%. Yogurts were flavoured with a strawberry flavour containing 17 compounds (6).
Sensory evaluation. Sensory evaluation was carried out with 30 untrained panellists.

Discriminative tests. The effect of solid fat fraction was investigated by triangle tests i) on non flavoured yogurts in order to focus on differences on texture perception, and ii) on flavoured yogurts in order to focus on differences on flavour differences.

Descriptive tests. A comparative descriptive analysis of the three samples (LMF, AMF, HMF) was performed on three attributes: overall odour intensity (orthonasal attribute), thickness and overall flavour intensity (retronasal attribute).

Rheological properties. The rheological properties of the three yogurts were measured at 10°C in harmonic regime with a controlled-stress rheometer (model RS1, Haake, Germany). Three types of measures were conducted: frequency sweep test, complex viscosity by stress sweep, flow curve of yogurt by increasing the shear rate from 0 to 100 s⁻¹, followed by decreasing the shear rate from 100 to 0 s⁻¹.

Flavour compound release. Measurements of flavour release were performed at 10°C using a gas chromatograph equipped with a flame ionization detector and an automatic headspace sampler CombiPal: either in static conditions or in dynamic conditions. Flavour release in static conditions was determined by SPME method (6). Diffusion coefficients in yogurts were determined from experimental release kinetics obtained in a diffusion cell (7).

Data analyses. Data analyses were carried out using SAS software package, version 9.1. Analyses of variance were performed to reveal the sensory and release differences between yogurts.

Results and Discussion

Influence of solid fat level on texture perception and physical properties. Sensory results revealed differences on texture perception between the 2 products with extreme fat compositions. In particular LMF yogurt (25% of solid fat level) was perceived thicker than the others.

Rheological properties study showed that the three yogurts are weak gels (storage modulus G’> loss modulus G’’ over the frequency range) as determined by frequency sweep test. The complex viscosities measured at low shear stress (0.1 Pa) did not significantly differ between the three yogurts (Table 1). Moreover, the thixotropic hysteresis loops of the three yogurts were not affected by the variation of solid fat level.

Table 1. Complex viscosity (Pa.s) for the three yogurts obtained at low shear stress (0.1Pa).

<table>
<thead>
<tr>
<th>Yogurt</th>
<th>Complex viscosity at 0.1 Pa (in Pa.s)</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMF yogurt</td>
<td>38.85</td>
<td>5.87</td>
</tr>
<tr>
<td>LMF yogurt</td>
<td>42.31</td>
<td>9.75</td>
</tr>
<tr>
<td>HMF yogurt</td>
<td>37.64</td>
<td>10.54</td>
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</tbody>
</table>

In conclusion, only the yogurt with the lowest solid fat level (LMF yogurt) was perceived thicker than the others, but this was not related to its rheological properties. An assumption to explain this difference could be the formation of a higher fat layer on the tongue at the origin of mouth-coating perception. Indeed, LMF
yogurt contained the lowest percent of solid fat at 10°C and was perceived as being the thickest. We could also assume a higher coating of this yogurt in mucous tongue helped by its high quantity of liquid fat. A halo effect could be thus supposed: coating perception would be evaluated by panellists on thick perception scale.

**Influence of solid fat level on olfactory perception and flavour release.** Triangle tests performed by sniffing on flavoured yogurts showed a significant difference only between LMF and HMF yogurts (p<0.1%). Moreover, odour intensity evaluation on the three yogurts showed that HMF yogurt was perceived more intense (23-30 % of variation) in odour than the others (p<0.1%).

In static conditions, release of the majority of flavour compounds (10/17) was the highest from HMF yogurt and 8 flavour compounds were the least released from LMF yogurts (Figure 1). The AMF yogurt presented an intermediary behaviour. Quantitatively, these modifications were mainly noticeable for hydrophobic flavour compounds. For ethyl acetate, a hydrophilic flavour compound, a different behaviour was observed: this compound was more released from LMF yogurt than from the others. All these results seemed to highlight that interactions (solubilisation) between flavour compounds and fat occurred with the liquid fraction of fat, and not with the crystalline part of fat. Liquid lipids can solubilise flavour compounds and act as a reservoir for the aroma as shown on emulsions or model dairy gels (2,4,8). In addition, flavour release and flavour perception are in agreement, in particular in static conditions and for hydrophobic flavour compounds.

![Figure 1](image).

**Figure 1.** Flavour release measurements performed by static headspace method by Solid Phase MicroExtraction (PDMS fibre) for □HMF, △AMF and ＊LMF.

Concerning diffusion coefficients, a significant effect of solid fat level was only observed for ethyl hexanoate, which was significantly higher in HMF yogurt than in others in accordance with olfactory perception (Figure 2). The diffusion of others aroma compounds was not significantly related to the solid fat level. Our study contributes thus to precise the mechanism involved in flavour perception during consumption. Mobility of aroma compounds (diffusion coefficient) would have only a weak impact on released flavour quantity in mouth, accentuated by the relatively short timescale of yogurt in mouth cavity when consumption.
Figure 2: Diffusion coefficients $D$ (m²/s) of 4 flavour compounds between the 3 products for □HMF, ▄AMF and ■LMF.

Conclusion

In studied flavoured stirred yogurts, solid fat level induced a large effect on flavour release and perception, but not on texture and rheological properties. This work clearly suggests that the underlying molecular organisation, which depends on lipid composition, takes a great part in flavour behaviour, with consequences in olfactory perception. To reduce fat in food, it is also essential to better take fat structure into account as well as the evolution of its physical state during eating to control flavour release and perception.

References