Organogel as fat replacer in cake batter

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Abstract
The use of organogels in food industry has been a subject of many studies, mainly because of the appeal of the consumers for healthier products. One of the features of organogels is the possibility of their use as saturated/trans fats replacement. In this context, the aim of this work was to study the physicochemical properties of organogels produced with edible ingredients. Moreover, its influence on the mechanical and rheological properties of cake batter was evaluated.

Key words:
Organogel, rheology, texture

Introduction
Organogels are viscoelastic systems formed by the mixture of organic gelators and liquid oils. In these soft materials, the oil phase is immobilized through capillary forces resulting from the three-dimensional network of self-assembled, intertwined gelator fibers. The development of organogels for application in food products has increased in the last years. They can be used as vehicles for hydrophobic bioactives, texturizer and as fat replacer of saturated and/or trans fats. These functionalities follows the trend for healthier foods and higher life quality. Thus, the aim of this study was to evaluate the physicochemical properties of organogels produced with high oleic sunflower oil (HOSO) and beeswax (BW) as organogelator. Moreover, the organogels obtained were evaluated as fat replacers in cake batter, traditionally produced with palm oil.

Results and Discussion
Organogels
The organogels were formulated by dissolving the beeswax (3% and 5% w/w) in HOSO under heating (80 °C, 30 min). Samples were cooled and stored at 25 °C and then evaluated according to its rheological and calorimetric properties. Rheological measurements indicated that surfactant concentration increasing lead to the production of stronger gels with higher complex modulus (G*) and less frequency dependence. Temperature sweeps showed that the gel point was around 43 °C for both concentration. Moreover, G* does not reach a plateau value with decreasing temperature, even after the gelation temperature, suggesting that the gel properties changed with time before to reach an equilibrium value.

Results from Differential Scanning Calorimetry (DSC) presented thermal behavior similar to the rheological measurements. The increased concentration of gelling agent has led to little increase of organogel crystallization temperature. Furthermore, the enthalpies of melting and crystallisation for each formulation showed similar values, which is consistent for reversible processes.

Cake batter
Cake batter was produced according Bennion, using the organogels as fat content. Palm oil and pure HOSO was used in the control formulations. Frequency sweeps of the raw batter showed that the cakes produced with organogels presented higher G* with less frequency dependence. Moreover, the increase of gelator content led to higher values of these parameters. In addition, control formulation produced with palm oil showed the less structured batter network, since it showed the lowest values of G*.

Mechanical properties are shown in Table 1. Results showed that the formulations had similar hardness, except for the formulation with pure HOSO. Observing the elastic modulus, the formulations with organogels showed higher values, followed by the control made with palm oil. This parameter is related to the firmness of the cake and its ability to maintain the properties under low stress application. The results indicated that the use of organogels led to cakes with similar characteristics of control but with higher firmness.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Hardness (10^3 N/m)</th>
<th>Maximum Deformation (mm)</th>
<th>Elastic Modulus (10^3 Pa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palm oil</td>
<td>16,54±0,75</td>
<td>1,21±0,01</td>
<td>2,68±0,37</td>
</tr>
<tr>
<td>Pure HOSO</td>
<td>12,51±0,40</td>
<td>1,21±0,01</td>
<td>2,13±0,87</td>
</tr>
<tr>
<td>BW 3% (w/w)</td>
<td>17,33±0,94</td>
<td>1,21±0,01</td>
<td>5,41±0,33</td>
</tr>
<tr>
<td>BW 5% (w/w)</td>
<td>15,05±0,70</td>
<td>1,21±0,01</td>
<td>4,70±0,91</td>
</tr>
</tbody>
</table>

Conclusions
Organogels produced with HOSO and beeswax presented gel behavior and thermo-reversibility. Moreover, rheological measurements showed that the crystallization is a dynamic and time-dependent event. The use of organogels as fat replacer in cake batter showed that the final product presented the same hardness of control formulations, but with improved firmness. Thus, organogels can be used as fat replacer in cake batter, maintaining texture properties and improving nutritional characteristics.

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