**Multiscale evaluation from one bubble to the foam of surface active properties of cellulose derivatives used for a starchy model sponge cake**

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The objective of the present study was to better understand the surface active properties of methylcellulose (MC) and hydroxypropyl methylcellulose (HPMC), alone and in blend, at the air/water interface, in order to evaluate the resulting efficiency for stabilizing a foam obtained by whipping a solution. The investigation was led at two complementary scales: 1) the stabilization of one bubble, using static and dynamic tensiometry; and 2) the stabilization of a real foam during whipping, using overrun determination and light microscopy examination of bubbles, combined with image processing. This strategy allowed the evaluation of structure-function relationships of MC and HPMC in aqueous systems during air incorporation.

Intrinsic viscosity and dilatational interfacial measurements showed that MC formed more rigid interfaces, despite a faster diffusion at the interface due to a molecular weight 10 times lower than HPMC. This could confer some fragility to the bubbles toward mechanical stresses. HPMC alone could have been a good candidate for foaming properties due to its higher flexibility (intrinsic viscosity 2.3 times higher than MC’s), viscosity and shear-thinning properties. However, due to its higher molecular weight, its diffusion to the air/water interface was not fast enough to prevent recoalescence, and the bubbles were bigger at first during whipping. When mixing HPMC+MC, the overrun was first lower than for HPMC alone, but the bubbles size was immediately lower, which is a good indicator of foam stability.

Therefore, a hypothesis about the structuring mechanism of cellulose derivatives at air/water interfaces was proposed. MC would adsorb first at the interface, stabilizing it but increasing its rigidity too much, thus its fragility against high mechanical stress. HPMC would come after to the interface but through its higher flexibility, would contribute to a higher resistance of the interface to mechanical stress, acting such as a plasticizer. As a consequence, less energy was necessary to obtain a well-stabilized foam when using both hydrocolloids in blend, compared to MC or HPMC used separately, due to the good complementarity and synergistic effect of the two cellulose derivatives.