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A Dry Bacterial Cellulose-Carboxymethyl Cellulose Formulation as Stabilizer for Pickering Oil-in-Water Emulsions

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Abstract

Hydrocolloidal microcrystalline cellulose (MCC) from plant sources, is already widely used in industry to regulate the stability, texture, rheology and organoleptic properties of many food and cosmetic formulations. Bacterial cellulose (BC) is produced biotechnologically by different microorganisms, but most efficiently by acetic acid bacteria from the genera *Komagataeibacter*. This biomaterial is a prominent alternative to the already marketed celluloses, being more pure, crystalline, and having nanoscale fibres with high aspect ratio which account for excellent mechanical properties. BC has already been used in its hydrated form for the stabilization of oil-in-water (o/w) Pickering emulsions (particle-stabilized systems, as an alternative for the conventional surfactant-stabilized). For the sake of storage, economy and practicality, additives for industries are preferentially provided in a dry or powder form. Co-drying cellulose fibres or crystals with water soluble polysaccharides helps maintaining the rheologic and structuring properties after rehydration. Dry powdered, rehydratable bacterial cellulose (BC) formulations are reported, being produced by different grinding, drying and dispersing methods which were studied in terms of the impact in the final product's properties.

The main objective of this study was to assess the stabilizing properties of BC in Pickering o/w emulsions. For this, an equimassic formulation of BC and 90 kDa carboxymethyl cellulose (BC:CMC) was prepared and spray dried. Isohexadecane-in-water emulsions (10:90) were prepared in the presence of 0.10%, 0.25% and 0.50% of the BC:CMC formulation. Visual and microscopic aspect of the emulsions was registered over time. Samples were also visualized in Cryo-SEM. Rheological tests were performed to assess the emulsion's viscosity profile, storage and loss moduli. Interfacial tension between the immiscible phases was measured with the Pendant Drop and Du Noüy Ring methods. For benchmarking purposes, the same emulsion preparation and analysis protocol was made with several different commercial cellulosic products and xanthan gum. In short, BC:CMC showed formation of a three-dimensional network and viscosity increasing (thickening) properties, crucial characteristics for emulsion stabilizing formulations. BC has technically superior properties that will allow it to compete with, or even replace, plant celluloses in industry.