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Preparation and characterization of esterified xylo-oligosaccharides-stabilized oil-in-water emulsions using microchannel emulsification

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Amphiphilically esterified oligosaccharides are value-added and functionality-added products of hydrolyzed agricultural residues of annual plants such as wheat straw, grain hulls, corn cobs and corn stalks, thereby increasing the value and potential utilization of agricultural waste in the food industry. Esterified oligosaccharides have hydrophilic and hydrophobic subregions, therefore they can act like low-molecular-weight surfactants and they may present good ability for oil emulsification probably due to steric stabilization.

Esterified oligosaccharides were prepared by an enzyme-catalyzed reaction of maltodextrin/xylo-oligosaccharide and palmitic acid. Maltodextrin with dextrose equivalent (DE) of 16 palmitate (DE16_P) and 9 palmitate (DE9_P), as well as xylo-oligosaccharide palmitate (Xylo_P), were used as sole emulsifier to stabilize O/W emulsion prepared by high-speed homogenizer. The effect of the concentration (10-50% (w/w)) and type of esterified oligosaccharides on the Sauter mean diameter and droplet-size distribution, the rate of coalescence (K_c), and the creaming properties of O/W emulsions were investigated. Esterified oligosaccharides adsorbed to the surface of the oil droplets. Esterified oligosaccharides formed polydisperse O/W emulsions with particle sizes between 12 and 70 μm, depended on concentration of esterified oligosaccharides. The Sauter mean diameter, K_c, and the creaming index decreased markedly, with increasing concentration of esterified oligosaccahrides. The type of ester minimally affected the Sauter mean diameter at each ester concentration. DE9_P inhibited coalescence and creaming more efficiently than other esterified oligosaccharides, mainly due to the higher viscosity of the continuous phase.

A series of an amphiphically esterified xylo-oligosaccharides (xylo esters) with three fatty acids– decanoic acid (C-10), lauric acid (C-12) and palmitic acid (C-16) – were used as emulsifier to generate O/W emulsions by microchannel emulsification (MCE). Grooved and straight-through MCE was used to study the droplet generation and stability of emulsions, respectively. Xylo ester-stabilized oil droplets were generated smoothly from MCE, but xylo esters stabilized emulsions were less monodispersed due to low surface activity. The combination of xylo esters (2.5% (w/w)) and Tween series (0.1% (w/w)) can improve the monodispersity of oil droplet due to increased viscosity and/or sufficient stabilization layer at O/W interface. Combination of xylo laurate (2.5% (w/w)) and Tween 20 (0.1% (w/w)) inhibited coalescence and oiling off more efficiently than only Tween 20 stabilized emulsions during evaluated storage period. Xylo esters improved the efficiency of monodisperse emulsion generation by both grooved and straight-through MCE and also enhanced emulsion stability.

This study suggested that esterified-oligosaccharides may be attractive alternative ingredients to control over the stability of emulsions for various applications in food products.