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Composite edible films reinforced by nano-sized particles, fibers and emulsions

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Abstract – Composite edible films were designed with the incorporation of nanoparticles, nanofibers (Fig. 1) and nanoemulsion resulting in edible films with improved water vapor and oxygen permeability as well as improved mechanical properties. Water vapor permeability was mainly influenced by differences in water solubility of reinforcement nanomaterials as well as filling of pores in the film matrix (Fig. 2), resulting also in improvement of tensile properties.

An ongoing challenge for composite edible films is the relatively high water vapor permeability and poor mechanical behavior of the hydrocolloid fractions. By using nanoscience, new forms of nanocomposites dispersed with nanofillers or nanoemulsions can be developed to minimize migration of water through hydrocolloid films as well as to improve mechanical properties.

Nanocomposite edible films have been developed by incorporating microcrystalline cellulose (MCC) nanofibers [1,2,3,4], chitosan nanoparticles [5] and nanoemulsions to edible films. Microcrystalline cellulose nanofibers and chitosan nanoparticles significantly improved the tensile strength of composite films formulated with hydroxypropyl methylcellulose (HPMC), chitosan and fruit-based edible films and which was attributed to the stronger interfacial adhesion between the polar groups of the fillers and the hydrophilic groups of the hydrocolloids and fruit matrixes. Incorporation of MCC nanofibers in chitosan [6], HPMC [1, 3,4,5] or fruit-based films [5] exhibited water barrier properties that improved with increasing quantity of nanofibers. Lipid coating of the MCC nanofibers resulted in further improvement of the water barrier properties of the HPMC films. The water vapor permeability values of the HPMC films also decreased significantly when chitosan nanoparticles were included in the film matrix. On the other hand the water barrier properties of hydrophilic films could also be improved by the addition of hydrophobic nanoemulsions into the film matrix. Because of their extremely small oil droplet size, droplet coalescence was avoided achieving sufficient short-term stability to minimize creaming during film casting.

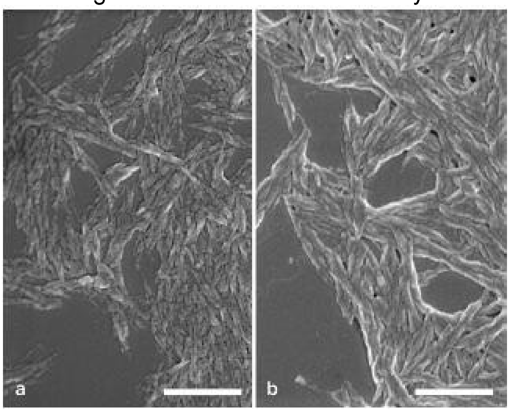

Figure 1: Scanning electron micrographs of microcrystalline cellulose (MCC) nanoparticles: **a)** unmodified MCC and **b)** lipid-coated MCC. Scale bars = 500 nm.

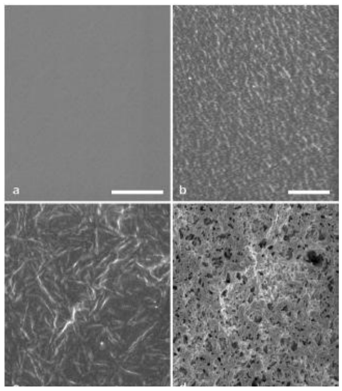

Figure 2: Scanning electron micrographs of **a)** Hydroxypropyl methylcellulose (HPMC) film surface, **b)** HPMC cross section, **c)** HPMC/MCC (3:0.8) film surface, and **d)** HPMC/MCC (3:0.8) film cross section. Scale **a**), 500 nm; **b-d**, 1 μm.

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