High pressure microfluidization reduces hydroxypropyl methylcellulose (HPMC) molecular weight but improves mechanical properties of microcrystalline cellulose (MCC)-reinforced HPMC films

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The increasing environmental concerns regarding the use of fossil fuels encourage the development of environmentally friendly alternatives for polymeric packaging production. Polysaccharide-based films generally have poorer mechanical properties than petroleum-derived polymers, requiring the development of novel biocomposites through the addition of reinforcement agents (e.g., natural fibers). Optimal fiber dispersion is continuously being investigated to provide fibers with furthered applicability. So, this work aimed at processing HPMC/MCC film-forming solutions through high pressure microfluidics, as well as at evaluating its influence on HPMC molecular weight (M_v) and films' mechanical properties. HPMC and HPMC:MCC (2:1) solutions were microfluidized at 20,000 psi for 0, 5, or 10 cycles. HPMC viscosimetric-average M_v was reduced from 470,000 (0 cycles) to approximately 260,000 g/mol in microfluidized samples, suggesting HPMC matrix degradation. This was supported by the reduction on films' tensile strength (TS) from 62.6 ± 6.5 (0 cycle) to 46.6 ± 3.8 (5 cycles) and 47.2 ± 5.9 MPa (10 cycles). The addition of non-microfluidized MCC remarkably decreased TS to 15.0 ± 1.2 MPa (0 cycle). This was attributed to the poorly spread MCC, acting more like a stress concentrator point than as a filler. Microfluidized HPMC:MCC films, however, showed TS of 57.5 ± 2.7 (5 cycles) and 69.5 ± 5.8 MPa (10 cycles). Microfluidization reduced MCC dimensions and allowed them to be more evenly distributed within the polymer matrix, preventing imperfections and enhancing their reinforcement efficiency. Though microfluidization process appears to be undesirable since it degraded HPMC chains, it is instead suitable on the optimization of fiber dispersion and on the improvement of its reinforcement effect.

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