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Physical-mechanical properties of hydroxypropyl methylcellulose films as affected by molecular weight and methoxyl content

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Aiming at minimizing the environmental impact caused by the use of synthetic, non-renewable polymers, naturally occurring alternatives have been increasingly studied. Cellulose is a rigid, infusible, water-insoluble and fibrous-like biopolymer. In order to improve its film-forming properties, its hydroxyl groups are partially etherified into hydroxypropyl and methoxyl groups, resulting in hydroxypropyl methylcellulose (HPMC). We evaluated the effects of methoxyl content (MC) and average viscosimetric molecular weight (M_v) on glass transition temperature (T_g), water vapor permeability (WVP), tensile strength (σ), and elastic modulus (E) of films produced from aqueous film-forming solutions comprising 2% (w/v) of HPMC. We studied METHOCEL™ E15 (MC: 28-30%; M_v : 120,000 g.mol⁻¹; T_g : 174 °C; WVP: 0.75 g.mm.kPa⁻¹.h⁻¹.m⁻²; σ : 31 MPa; E : 1.45 GPa), E4M (MC: 28-30%; M_v : 530,000 g.mol⁻¹; T_g : 178 °C; WVP: 0.92 g.mm.kPa⁻¹.h⁻¹.m⁻²; σ : 67 MPa; E : 1.76 GPa), and K4M (MC: 19-24%; M_v : 550,000 g.mol⁻¹; T_g : 210 °C; WVP: 1.52 g.mm.kPa⁻¹.h⁻¹.m⁻²; σ : 52 MPa; E : 1.74 GPa). Longer HPMC chains led to stronger (higher σ) and stiffer (higher E) films having higher T_g due to the increased physical entanglement and lower free volume and mobility. Films with higher MC were stronger due to the anchoring effect of methoxyl groups. Also, they presented lower T_g and WVP as a result of the lower occurrence of hydroxyl groups, that provide polarity and hydrophilicity. We demonstrated that both MC and molecular weight influence the physical-mechanical properties of HPMC films and should be taken into account in the development of novel bio-based materials with suitable properties.

Biography

Caio G Otoni has completed his BSc in Food Engineering from Federal University of Viçosa and is currently a PhD student in Materials Science and Engineering/Polymers at Federal University of São Carlos. His research project is being developed at the National Nanotechnology Laboratory for Agribusiness, Embrapa Instrumentação, a Brazilian federal research organization. He was a research volunteer for one year at the United States Department of Agriculture/ARS/ WRRRC. He has published over 14 papers in scientific journals and acts as a reviewer of Journal of Agricultural Science and Technology and Ciência Rural.

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