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{ MODIFICATION OF AMYLOSE CONTENT AND MECHANICAL OPTIMISATION OF
STARCH-BASED FILMS FOR ENHANCED BARRIER PROPERTIES VIA
CROSS-LINKING }

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FILMS FOR ENHANCED BARRIER PROPERTIES VIA
CROSS-LINKING**

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ABSTRACT

MODIFICATION OF AMYLOSE CONTENT AND MECHANICAL OPTIMISATION OF STARCH-BASED FILMS FOR ENHANCED BARRIER PROPERTIES VIA CROSS-LINKING

Petroleum-based plastics pose significant environmental risks, necessitating the development of sustainable, biodegradable alternatives. However, starch-based films often suffer from inherent mechanical weakness and moisture sensitivity. This study evaluated the influence of amylose content on the physicochemical properties of starch films and optimized Mung Bean (MB) starch films through citric acid (CA) cross-linking. Films derived from Corn (CN), Potato (PT) and Mung Bean (MB) were characterized for mechanical and barrier properties according to ASTM D882 and ASTM E96 standards, while chemical structural changes were analyzed using Fourier Transform Infrared (FTIR) spectroscopy. The investigation revealed a direct correlation between amylose levels and film rigidity. MB starch films, possessing the highest amylose content, exhibited superior mechanical properties with a tensile strength of 0.61 ± 0.04 MPa and Young's Modulus of 8.97 ± 0.72 MPa. These values represented a tensile strength increase of approximately 79% and 126% compared to CN and PT films respectively, confirming that higher amylose content facilitates a stronger polymer network via hydrogen bonding. Subsequent cross-linking with citric acid successfully enhanced the water barrier properties of the MB films. FTIR analysis confirmed the formation of ester linkages between starch hydroxyl groups and citric acid, evidenced by a distinct carbonyl peak (C=O) at 1732 cm^{-1} . The 20% (w/w) citric acid concentration (MB-CA20) was identified as optimal, achieving the lowest Water Vapour Transmission Rate (WVTR) of $156.79 \pm 59.07\text{ g}\cdot\text{m}^{-2}\cdot\text{day}^{-1}$ and the lowest Water Vapour Permeability (WVP) of $(8.59 \pm 3.24) \times 10^{-11}\text{ g}\cdot\text{m}^{-1}\cdot\text{s}^{-1}\cdot\text{Pa}^{-1}$. Concentrations increased to 25% resulted in reduced performance due to the plasticizing effect of excess acid disrupting the film matrix. Consequently, the MB-CA20 formulation provides an effective balance of structural integrity and moisture resistance, demonstrating significant potential as a biodegradable food packaging material. Future work is recommended to assess the soil biodegradability and surface hydrophobicity of these optimized films.

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