Edible films from cellulose microfibrils and solid fats

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Polysaccharide-based edible films are gaining attention as sustainable alternatives to synthetic packaging due to their biodegradability and mechanical strength, which arise from extensive hydrogen bonding and non-covalent interactions. However, their performance deteriorates under high relative humidity (RH), as water disrupts these interactions, leading to swelling and increased water vapor permeability (WVP) and oxygen permeability (OP) [1].
To overcome these limitations, hydrophobic fillers such as oils, waxes, and nanoparticles have been incorporated into film matrices. Oils effectively reduce WVP but are less effective against oxygen due to high oxygen solubility [2]. In contrast, solid lipids like waxes, particularly palm stearin, offer dual barrier functionality by impeding both water and oxygen diffusion [3]. The tortuous path theory explains how filler geometry and alignment influence permeability, with layered or elliptical particles providing superior barrier properties compared to spherical ones [4].
Recent studies have shown that molten lipids can self-organize with cellulose microfibrils (CMFs) into layered structures, enhancing barrier performance [5]. Upon cooling, waxes may retain this architecture, allowing microstructure control via thermal processing. Palm stearin, with a melting range of 40–62 °C, is especially promising due to its tunable mechanical and barrier properties [6].
Additionally, wax-containing films may enable encapsulation of oil-based pastes and offer heat-sealing capabilities, broadening their application in food packaging. These innovations align with current trends in sustainable and functional packaging solutions [7].

Keywords:
Polysaccharide films, edible packaging, permeability, wax fillers, palm stearin, microstructure

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