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Allergenic Evaluation of Bee Pollen and Its Derived Sporopollenin Microcapsules for Food and Biomedical Applications

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Pollen grains are emerging as innovative biomaterials for applications ranging from oral drug delivery to the encapsulation of food ingredients and the development of pollen-based building blocks, owing to their robust, chemically inert, and mechanically durable sporopollenin walls. However, concerns persist regarding the safety and application of sporopollenin microcapsules (SMCs) or derivatized sporopollenin materials purified from pollen grains traditionally associated with allergies. Herein, we address the critical question of whether bee pollen and sporopollenin shells purified from bee pollen cause allergic reactions by evaluating their interaction with human immunoglobulin E (IgE) antibodies in sera from patients with and without allergic sensitization to pollen from specific species.

SMCs from Castanea sativa, Amaranthaceae, and Olea europaea pollen types were successfully fabricated using a species-independent chemical treatment. Nitrogen-based total protein analysis revealed that the protein content in raw bee pollen samples, initially ranging from 14% to 24%, was reduced to 2.8%–3.2% after chemical treatment. Scanning electron and confocal laser scanning microscopy confirmed the successful production of hollow and clean SMCs. The Covaris Adaptive Focused Acoustics™ technology was employed for protein extraction from raw pollen and SMCs, yielding 0.7 ng – 1.2 ng and 0.026 ng – 0.028 ng of protein per pollen grain, respectively. SDS-PAGE, followed by immunoblotting analysis, showed that proteins extracted from raw bee pollen strongly reacted with IgE antibodies in human sera, whereas SMCs did not trigger allergic sensitization.

Overall, our findings suggest that while raw bee pollen proteins could elicit allergic reactions, SMCs derived from them do not, highlighting their potential as safe biomaterials for various applications and offering valuable insights into the allergenic potential of bee pollen.

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