PP-318 [Apitherapy]
Enzymatic hydrolysis of bee pollen cell wall and extraction of protein isolates to enhance the structural, functional, and nutritional profile

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Background
Bee pollen is a nutrient-dense natural product, rich in proteins, vitamins, and bioactive compounds, but its rigid structural layers (exine and intine) limit nutrient release and functional application. Enhancing protein extraction and functionality from bee pollen could improve its value as a food ingredient and dietary supplement.

Problem Description
The tough cell wall of bee pollen reduces protein availability, making it a challenge to extract high-quality protein isolates with desirable functional properties. Enzymatic hydrolysis with protease provides a promising solution, but optimized conditions are needed to achieve efficient cell wall disruption and enhance protein yield.

Methodology
Response Surface Methodology (RSM) was used to determine optimal enzymatic hydrolysis conditions for bee pollen. The study identified the ideal parameters as 0.25% enzyme concentration, 49°C temperature, pH 7.3, and 12 hours of hydrolysis. Protein extraction was performed at an extraction pH of 10 and precipitation pH of 4.5, yielding 19% protein with 85% purity. Key response variables included wall-breaking rate, protein dispersibility, antioxidant activity (DPPH), and total phenolic content.

Results and CONCLUSION: Protein isolates from enzymatic pre-treatment (PA-BPPI) showed superior functional and nutritional properties compared to untreated isolates (BPPI). PA-BPPI exhibited 80% solubility, water-holding capacity of 234%, oil-holding capacity of 198%, emulsifying activity index of 190.25 m^2/g, and emulsifying stability index of 22 minutes. Nutritional improvements included higher levels of essential amino acids (lysine, leucine, and isoleucine), with an Essential Amino Acid Index (EAAI) of 80.29, Biological Value (BV) of 75.81, and Nutritional Index (NI) of 66.81. Thermal and FTIR analyses confirmed structural modifications enhancing functionality.

Practical Implications for Beekeepers
Enzymatic pre-treatment adds value to bee pollen, enabling its use in functional foods such as protein-enriched snacks, beverages, and emulsions. Improved amino acid profiles make bee pollen protein isolates ideal for dietary supplements targeting muscle growth and recovery. Beekeepers can benefit from diversified income streams and meet the rising demand for plant-based functional ingredients.