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Technological Advancements in the Development of Plant-based Meat: Innovations, Challenges, and Future Prospects

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ABSTRACT

The increasing demand for sustainable and nutritionally balanced meat alternatives has led to significant advancements in plant-based meat technology. Innovations in ingredient selection, processing techniques, and formulation strategies have enabled the creation of plant-based products that closely replicate the texture, flavour, and nutritional profile of conventional meat. Key protein sources such as soy, pea, wheat, mycoprotein, and algae-based proteins are being explored to enhance protein quality and functionality.

Advanced processing techniques, including high-moisture extrusion and shear cell technology, have been instrumental in improving the fibrous texture and water-holding capacity of plant proteins, making them more meat-like. Novel structuring methods such as 3D food printing are being investigated to achieve greater control over texture and composition. Additionally, emulsion and encapsulation technologies are being utilised to mimic the fat distribution and juiciness of conventional meat.

Despite these advancements, challenges remain in optimising sensory attributes, amino acid profiles, and large-scale production efficiency. The next phase of innovation will focus on integrating precision fermentation, cell-based scaffolding to enhance product quality and sustainability. Further research into bioactive fortification, probiotics, and dietary fibre incorporation could improve the health benefits of plant-based meats. As plant-based meat alternatives continue to evolve, interdisciplinary research and technological advancements will be key to overcoming current limitations and expanding their market potential.

Keywords: Plant-based meat, Protein alternatives, High-moisture extrusion, 3D printing, Encapsulation

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