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Untapped Plant Biomaterials: Novel Scaffold Platforms for Cultivated Meat Biomanufacturing

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Abstract

Food resilience is a shared priority for Singapore and the United Nations' Sustainable Development Goals. Growing population pressures and environmental damage continue to threaten global food security [1]. In response, cultivated meat (CM) has gained significant research attention as an alternative protein source. CM relies on the in vitro growth of animal cells and avoids traditional slaughter altogether. Scaffolds play a key role in helping cells stick and develop muscle tissue [2, 3]. This study sought to minimise the reliance on animal-derived raw materials in cultured meat (CM) production by developing and optimising novel plant-based scaffolds in multiple formats, and by evaluating their structural and functional properties with various cell types.

The scaffolds' biofabrication involves hydrogel crosslinking and freeze-drying techniques to create porous sponge structures. Casting was completed in 3D printed moulds to enable scalable production. After sterilisation and conditioning in culture media, we tested sponge scaffolds with C2C12 murine myoblasts, porcine stem cells, and quail muscle cells (QMC). For biological characterisation, we measured cell viability and growth using PrestoBlue metabolic assays and Live/Dead/Nuclei staining. The results show that plant-based scaffolds supported cell adhesion and growth. Sponge-format structures consistently had higher metabolic activity than control samples. We examined the muscle differentiation through immunofluorescence (IF) staining, focusing on a few muscle differentiation markers. IF staining confirmed the presence of muscle markers, indicating successful differentiation. In summary, these results show that animal-free, plant-based scaffolds can serve as a platform for CM production. Future work will assess how the scaffolds perform in dynamic culture and serum-free media conditions.

References

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