PhD Project Advertisement

Project title: Rethinking Cultured Meat (CM) Growth Medium: Can Grassland Plant-Derived Supplements Sustainably Support CM Production?

Project No: FBS2022-68-Wonfor-ar

Lead supervisor:
Dr Ruth Wonfor, IBERS, Aberystwyth University
Email: rec21@aber.ac.uk

Co-supervisors:
Dr David Bryant, IBERS, Aberystwyth University, dgb@aber.ac.uk
Dr Laurence Smith, School of Agriculture Policy & Development, University of Reading, l.g.smith@reading.ac.uk
Mr Illtud Dunsford, Cellular Agriculture Ltd, illtud@cellularagriculture.co.uk

Project description:

We are at the beginning of a fifth era of agriculture. One at the convergence of data, precision agriculture and biotechnology. Cultured protein/cultivated meat heralds an age of biological innovations that can provide alternative nutritious, flavourful and high-quality protein that is indistinguishable to the traditional. Cultured Meat (CM) research focusses on scalable production system bottlenecks i.e. bioreactor design, scaffolds, cell source and media formulation. The growth medium used for the proliferation and differentiation of the cells used in CM is essential to be able to produce the final product efficiently. Furthermore, formulation of the medium should also be considered in the carbon footprint of the final product, in order to produce a carbon neutral alternative meat protein.

CM media is provided through commercially available base media products, containing an energy source, such as glucose, amino acids (AA, i.e. L-glutamine) and vitamins, but must also be supplemented with additional nutrients such as, hormones and growth factors, amongst others. These are usually provided through foetal bovine serum (FBS) supplementation, dependent on the slaughter of pregnant cows. For meaningful global impact, CM protein production needs be both scalable and environmentally sustainable, which is the focus of Cellular Agriculture Ltd to reach large scale cultured protein production.

There is considerable uncertainty over the environmental impacts of CM production; although global warming will be less with CM than with cattle initially, this may not apply in the long term because the methane (CH_4) associated with cattle production does not accumulate in the atmosphere, unlike CO_2, the main greenhouse gas associated with CM production[1]. Future impacts of CM will therefore depend on the availability of renewable systems of energy generation and current/future production systems in animal agriculture[2]. Moreover, assessments of CM to date have tended to overlook the multiple ecosystem services provided by livestock farming systems (e.g. socio-cultural benefits such as tourism provision), through a single-issue focus, limiting the applicability of the results to policy makers and practitioners alike[3].

Approximately 70% of the UK's commercial forage crops are grasses (Loillium/Festuca spp.) and clover (Trifolium spp.) from which a fructose and protein nutrient rich juice can be readily extracted. In cattle and sheep fructose and protein undergo metabolism in the rumen producing volatile fatty acids (VFA's) and microbial cellular protein (MCP) which undergoes proteolysis to AA for nutritional uptake along with VFAs. Both VFA's and MCP can be produced during the

acidogenic phase of anaerobic digestion (AD), prior to production of CH_4, and following proteolysis and downstream processing (DSP) could potentially be a media for CM production.

The hypothesis to be tested in this studentship is: Protein and WSC-rich juice extracted from forage grass/clover pre or post acidogenic AD can supplement the nutritional requirements of CM media formulation and that this grassland derived media will have a positive sustainability impact for future CM production as determined through a holistic LCA (fig 1).

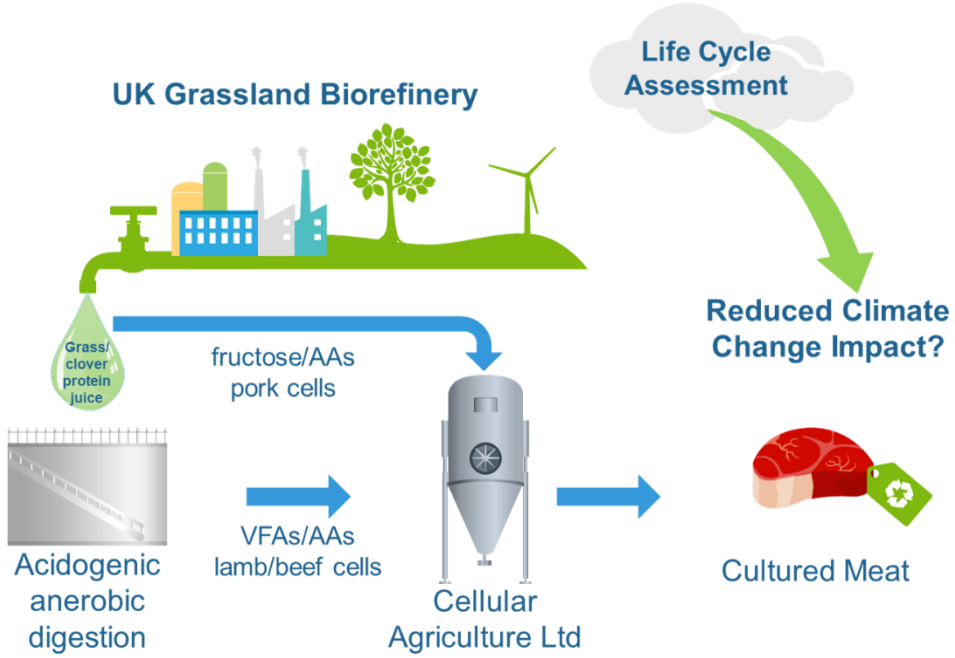

Figure 1. Developing plant based growth media from UK grasslands for cultured meat production and life cycle assessment of associated greenhouse gas emissions.

Objectives:

1. Development of a biorefining process for forage juice and optimisation of the acidogenic AD microbial consortia and proteolysis to produce VFA and MCP peptides for CM production.
2. Test pre and post AD products on porcine and bovine cells i.e. proliferation, Pax-7 expression (marker for muscle stem cells) and metabolism of myogenic cells, as well as the ability to differentiate into the myotubes required for CM formulation.
3. Assess cellular proliferation with the plant-derived media formulation in Cellular Agriculture's bioreactor format i.e. time, temperature and process stability.
4. Holistic sustainability assessment of plant-based media formulation of CM via LCA alongside human nutrition, animal-welfare, and social-wellbeing indicator analysis.

Training opportunities:

The student will undergo interdisciplinary training in biorefining and grassland science, anaerobic fermentation, population dynamics, bioinformatics and biotechnology to investigate protein and carbohydrate bioconversion to media formulations. Specific cell culture experimental design, methodological skills and analysis for CM production (i.e. cell culturing, biological analysis, microscopy) will be developed through experimental work. The student will be trained in LCA and approaches for sustainability indicator evaluation and uncertainty analysis.
The training will be supported by expertise in AD, cell biology, statistical design of experiments, analytical chemistry and manufacturing design.

The student will be trained to complete the following:

1. Determination of soluble protein/carbohydrate content in grass/clover juice composition, major bioconversions during acidogenic AD, membrane separation and broth composition.
2. Cell culture maintenance and assessment to establish the effects of the novel media components on cell proliferation and differentiation for CM.

3. Technical transfer of the media process and formulation to state-of-the-art commercial cultured meat bioreactor platform at Cellular Agriculture Ltd.
4. Life Cycle Assessment within the SimaPro software, to reveal the environmental impacts of current and alternative CM production systems.

There will be a 3-month placement at Cellular Agriculture Ltd. to gain commercial experience in an exciting new industry in the UK.

Student profile:

Applicants should hold, or expect to obtain, an upper-second class honors degree or higher in biological sciences i.e. Microbiology, bio/tissue engineering or related subjects. Applicants with practical experience in cellular/microbiology and statistics are particularly welcome. An interest in food biotechnology and an understanding of the challenges facing the Agri-Food sector in sustainably meeting nutritional needs are desirable, as are experience of presenting and publishing.

AU is a Bilingual Institution which complies with the Welsh Language Standards and is committed to Equal Opportunities. Students are welcome to apply in Welsh or English and any application submitted will be treated equally.

References:

1. https://cedelft.eu/publications/rapport-lca-of-cultivated-meat-future-projections-for-different-scenarios/
2. Lynch et al. (2019) *Frontiers in Sustainable Food Systems*, 3:5.
3. Chriki & Hocquette (2020). *Frontiers in Nutrition*, 7: 7.
4. https://www.oxfordeconomics.com/recent-releases/The-socio-economic-impact-of-cultivated-meat-in-the-UK

Funding particulars:

This project is a CASE studentship

For up to date information on funding eligibility, studentship rates and part time registration, please visit the FoodBioSystems website.