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Developing Scalable Production Methods for Cultured Pork and Turkey Meat: Beyond the Petri Dish

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Objectives

Evolving consumer trends for the animal agriculture industry highlight concern for animal welfare, food safety, and environmental sustainability. Customers are increasingly motivated to buy meat products that align with their lifestyles and personal values. Growing meat products outside of the animal has become a buzzworthy solution to meet the needs of these customers. The emerging cultured meat industry produces meat through biomanufacturing, using techniques initially developed for medical research, such as cell and tissue culture. The research described here presents the development of a culture process for pork and turkey meat: establishing animal cell lines, culturing cells to increase mass yields, and designing cultured meat product prototypes.

Materials and Methods

Myogenic porcine cells were isolated from the biceps femoris muscle of a 3 mo old female domestic pig, and myogenic turkey cells were obtained from the pectoralis major muscle of a 1 wk old male domestic turkey. A sample of cells from each species were immunostained for myosin heavy chain to confirm their ability to fuse into multinucleated muscle fibers. Myogenic porcine and turkey cells were expanded in vitro and used to make 3-dimensional cultured meat prototypes. The meat was grown using a tissue engineering technique that embeds muscle cells into an edible scaffold composed of animal collagen. The collagen assembles the cells into a 3D matrix and provides texture. The meat samples were matured for 7 d to allow muscle fiber formation and tissue development and immunostained for myosin heavy chain. The samples were imaged with an Olympus multiphoton microscope and the images were processed in Fiji.

Results

The cell isolation method produced myogenic porcine and turkey cell populations that could spontaneously form multinucleated myotubes, and these myotubes expressed myosin heavy chain. Embedding the muscle cells into a collagen 1 protein matrix allowed growth of 3D pork and turkey meat prototypes. These samples possessed long multinucleated muscle fibers expressing myosin heavy chain, with similar histological architecture to muscle from an animal.

Conclusion

This research demonstrates that small cultured pork and poultry meat prototypes can be easily grown in a laboratory setting. However, many technical challenges remain for scaling up biomanufacturing methods to produce cultured meat at a commercially viable level. These challenges include: 1) Developing immortalized meat cell lines to avoid the need to repeatedly sample animal tissues to obtain new cells, 2) Creating ultra low cost fetal bovine serum-free culture media to feed the cells, 3) Improving tissue engineering/bioprinting techniques to increase the size of meat that can be grown, and 4) Inventing 'proliferation' bioreactors that manufacture high yields of meat cells, and 'maturation' bioreactors that can support 3D meat growth and development.

