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SUSTAINABLE MEAT PRODUCTION – RECIRCULATION OF BLOOD FOR CULTIVATED MEAT

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I. INTRODUCTION

Traditional meat provides rich and digestible nutrients, but its production has a large impact on the environment. A way to reduce the impact of animal production is to increase the use of the whole animal and increase the value of each side stream by e.g. upcycling blood as a side stream product, resulting in a total increase in product per slaughtered animal. Alternatively, the solution can be to explore new technologies like cultivated meat (CM) to create conventional meat alternatives. However, in the view of circular bioeconomy of food production, these two approaches can be combined, so slaughterhouse blood from the conventional meat production is used as media for the cultivation of muscle satellite cells (SCs) providing growth factors and nutrients for the cells for cultivated meat.
The foundation of cultivated meat lies in the proliferation and differentiation of primary satellite cells (SCs), a concept that has already been proven. Yet, the challenge remains in developing a cost-effective and sustainable production methodology for scaling up. In the present study we explore the use of slaughterhouse blood as an alternative to fetal bovine serum (FBS) as the golden standard for proliferation of SCs and further evaluate the potential of porcine blood as a source of nutrients for the growth of SCs.

II. MATERIALS AND METHODS

Bovine satellite cells were isolated from two muscles *M. Supraspinatus* (SS) and *M. Semimebranosus* (SM) from a Danish Holstein bull calf (1-month-old) and a Holstein dairy cow (3-year-old), repectively according to method described by Skrivergaard et al [1]. The cells used for the experiment were in passage 3, and seeded according to Skrivergaard et al [1]. The proliferation potential of the cells were evaluated by cell counting using flourescent Hoechest dye (Thermo Scientific, USA) according to [2].
Blood samples were collected from a commercial pig slaughterhouse (Danish Crown, Horsens, Denmark), where blood from 10 cross-breed (Duroc x Landrace x Yorkshire) slaughter pigs of approxmaltely 6 months were collected as a pool of either serum (dry tube) or plasma (tube with citrate-phosphate-dextrose).
To evaluate the possible potential of exchanging FBS with either porcine serum or plasma from slaughter pigs cells from cow SM and calf SS were cultured in seeding media for 24 hours [2] (~2000 cells/ well), and then changed to DMEM (Gibco, UK) with 10% of FBS, 10% of pool of porcine serum, 10% of pool of porcine plasma or only DMEM (n=12 per media).
Data was analyzed with one-way analysis of variance (ANOVA) followed by Tukeys post hoc test (OriginLab Corporation, Northampton, MA, USA), and expressed relative to the golden standard (10% FBS).

III. RESULTS AND DISCUSSION

Taking the circular approach towards meat production whether it is through conventional or cultivated meat production may be a solution to get more out of the single animal both from an economic point of view as well as the amount of nutritious protein rich biomass, while reducing the overall climate impact per kg of biomass. In figure 1 the effect of exchanging the FBS in the growth media of cultivated SCs with either porcine serum or plasma from the slaughterhouse blood is shown. Both porcine serum and plasma could support the same level of proliferation of SCs or even more than FBS. Support of proliferation is a requirement for production of biomass, as the number of cells decides the final amount of biomass in the further process where the SCs are stimulated to differentiate to myotubes. This suggests that FBS can be exchanged directly with serum and plasma produced from the blood of slaughter pigs. Porcine plasma is already available as a commercial product at e.g. the slaughterhouse Danish Crown, Horsens, Denmark. The next step is to further explore the nutrients in blood as a resource of e.g. amino acids which can exchange the basic growth media like DMEM. Ongoing research in our labs is addressing this by targeted hydrolysis of the blood proteins, to deliver an optimized basic media for SCs proliferation based on bio circulation of side streams from the slaughterhouse.

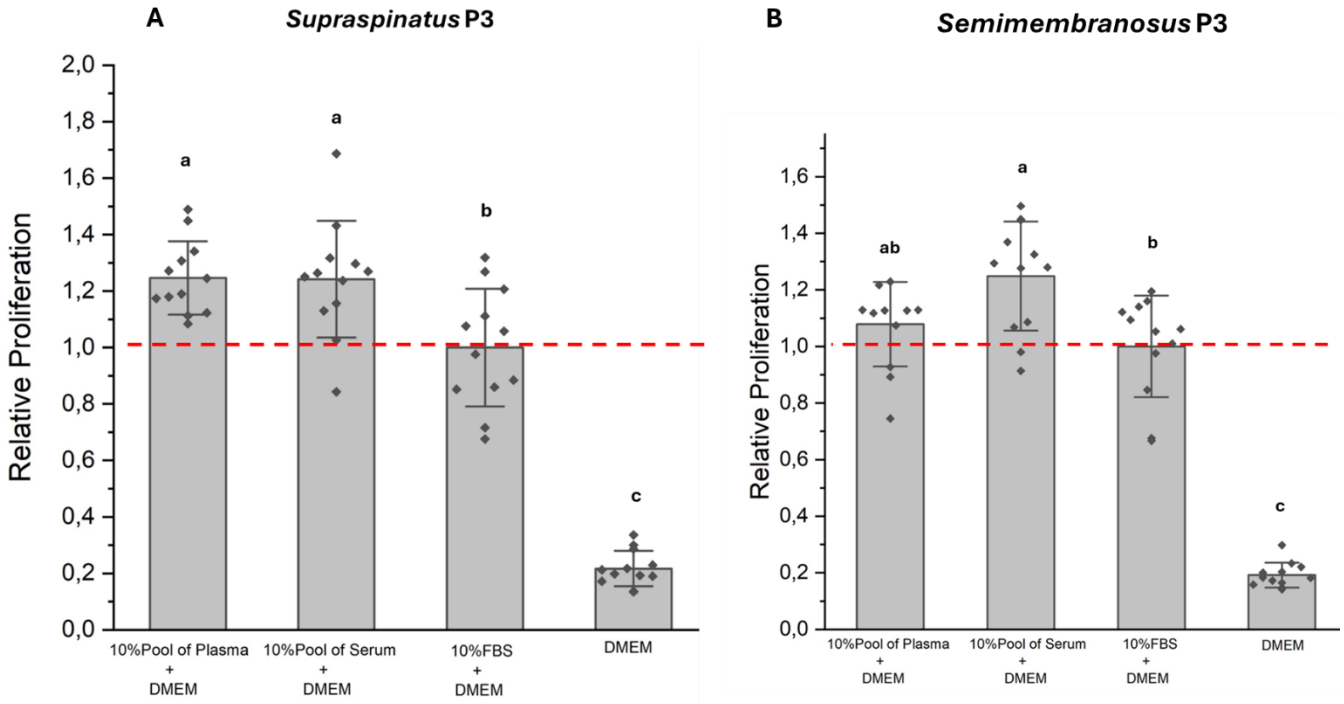


Figure 1 Relative proliferation of SCs in DMEM media with 10% pool of plasma or serum from 6 months-old slaughter pigs or DMEM compared with DMEM with 10% FBS. A) SCs from calf *M. Supraspinatus* (passage 3) B) SCs from Dairy cow *M. Semimebranosus* (passage 3). [a,b,c] Within muscle, bars not sharing a common letter are significantly different ($p<0.05$). (n=12, error bars indicate SD).

IV. CONCLUSION

Sustainable meat production can be viewed as a combination of conventional as well as cultivated meat production where the blood side stream from the conventional slaughterhouse can be used as a media in the cultivated meat production delivering growth factors and nutrients. We have so far shown that FBS can be exchanged with porcine serum or plasma sampled directly at a commercial slaughterhouse as media component with similar or better proliferation potential of the SCs.

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REFERENCES

1. Skrivergaard, S.; Rasmussen, M. K.; Therkildsen, M.; Young, J. F. (2021) Bovine satellite cells isolated after 2 and 5 days of tissue storage maintain the proliferative and myogenic capacity needed for cultured meat production. International Journal of Molecular Sciences, 22(16).
2. Skrivergaard, S.; Young, J.F.; Sahebekhtiari, N.; Semper, C.; Venkatesan, M.; Savchenko, A.; Stogios, P.J.; Therkildsen, M.; Rasmussen, M.K. (2023) A simple and robust serum-free media for the proliferation of muscle cells. Food Research International, bind 172, 113194.