Metabolizm energetyczny w oocytach i zarodkach przedimplantacyjnych bydła

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Abstract

Energy metabolism encompasses all biochemical processes by which cells obtain the energy necessary for proper functioning. This also applies to oocytes and embryos, in which energy homeostasis is fundamental to their high developmental competence. One of the regulatory elements of metabolism within the ovarian follicle are folliculosomes - extracellular vesicles that penetrate oocytes and modulate their metabolic pathways. Significant changes in energy acquisition and utilization are also observed in embryos at successive stages of preimplantation development. Therefore, research is being conducted to determine the effects of various factors on parameters of energy metabolism. This doctoral dissertation comprises two experiments focused on selected aspects of energy metabolism: (1) during in vitro maturation of oocytes, and (2) at subsequent stages of preimplantation development in bovine embryos.

In the first experiment, folliculosomes were characterized as elements of intercellular communication within the ovarian follicle, and their effect on oocytes maturing under physiological and metabolically compromised conditions was assessed. It was demonstrated that folliculosomes are transported into the oocyte via transzonal projections, and their uptake by follicular cells increases under metabolic stress. Supplementation of the IVM medium with folliculosomes (under both physiological and altered metabolic conditions) significantly improved culture quality parameters and positively influenced the lipidomic profile of the resulting embryos. These effects were also observed at the mRNA expression level and in the characterization of lipid droplets within the oocyte–cumulus complexes.

In the second experiment, lipid droplet parameters of bovine embryos were characterized at various stages of preimplantation development, from the zygote to the blastocyst stage. The analyses revealed that lipid droplet parameters undergo dynamic changes throughout preimplantation development. In bovine embryos, the most pronounced decline in lipid parameters was observed at the 8–16 cell stage, coinciding with embryonic genome activation. Lipid droplet parameters displayed species-specific features (cattle vs. pig): pig embryos had significantly larger lipid droplets at each developmental stage, but fewer droplets compared to cattle. Moreover, the presence of the male gamete (in vitro fertilization vs. parthenogenesis) was shown to influence these parameters. Particularly significant differences between IVF and parthenogenetic embryos were noted at key developmental stages, such as the 8–16 cell stage and blastocyst.

The obtained results describe, for the first time, folliculosomes as vesicles capable of compensating for deficits in oocyte–cumulus complexes caused by maturation under compromised energy metabolism. Additionally, a species-specific pattern of lipid droplet parameter changes was observed across preimplantation stages, which may serve as a sensitive indicator of embryo quality and developmental potential.

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