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Heat Stress Responses in Spermatozoa: Mechanisms and Consequences for Cattle Fertility

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Abstract

Currently, the world is facing the negative impact of global warming on all living beings. Adverse effects of global warming are also becoming obvious in dairy cattle breeding. In dairy bulls, low fertility has frequently been reported during summer season especially in tropical or subtropical conditions. Typically, spermatozoa at post-meiotic stages of development are more susceptible to heat stress. During this period extensive incorporation of histone modifications and hyperacetylation turns the chromatin into an unstable conformation. These unstable forms of chromatin are thought to be more vulnerable to heat stress, which may have an effect on chromatin condensation of spermatozoa. Spermatozoa with altered chromatin condensation perturb the dynamics of DNA methylation reprogramming in the paternal pronucleus resulting in disordered active DNA demethylation followed by *de novo* methylation patterns. In addition, there was a tendency of decreased size in both paternal and maternal pronuclei after fertilization of oocytes with heat-stressed spermatozoa, leading to lower fertilization rates. In this review, we will focus on the mechanisms of heat stress-induced sperm defects and provide more detailed insights into sperm-borne epigenetic regulations.

Keywords: Heat stress, bull fertility, sperm epigenetics, DNA methylation, miRNAs