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Sperm Mobility Determines Fertility in Roosters

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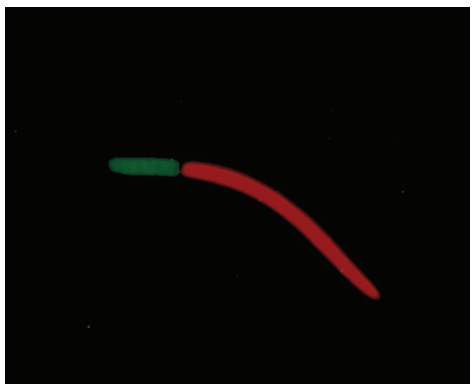
Fertility of meat-type chickens or broilers has declined significantly over the past several decades and is a major economic impediment to productivity in the broiler industry. Understanding sperm mobility (the ability of a population of sperm cells to move forward against resistance at body temperature) and motility (the ability to move forward under its own power) is essential to enhancing fertility in poultry. Research conducted at Oregon State University (OSU) by Dr. David Froman and sponsored by the National Research Initiative (NRI) has made substantial progress towards understanding the cause of reduced fertility in broiler roosters and in development of solutions to this problem.

Froman addressed three critical questions in previous NRI-sponsored research conducted at OSU. First, to what extent does sperm mobility affect rooster fertility? Work in Froman's laboratory demonstrated that sperm mobility is a primary determinant of fertility in roosters. Second, can sperm mobility be altered by genetic selection? Froman conducted breeding experiments with roosters selected for high rates of sperm mobility, and results demonstrated that there is a genetic component to rooster fertility. Third, what makes an individual sperm cell mobile? Computer-assisted sperm motion analysis demonstrated the distinction between mobile and motile sperm cells. If velocity was below critical speed, sperm cells were motile but not mobile. Only mobile sperm ascend the oviduct to fertilize the ova, or eggs, by moving against resistance within the hen's reproductive tract. Thus, the sperm mobility assay estimates the efficacy of a rooster's sperm cells as opposed to the number, shape, or integrity of sperm. A version of the sperm mobility assay, developed in Froman's laboratory and patented in 1999, is now available commercially. The sperm mobility assay is being used within the United States primary breeder industry to select roosters producing the most mobile sperm (and thus the most fertile sperm) for artificial insemination of hens.



Nancy Corn, Clemson University

PHOTOMICROGRAPH OF ROOSTER SPERM SHOWING THE SPERM HEAD OR NUCLEUS (STAINED RED) AND THE HELIX OF MITOCHONDRIA (STAINED GREEN) CONTAINED WITHIN THE TAIL OR AXONEME

Research conducted at Oregon State University has made substantial progress toward understanding the cause of reduced fertility in broiler roosters and in development of solutions to this problem.

Progressive motility depends upon the interaction between two organelles. The first is a molecular motor known as the axoneme, which is commonly called the sperm cell's tail. Motors do not function without energy input, and the chemical energy for the 'motor' of a sperm cell is generated by a helix of mitochondria (stained green in the accompanying photomicrograph), which surrounds the initial portion of the axoneme. Whereas the shape and dimensions of sperm cell organelles tend to be uniform, the movement of the sperm cell varies considerably among sperm within an ejaculate. Likewise, there is large variation in this quality among roosters within a population. Such variation can be detected by a sperm mobility assay, which measures the net movement of a sperm cell population against resistance at body temperature. This work has changed the dogma that sperm motility is an important determinant of rooster fertility when, in fact, it is sperm mobility that is much more important.

A SPERM MOBILITY ANALYZER IS NOW AVAILABLE COMMERCIALLY TO ASSESS FERTILITY OF ROOSTERS ON THE FARM

Sperm Mobility Analyzer, Animal Reproduction Systems, Chino, CA

Froman's current NRI-sponsored research has led to an understanding that some roosters ejaculate large numbers of sperm that contain dysfunctional mitochondria. Sperm from these roosters are immobile and, consequently, these males are subfertile. Proteomic analysis is now being used in an attempt to identify proteins that compromise a sperm cell's ability to function effectively as a self-propelled DNA delivery vehicle. Thus, Froman's long-term research goals are to discover genes that control male fertility and then to apply this information to improve reproductive performance of broiler breeder roosters, thereby improving productivity in the poultry industry.

IMPACT

OSU research has addressed the decrease in fertility of broiler roosters that is a major economic impediment to productivity in the broiler industry. This work demonstrated that sperm mobility is an important determinant of fertility and led to development of an assay to measure fertility of roosters on the farm. This sperm mobility assay is used successfully in the poultry industry to select breeder roosters with the greatest fertility. This work also provides a conceptual basis for understanding why cryopreservation has met limited success with chicken semen. Any technical advance in this area would be valuable to commercial poultry breeders.

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