Relieving stress on broiler breeder fertility through the use of phytogenics

How can stress impact male broiler breeder fertility? With the increasing global demand for affordable high-quality protein year on year, poultry meat production must be more efficient than ever.

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Normal commercial pressures for male and female broiler breeders can lead to untold stress on the bird. No matter what intervention is used, this is unavoidable. Maybe it can be reduced, but never eliminated.

Common sources of stress include climatic conditions (heat stress), environmental, physical, social (high stocking density, competition), nutritional (feed restriction), and physiological (a process of sexual maturity). These stressors can negatively impact the health and performance of poultry.

Adapting to stressful situations

Poultry can respond to stress and adapt to the 'situation' by activating the hypothalamus-pituitary-adrenocortical cascade, which causes a release of hormones such as corticosterone and cortisol, but as a result, can impair the production of reproductive hormones such as testosterone.

When testosterone levels are reduced, this can lead to a reduction in the spermatogenesis process as well as a reduction in sexual behaviour by the male.

Spermatogenesis is a concerted sequence of events during the maturation of spermatogonia into spermatozoa, and it is regulated by the interplay of different autocrine, paracrine and endocrine hormonal stimuli.

The development and maintenance of spermatogenesis are dependent on the pituitary gonadotrophins; follicle stimulating hormone (FSH), and luteinising hormone (LH). FSH affects independently, and together with testosterone, the proliferation, maturation, and function of the supporting Sertoli cells in the seminiferous tubules, these produce regulatory signals and nutrients to maintain developing germ cells.

Testosterone is a prerequisite for sperm production and maturation and activates the androgen in Sertoli cells to initiate the functional responses required for spermatogenesis. Sertoli cells form structurally and biochemically a supporting environment for the maturing germ cells, but, where the number is ultimately determined by FSH action.

When birds are stressed this can lead to the production of reactive oxygen species (ROS), which are deleterious to the birds' performance, but importantly, in this instance, sperm quality. The high lipid content of plasma membranes in sperm means they are susceptible to lipid peroxidation by ROS.

If seminal plasma lipid peroxidation increases, this causes morphological abnormalities and motility problems for sperm, negatively affecting fertility. The antioxidant capacity of sperm is low, but the enzymatic and nonenzymatic seminal plasma antioxidants protect sperm by scavenging ROS.

An effective antioxidant system can counteract cell membrane lipid peroxidation and reduce the production of ROS that cause damage to sperm DNA fragmentation, affecting progeny viability.

The characteristics of reduced fertility mainly include reduced semen volume, sperm concentration, viability, motility, and decreased antioxidant capacity. Oxidative stress inhibits steroidogenic enzymes for testosterone synthesis, impacting spermatogenesis and mating behaviour, therefore successful egg fertilisation.

Furthermore, stressors cause a central stress response primarily mediated by the hypothalamic-pituitary-adrenal (HPA) axis. This axis governs the multiple systems, including the reproductive system. Cortisol is synthesised and regulated in the hypothalamic-pituitary-adrenal (HPA) axis in response to stress.

Cortisol inhibits testosterone production by reducing the hypothalamic-pituitary-gonadal (HPG) activity and blocking the androgen receptors. If testosterone production is reduced, then spermatogenesis cannot occur optimally.

Fertility is one of the main influential factors tightly associated with the economic outcome in poultry flocks.

One male is responsible for producing a massive number of fertilised eggs, which can exceed more than 1,000 eggs per year. The hatching success rate will never be better than the male fertility rate.

Stress, alongside several other factors, such as genetics, age, and nutrition, can impair the characteristics of semen and reduce the fertility of poultry males. Female fertility is also important; however, as the ratio of males to females is low, male fertility is more important for overall flock fertility.

Impacting fertility through hormone manipulation?

More recently, phytogenic feed additives (PFA) have been given substantial attention because they are affordable, available, and safe. Most notably, in this case, PFA can contribute to enhancing the reproductive efficiency of poultry because of their antioxidant and anti-inflammatory properties and lower toxicity than synthetic antioxidants.

The antioxidant properties of Phytogenics are based on their ability to stimulate the cellular antioxidant capacity by stimulation of the cellular antioxidant response element (ARE), resulting in increased production of antioxidant enzymes like superoxide dismutase (SOD) and glutathione peroxidase (GPx).

Phytogenics can increase the synthesis of steroidogenesis and hence testosterone secretion and alleviate some of the harmful effects of stress.

Several authors have found that the addition of vitamin E, ginger, rosemary, turmeric and propolis have shown positive impacts on sperm characteristics. Fouad et al. (2020) explained that vitamin E enhanced the function of sperm mitochondria and reduced lipid peroxidation of the sperm membrane, to increase the sperm membrane integrity.

It could be suggested that these active ingredients that have antioxidant properties are required to maintain testis development, and thus spermatogenesis, which could explain the increase in sperm volume and concentration.

It also must be considered that any negative impact on reproductive performance can represent a considerable reduction in profit for the producer and industry due to the current price of day-old chicks and feed costs.

Phytogenic feed additives have been shown to reduce the effects of stress, as detailed above, minimising the impact on reproductive inefficiency.

The specific combination of active compounds can lead to increased testosterone production, thus improving fertility and ultimately increasing hatchability. ■

References are available from the authors on request