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Transgenerational epigenetic effects - we are how and what our parents ate?!

Epigenetics refers to heritable modifications in gene expression without an actual change in the underlying DNA nucleotide sequence (i.e. change in phenotype without change in genotype). DNA methylation, histone modification and non-coding/micro RNA gene silencing are considered primary mechanisms for epigenetic changes. Transgenerational epigenetic changes result in offspring showing phenotypic traits affected by the environmental circumstances of their parents. Numerous factors can result in epigenetic changes, including diet composition, feed and lighting regimes, toxins, maternal antibodies, hormones, antimicrobial compounds, microbiota, etc. (Berghof et al., 2013).

Commercially, broiler breeder hens may be fed around 60% of their *ad-libitum* feed intake to increase productivity and reduce costs (Hynd et al., 2016) and Van der Waaij et al. (2011) found that such feed restriction of these hens can result in their offspring weighing less, with more abdominal fat, at slaughter than offspring of *ad-libitum* fed hens. More recently, Hynd et al. (2016) grouped broiler breeder hens according to bodyweight (low, medium and high), fed them to maintain these differences and reported that male progeny raised to 42 days of age were heavier from high and medium bodyweight hens than low bodyweight hens. Maternal lighting regime has also been shown to influence the feeding behaviour and growth of their offspring. Two groups of hens were raised with a predictable or unpredictable lighting regime, while the offspring were exposed to a predictable lighting regime. Offspring from the unpredictable lighting regime were more competitive and grew faster (see Berghof et al., 2013). Broiler breeder (both maternal and paternal) nutrition is also a factor that can influence offspring development and performance (Chang et al., 2016). Feeding of medium to high energy and low protein diets, both early in the breeder’s life and the laying period, can enhance offspring performance, while progeny breast meat yield can be improved by increasing the energy:protein ratio from the rearing to laying phase. Other breeder nutrients, such as vitamins (e.g. D & E) and minerals (e.g. selenium, zinc & manganese), are considered to have a direct impact on offspring performance (Chang et al., 2016).

Parental nutrition can also influence intestinal development and immune function of their progeny. An enhanced broiler breeder diet (vitamin and mineral supplementation) altered immune and intestinal gene expression, while feeding a mycotoxin-contaminated diet to breeders changed macrophage activity and peripheral blood antibody concentrations (Berghof et al., 2013). Moreover, maternal antibodies may be potent immunoregulators and impact neonatal B and T cell repertoire, thus linking maternal antigen exposure to offspring immune development (Berghof et al., 2013). Similarly, maternal microbes can be transferred to offspring and help develop and educate their immune system, although some production practices (e.g. egg disinfection) interfere with this transference, which is unlikely to be desirable. Soler et al. (2011) investigated the relationship between innate immunity (natural antibodies) and eggshell bacterial density and reported a negative relationship, which may mean that enhanced parental immune function can reduce the transfer of less desirable microbes to offspring.

Conclusion

There is increasing awareness of parental influences, beyond genotype, on the development and growth of their progeny, including epigenetic processes. Studies show that parental nutrition, feed and lighting regimes, antibodies, microbiota, etc. can impact the behaviour, health (e.g. immune function, pathogen transference, etc.,) and productivity of the offspring. Given the number of descendants that breeding stock can have, there is clear justification to increase our focus on the parent generations to suitably influence the attributes of their progeny. This can have considerable advantages in better preparing the offspring for independent life, thus facilitating a better start, which is likely serve them well throughout their productive life. Furthermore, in poultry, *in-ovo* manipulation offers great promise to better prepare hatchlings for post-hatch life. These approaches support concepts based on early-life interventions as being particularly effective to promote animal health, welfare and productivity.

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