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Effects of growth pattern and dietary protein level during rearing on feed intake, eating time, eating rate, behavior, plasma corticosterone concentration, and feather cover in broiler breeder females during the rearing and laying period

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ABSTRACT

An experiment was conducted to evaluate the effect of growth patterns (GP) and dietary crude protein levels (CP) during rearing (2–22 weeks of age) on feed intake, eating time, eating rate, behavior, plasma corticosterone concentration, and feather cover in broiler breeder females during the rearing and laying period. A total of 768 day-old Ross 308 broiler breeder chicks, of which 288 hens were followed during the laying period, were allotted to 6 different treatments during the rearing period according to a 2 × 3 factorial design, with 8 replicates (pens) per treatment. Two growth patterns were followed by a restricted feeding regime up to a target body weight (BW) at 20 weeks of age of 2200 g (standard growth pattern = SGP) and 2400 g (high growth pattern = HGP) and 3 dietary protein levels (high = CPh, medium = CPm, and low = CPl). During lay, all birds were fed a standard breeder diet and followed a standard growth pattern. During rearing, HGP birds were fed on average 6.5% more feed than SGP birds. In HGP birds, eating time (min/day) during the rearing period increased by 17%, whereas eating rate (g feed/min) decreased by 8%, compared to SGP birds. This prolonged feeding behavior of HGP birds, but stereotypic object pecking and animal pecking was not reduced. Feather cover was not affected by growth pattern during the rearing and laying period. Only at 16 weeks of age a lower plasma corticosterone concentration was found for the HGP birds. HGP birds showed more feeding and sitting behavior, but less foraging behavior during the rearing period, while during the laying period only more walking behavior was observed. In order to maintain target weights, feed intake levels of CPm and CPl during rearing were set 4.6 and 10.0% higher than CPh, whereas eating time was increased by 22 and 63% and eating rate was decreased by 9 and 26%, respectively. A prolonged eating time during rearing for CPm and CPl birds resulted in more time spend feeding and resting and less stereotypic object pecking and animal pecking compared to CPh birds during rearing. In contrast to the rearing period, feed intake and eating time were not affected by CP level during rearing at 22 weeks of age, whereas eating rate was increased by 8 and 16% for CPm and CPl, respectively, compared to CPh. At 27 weeks of age the effect of CP level during rearing on eating rate had disappeared. Plasma corticosterone concentrations were not affected by dietary protein level during

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the rearing and laying period. Feather cover was inferior by lowering the dietary protein level, in particularly during the first 11 weeks of rearing. No effect of GP was found on feather cover. It is concluded that dietary protein levels positively affected some behavioral traits during the rearing period, whereas these traits were only slightly affected by growth patterns. However, the physiological parameter (plasma corticosterone concentration) was not affected.

1. Introduction

Over the past 30 years, growth potential of broiler breeders has increased drastically, due to selection on growth and feed efficiency of the progeny (Renema et al., 2007). *Ad libitum* feeding of such broiler breeder females during the rearing period resulted in a high BW prior to the laying period, resulting in excessive mortality (Heck et al., 2004) and decreased reproductive performance (Yu et al., 1992; Hocking et al., 2002). Therefore, feed intake of broiler breeders during rearing is restricted to 25–33% of *ad libitum* intake (Savory et al., 1996; De Jong et al., 2002). The most severe restriction usually occurs between 7–8 and 15–16 weeks of age (De Jong and Jones, 2006). Feed restricted broiler breeders show behavioral disorders that are indicative of hunger and frustration, such as stereotypic object pecking and over-drinking (i.e., Hocking et al., 1996, 2001; Savory and Kostal, 1996; De Jong et al., 2002). In addition, indicators of chronic stress in birds such as increased plasma corticosterone concentrations (Hocking et al., 1996; Savory and Mann, 1997; De Jong et al., 2002) and increased heterophil to lymphocyte (H/L) ratios (Hocking et al., 1993, 1996; Savory et al., 1993) are observed.

The best method for improving welfare in parent stock of so-called fast growing broilers is not yet elucidated. One of the methods to reduce the negative effects of feed restriction on bird welfare could be the application of alternative feeding strategies that may enhance eating time during the day (De Jong and Van Krimpen, 2011). De Jong et al. (2005a) applied scattered feeding and feeding twice a day during rearing, thereby increasing eating time, but they did not find any effect on physiological indicators of stress and hunger. Nielsen et al. (2011) found that high levels of dietary insoluble fibre in the rearing period, in combination with scattered feeding, may improve the welfare of broiler breeders. Diluting the feed also increased the time spent eating, which is noted as a promising method for improving bird welfare (Hocking et al., 2004; De Jong et al., 2005b). In some studies, dietary dilution (by adding fibre) reduced stereotypic object pecking (De Jong et al., 2005b; Hocking et al., 2004), although these effects were not observed in other studies (Hocking, 2006; Jones et al., 2004). It could be argued that feeding a lower dietary protein level while maintaining the same growth rate demands a higher feed intake level and prolonged feeding behavior which may decrease stereotypic pecking behavior (Hocking et al., 2004; Mason et al., 2006). To the authors knowledge, no studies until now have been conducted in which dietary protein levels and growth patterns are investigated together. The current study aimed to evaluate the effects of different growth patterns and dietary protein levels on feed intake, eating time, behavioral traits, plasma corticosterone concentration, and feather cover in broiler breeder females. It was hypothesized that a high growth pattern (a 200 g higher BW at 20 weeks of age) and a low dietary protein level would increase eating time and decrease stereotypic behavior, thereby improving broiler breeder welfare.

2. Materials and methods

2.1. Housing, birds, and management

A total of 768 day-old Ross 308 female broiler breeder chicks were housed in two identical climate-controlled rooms. All chickens were individually identified by wing tags, beaks were trimmed at 3 days of age. Each room contained 24 floor pens (0.90 m × 1.50 m), and each pen contained 16 birds at the start of the experiment. This number was gradually reduced to 6 pullets at 20 weeks of age due to grading (removing the smallest pullets) and dissection procedures (Van Emous et al., 2013). So, initial stocking density of 11.9 pullets per m^2 at day old was reduced to 4.4 pullets per m^2 at 20 weeks of age. The sidewalls of the pens were built of wire so that pullets could see birds in other pens. Each pen contained 2 perches (1.8 m total length), 2 feeding troughs (1.0 m total length), and 4 nipple drinkers (nipple line was also used as perch), whereas wood shavings were used as litter. During the first two days, temperature in the house was maintained at 33 °C. From day 3 onwards, the temperature was gradually reduced to 20 °C at 5 weeks of age. Light was set at 24 h per day for the first two days, with a gradual reduction to 8 h at day 21, which was maintained until day 147 (week 21). Birds were photostimulated with 11 h of light in week 22, and day length was gradually extended by 1 h (later 0.5 h) per week to a L:D schedule of 15 h of light and 9 h of dark at 27 weeks of age. The photoperiod lasted from 04:00 to 19:00 h. This schedule was maintained until the end of the experiment at 40 weeks of age. During rearing and laying, a light intensity of 20 and 60 lx, respectively, was applied at bird level.

Feed was provided *ad libitum* during the first two weeks of the rearing period. Thereafter birds were fed restricted to keep the respective target body weight (BW). Birds were fed every day and all diets were provided in mash form. Water intake was restricted during the rearing and laying period by limiting the water supply till 2 h after feeding time, in order to prevent over-drinking. Throughout the experiment, litter quality was maintained by adding new wood shavings every 6 weeks. At 20 weeks of age, an accessible laying nest was placed at the front side of each pen, while one of the feeding troughs was removed. Pullets were vaccinated according to a standard vaccination program