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Effects of different dietary protein levels during rearing and different dietary energy levels during lay on behaviour and feather cover in broiler breeder females

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ABSTRACT

An experiment was conducted to determine the effects of different dietary protein levels during rearing and different dietary energy levels during lay on behaviour and feather cover in broiler breeder females. A $2 \times 3 \times 2$ factorial arrangement of treatments was used. A total of 2880 Ross 308 14-day-old broiler breeder pullets were fed between weeks 2 and 22, a high (CPh) or low (CPl) crude protein (CP) diet. Between weeks 22 and 45, the breeders were fed either a high, standard, or low energy diet (3000, MEh1; 2800, MEs1; 2600, MEl1, kcal/kg AME_n (apparent metabolisable energy, corrected for nitrogen), respectively). Between weeks 45 and 60, the breeders were fed a standard or high energy diet (2800, MEs2; 3000, MEh2, kcal/kg AME_n, respectively). During rearing, CPl pullets received 12.1% more feed, resulting in a 137% increased eating time and 47% decreased eating rate. This increased feeding, sitting, and comfort behaviour while standing, walking, foraging, stereotypic object pecking, and bird pecking were reduced. Feather cover was poorer when pullets were fed a low protein diet during rearing, but this effect was not present during lay. A 7.6% lower feed intake for the MEh1 birds resulted in a 21% decreased eating time and 19% increased eating rate compared with the MEs1 birds. Birds on the MEh1 diet spent less time feeding and more time sitting, comfort, and stereotypic object pecking behaviour compared with the MEs1 birds. Birds fed the MEh1 diet showed a poorer feather cover during the entire lay compared with the MEs1 birds. A 7.7% higher feed intake for the MEl1 birds resulted in a 31% increased eating time and 18% decreased eating rate compared with the MEs1 birds. MEl1 birds spent more time feeding and less time foraging, comfort, and stereotypic object pecking compared with the MEs1 birds. No effect on feather cover was found for the MEl1 compared with the MEs1 birds. The MEh2 birds received 8.8% less feed resulted in a 16% decreased eating time and 9% increased eating rate. The lower feed intake resulted in less time spent feeding and standing, and more time spent foraging and comfort behaviours. Feather cover was not affected by dietary energy level during the second phase of lay. In conclusion, feeding broiler breeders a higher amount of feed due to a higher energy-to-protein ratio resulted in an increased eating time and less stereotypic object pecking behaviour what is an indication of reduced hunger and frustration. This was much more expressed during rearing than lay. However, a low daily protein intake during rearing and first phase of lay can lead to a poorer feather cover.

1. Introduction

Due to the directed selection for faster growth and feed efficiency of broilers during the last decades, also broiler breeders show these traits (Renema et al., 2007). Modern broiler strains show a four times higher daily growth, while feed conversion ratio is less than half compared with strains in use 60 years ago (Zuidhof et al., 2014). The detrimental impact of a high genetic growth potential of breeder pullets has been observed by several researchers who found significant negative effects on production and mortality when breeders were provided feed *ad libitum* (see Renema and Robinson, 2004 for a review). To prevent these problems, broiler breeders are feed restricted between 67 and 75% of *ad libitum* feed intake during the rearing period (Savory et al., 1996; De Jong et al., 2002) and up to 50% during laying (Bruggeman et al., 1999). It is suggested by Van Emous et al. (2014) that feed restriction level for modern-day breeders is more severe due to the still increasing growth potential of the offspring. Feed restriction compared

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with *ad libitum* feed intake can lead to a seven times lower mortality, improved egg quality, 1.5 times higher peak production and 20–25% higher egg production (Heck et al., 2004). On the other hand, numerous studies have shown that feed restricted broiler breeders show behavioural disorders (stereotypic object pecking, over-drinking, and pacing) that are indicative of frustration, boredom, and hunger (De Jong and Jones, 2006; D'eath et al., 2009). Stereotypic object pecking normally starts after feeding, and is mostly performed at the litter, drinkers, feeders, walls of the pen, or to flock mates (Kostal et al., 1992; Savory and Maros, 1993; Savory and Kostal, 1996; De Jong et al., 2002; Hocking et al., 2002). To prevent over-drinking, also water intake is often restricted in practice (Van Krimpen and De Jong, 2014). Pacing is mainly observed before feed is provided to the birds (Savory and Maros, 1993). Improving behaviour and, thereby, welfare in broiler breeders is not a simple task because feed restriction is regular practiced (Decuypere et al., 2010). During the past two decades, researchers have investigated alternative management strategies (feeding and diet composition) to improve welfare by reducing the negative effects of feed restriction in combination with an adequate growth pattern and reproduction results. Scatter feeding and feeding twice a day during rearing resulted in an increased eating time but no positive effects on physiological indicators of stress and hunger (De Jong et al., 2005a). Scatter feeding in combination with high levels of dietary insoluble fibre may improve welfare of broiler breeders due to the absent of stereotypic object pecking and increased dust bathing and comfort behaviour (Nielsen et al., 2011). Dilution of the feed increased the time spent eating, which is noted as a promising method for improving breeder welfare (De Jong et al., 2005b). In some studies, dietary dilution (by adding fibre) reduced stereotypic object pecking (Hocking et al., 2004; De Jong et al., 2005b), although these effects were not observed in other studies (Jones et al., 2004; Hocking, 2006). Recently, a partly diluted diet (isocaloric and low CP) was applied to breeder pullets that resulted in an increased eating time, decreased eating rate, increased resting, and decreased stereotypic pecking behaviour (Van Emous et al., 2014).

Besides feed restriction, a poor feather cover also has negative effects on welfare of the broiler breeders (Van Emous and De Jong, 2013). A good feather cover is important to protect broiler breeders from skin damage caused by objects or rough mating behaviour (De Jong et al., 2009) and for thermoregulation of the birds as shown in layers (Peguri and Coon, 1993). The quality of feather cover of broiler breeders has decreased over the last decade due to hitherto, unknown reasons (Van Emous and De Jong, 2013). However, dietary CP level is considered as a major nutritional factor influencing feather growth and development (Urdaneta-Rincon and Leeson, 2004). Previous research suggests that dietary CP level affects feather growth (Twining et al., 1976; Aktare et al., 1996; Melo et al., 1999). Moreover, Van Emous et al. (2014) found that feeding low protein diets during rearing to breeder pullets negatively affected feather cover during the initial rearing period.

Most studies, which are conducted to improve the behaviour of breeders, focused on effects of different feeding strategies during the rearing period (*e.g.* Hocking et al., 2004; Jones et al., 2004; De Jong et al., 2005a,b; Hocking, 2006). The current study was conducted to investigate the effects of different dietary protein levels during the rearing period as well as the effects of different dietary energy levels during the laying period on behaviour and feather cover in broiler breeder females.

2. Materials and methods

The protocol for the experiment conformed to the standards for animal experiments and was approved by the Ethical Committee of Wageningen UR, The Netherlands.

2.1. Experimental design

The study consisted of a $2 \times 3 \times 2$ factorial completely randomised design with two CP levels (CPh = high protein; or CPl = low protein) during rearing between 2 and 22 weeks of age; high, standard, and low dietary energy levels during the first phase of lay between 22 and 45 weeks of age (3000, MEh1; 2800, MEs1; 2600, MEl1, kcal/kg AME_n, respectively) with 14.4% CP, 0.53% dig Lys., and 0.50% dig. M + C; and standard and high dietary energy levels during the second phase of lay between 45 and 60 weeks of age (2800, MEs2; 3000, MEh2, kcal/kg AME_n, respectively) with 14.1% CP, 0.52% dig. Lys., and 0.49% dig. M + C.

2.2. Birds, housing, and management

A total of 3000 Ross 308 female broiler breeder one-day-old chicks (Aviagen-EPI, Roermond, The Netherlands) were allotted to 36 floor pens (4. 5×2.5 m) in two identical climate rooms. The experiment started at 14 day with 80 pullets per pen (2880 in total). From the first day, an extra pen was available for 120 extra pullets to replace dead chicks until 14 days. Due to mortality, sex errors, and culling (removing the smallest), the number of pullets gradually reduced to 76 (week 6), 73 (week 15), and 70 (week 22). Males were reared elsewhere and introduced into the pens when the hens were 23 weeks of age (eight per pen; male/female ratio of 11.4%). Male/female ratio was gradually reduced (due to adaptation problems) to 10.0% (seven males/pen) and 7.1% (five males/pen) at 25 and 27 weeks of age, respectively. At 34 and 36 weeks of age, one original male per pen was replaced by a sexually mature spike male. At 47 weeks of age, one (small and/or inactive) male per pen was culled leaving four males per pen.

The pullets were housed in pens with wood shavings and an elevated floor (1.2×2.0 m) with plastic slats. The sidewalls of the pens were constructed from wire mash so that pullets could see birds in other pens. Pullets were fed by manual feeding pans till 15 weeks of age and from that age onwards an automatic pan feeding system (5 pans; each 16 holes) with a male exclusion system was used. Males were provided feed in one manual feeding pan per pen, which was located at a minimum height of 50 cm to prevent female access to the feed. Water was provided by one bell drinker per pen located above the litter floor till 11 weeks of age and from that age onwards above the slatted floor. Per pen, four laying nests (94×33 cm) were available to the hens from 23 weeks of age onwards. During the rearing and laying period, feed was provided at 07:45 and 10:30 h, respectively. Water was provided, for each specific dietary treatment, from 15 min before provision of the feed to 2 h after the feeding pans were emptied. This meant that treatments with a longer eating time, due to a larger amount of feed, had access for a longer time to water. Feed was provided *ad libitum* during the first 2 weeks of the rearing period and from 14 day onwards pullets were fed restricted amounts of feed every day. Birds were fed amounts of feed to maintain the breeder recommended target BW during the entire experiment (Aviagen-EPI, Roermond, The Netherlands).

During the rearing period, pullets followed a four phase feeding system (diets in mash form). The starter-1 diet was fed from weeks 0 to 2, the starter-2 diet from weeks 2 to 6, the grower diet from weeks 6 to 15, and the pre-breeder diet from weeks 15 to 22. Within each phase, diets were formulated to be isocaloric (AME_n basis) and digestible amino acids were lowered by 16% for the CPl diet when compared with the CPh diet. Diets during lay were formulated to be isonitrogenous. Treatments comprised of 18, 6, and 3 replicates per treatment in the rearing period, first, and second phases of the laying period, respectively. Males received a standard male diet (2560 AME_n kcal/kg; 12.9% CP; 0.4% dig. Lys; 0.4% dig. M + C; 1.0% Ca;