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Influence of feed form and energy concentration of the rearing phase diets on productivity, digestive tract development and body measurements of brown-egg laying hens fed diets varying in energy concentration from 17 to 46 wk of age

B. Saldaña[a], C.E. Gewehr[a,1], P. Guzmán[a], J. García[b], G.G. Mateos[a,*]

[a] Departamento de Producción Agraria, Universidad Politécnica de Madrid, 28040 Madrid, Spain
[b] Camar Agroalimentaria, S.L., 45214 Toledo, Spain

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ABSTRACT

The influence of feed form and energy content of the rearing phase diets on hen productivity, gastrointestinal tract (GIT) traits and body measurements was studied in brown-egg laying hens fed diets differing in energy concentration from 17 to 46 wk of age. The experiment was completely randomized with 12 treatments arranged as a $(2 \times 3) \times 2$ factorial with two feed forms (mash vs. crumbles) and three AME_n concentrations of the rearing phase diets (low, medium and high) and two AME_n concentrations (11.10 vs. 11.52 MJ/kg) of the laying phase diets. The AME_n of the rearing phase diets differed in 0.42 MJ/kg in all three periods (1–5 wk, 5–10 wk and 10–17 wk of age). Hen productivity was determined from 17 to 46 wk and GIT and body traits were measured at 46 wk of age. The characteristics of the rearing phase diets did not affect any of the production, GIT traits or body measurements studied during the laying phase, except body weight gain (BWG) from 17 to 46 wk of age that was higher ($P < 0.01$) in hens that were fed mash during the rearing phase than in hens that were fed crumbles. An increase in the energy content of the laying phase diet from 11.10 to 11.52 MJ AME_n/kg reduced feed intake ($P < 0.001$) and improved feed conversion ratio ($P < 0.001$) from 17 to 46 wk and reduced gizzard contents ($P < 0.01$) at 46 wk of age but did not affect any of the other production trait studied. The characteristics of the rearing and laying hen diets did not affect any of the GIT traits or body measurements at 46 wk of age. Body weight of the hens was positively ($P < 0.001$) related with body length, body mass index, tarsus length and tarsus diameter at this age. The data indicate that neither feed form nor energy concentration of the rearing phase diets affected subsequent hen performance. An increase in the AME_n content of the layer diet from 11.10 to 11.52 MJ/kg decreased feed intake and improved feed conversion ratio but did not affect hen production or egg quality.

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Abbreviations: AME_n, apparent metabolisable energy, corrected for nitrogen; ADFI, average daily feed intake; BMI, body mass index; BW, body weight; BWG, body weight gain; FCR, feed conversion ratio; GIT, gastrointestinal tract; HE, high energy; LE, low energy; LNA, linoleic acid; ME, medium energy.

* Corresponding author.
E-mail address: gonzalo.gmateos@upm.es (G.G. Mateos).
[1] Current address: Departamento de Produção Animal, Universidade do Estado de Santa Catarina, 88520-000 Lages, Brazil.

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1. Introduction

Light hens produce less eggs at the start of the laying period and lay smaller eggs during the laying cycle than heavy hens (Leeson et al., 1997; Pérez-Bonilla et al., 2012a), resulting in a reduction in flock profitability (Pérez-Bonilla et al., 2012b). Two potential nutritional strategies used for increasing the initial body weight (BW) of the hens at the onset of egg production are the feeding of crumbled diets (Frikha et al., 2009a; Gous and Morris, 2001; Saldaña et al., 2015a) and the use of high energy diets (Frikha et al., 2009b; Saldaña et al., 2015b) during the rearing phase. However, Nir et al. (1994) and Serrano et al. (2013) in broilers and Guzmán et al. (2015a) and Saldaña et al. (2015a, b) in pullets, have shown that feeding crumbles or pellets reduced the relative weight (g/kg BW) of the gizzard and the development of the gastrointestinal tract (GIT) as compared with feeding mash. Also, when the energy concentration of the diet increases, fiber content decreases, which also reduces GIT development (González-Alvarado et al., 2007; Jiménez-Moreno et al., 2009a; Sacranie et al., 2012). A poorly developed GIT affects feed intake and might result in pullets not consuming enough energy to meet their requirements for optimal egg production during the first weeks of the laying phase (Pérez-Bonilla et al., 2012b; Guzmán et al., 2016). Consequently, the effects of greater BW but reduced GIT capacity at 17 wk of age, because of feeding a high energy diet in crumble form during the rearing phase, might counteract each other and the final effect on egg production and egg size might depend on other nutritional and management practices.

Laying hens eat to satisfy their energy requirements and therefore, voluntary feed intake decreases as the energy content of the diet increases (Leeson et al., 1997). However, low energy diets might result in hens consuming less feed than required to maximize egg production, especially in light birds at the onset of egg production (Pérez-Bonilla et al., 2012a). Moreover, high energy diets contain usually increased amounts of supplemental fat which may result in improved feed efficiency and an increase in egg size (Mateos and Sell, 1981; Grobas et al., 1999a).

Body measurements, such as body length, body mass index (BMI; g BW/body length^2) and tarsus length and diameter, are useful criteria to predict body size and future production of laying hens (Ojedapo et al., 2012; Guzmán et al., 2016). However, the information available on the effects of the characteristics of the rearing and laying hen diets on these variables are limited.

The hypothesis of this research was that pullets fed high energy diets in crumble form during the rearing phase could have greater BW but less developed GIT at the start of the laying phase than pullets fed low energy diets in mash form, which could result in similar productivity during the laying phase. Also, feeding low energy diets during the laying phase could result in reduced egg mass production and egg weight, effects that could be more pronounced in those hens that were lighter or had a poor developed GIT at the onset of the egg production cycle. This research evaluated the effects of feed form and energy concentration of the rearing phase diets on performance, egg quality, digestive tract traits and body measurements of hens fed diets differing in energy concentration from 17 to 46 wk of age.

2. Materials and methods

The procedures described in this research were approved by the Animal Ethics Committee of the Universidad Politécnica de Madrid and were in compliance with the Spanish guidelines for the care and use of animals in research (Boletín Oficial del Estado, 2007).

2.1. Husbandry, diets and experiment design

Details on bird management and feeding program from hatching to 17 wk of age have been reported by Saldaña et al. (2015b). Briefly, one-day-old Lohmann Brown Classic pullets were placed in an environmentally controlled barn and allotted in groups of 50 into 36 cages with similar initial average BW. The feeding program consisted of three periods (0–5 wk, 5–10 wk and 10–17 wk of age) in which the energy concentrations of the diets varied in 0.42 MJ/kg (from 11.93 to 12.77, 11.30 to 12.14 and 11.10 to 11.94 MJ AME_n/kg for the three feeding periods, respectively). During the rearing phase, the treatments consisted in six diets arranged as a 2 × 3 factorial with two feed forms (crumbles vs. mash) and three energy concentrations (LE, low energy, ME, medium energy; HE, high energy). Each treatment was replicated six times. All diets had similar amino acids and nutrient content per unit of energy. The ingredient composition and the calculated and determined nutritive value of the rearing phase diets are shown in Table 1.

At 17 wk of age, pullets from each of the six previous rearing treatments (LE, ME and HE in mash or crumble form) were pooled and then, distributed in groups of nine birds into ten enriched cages (40 cm × 80 cm × 68 cm; Facco S.A., Padova, Italy). Half of the cages of each of the six groups received a low energy layer diet (11.10 MJ AME_n/kg) and the other half a high energy layer diet (11.52 MJ AME_n/kg). The two layer diets had the same nutritive value per unit of energy (FEDNA, 2010). Feed in mash form and water were provided for ad libitum consumption. The light program consisted of 15 h for the first week of the experiment and 16 h thereafter. Room temperature was recorded daily throughout the experiment with a maximum of 27 ± 3 °C (July, second period of the experiment) and a minimum of 23 ± 3 °C (January, last period of the experiment). The experiment lasted for seven periods of four week each, with the exception of the first period that lasted five wk (17–22 wk). The ingredient composition and the calculated and determined analyses of the laying phase diets are shown in Table 2.

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