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A comparative study on the effects of dietary sunflower hulls on growth performance and digestive tract traits of broilers and pullets fed a pullet diet from 0 to 21 days of age☆

M.V. Kimiaeitalab, S. Mirzaie Goudarzi, E. Jiménez-Moreno, L. Cámara, G.G. Mateos*

Departamento de Producción Agraria, Universidad Politécnica de Madrid, 28040 Madrid, Spain

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ABSTRACT

The effects of the inclusion of sunflower hulls (SFH) in the diet on growth performance, coefficient of total tract apparent retention (CTTAR) of nutrients, gastrointestinal tract (GIT) traits and short chain fatty acid (SCFA) concentration in the cecum were studied in chicks from 0 to 21 d of age. Treatments consisted in the combination of two chicken lines (female broilers vs. pullets) and two levels of SFH inclusion (0 vs. 30 g/kg). The control diet contained 11.94 MJ AME_n, 191 g crude protein, 9.8 g digestible Lys and 101 g neutral detergent fiber/kg. The experimental diet included 30 g SFH/kg at the expense (wt:wt) of the control diet. Growth performance was better ($P < 0.001$) in broilers than in pullets at all ages. Moisture content of the excreta was lower ($P < 0.001$) in pullets than in broilers at 21 d of age but an opposite effect was observed at 9 d. At 9 d of age, nutrient retention ($P < 0.001$) and AME_n of the diet ($P < 0.01$) were higher in broilers than in pullets but at 21 d of age the only difference detected was for N retention ($P < 0.001$). In absolute terms (g or cm) broilers had heavier ($P < 0.001$) digestive organs and longer small intestine (SI) and cecum than pullets. In relative terms, however, the GIT ($P = 0.062$), proventriculus ($P < 0.001$), gizzard ($P < 0.001$) and pancreas ($P < 0.01$) were heavier at 21 d, and the SI and the cecum were longer ($P < 0.001$) at both ages in pullets. SFH inclusion did not affect growth performance or organ weights at any age but increased the absolute length of the SI and cecum and the AME_n of the diet at 21 d of age ($P < 0.05$). At 21 d of age, fiber inclusion reduced moisture content of the excreta in broilers but no effects were observed in pullets ($P < 0.05$ for interaction). The pH of the GIT and the concentration of SCFA in the cecum were not affected by chicken line or SFH inclusion. Villus height and crypt depth were higher ($P < 0.001$) in broilers than in pullets but were not affected by SFH inclusion. In summary, broilers showed greater growth performance and nutrient retention at 9 d of age and better ileum absorptive capacity at 21 d than pullets. The dilution of the diet with 30 g SFH/kg did not affect chick performance and in fact, improved the AME_n of the diet in both chicken lines at 21 d of age.

Abbreviations: ADFI, average daily feed intake; AME_n, apparent metabolisable energy nitrogen corrected; BW, body weight; CD, crypt depth; CP, crude protein; CTTAR, coefficient of total tract apparent retention; DDGS, distiller's dried grains with solubles; DM, dry matter; ECR, energy conversion ratio; EI, energy intake; F:G, feed to gain ratio; GE, gross energy; GIT, gastrointestinal tract; N, nitrogen; NDF, neutral detergent fiber; OH, oat hulls; OM, organic matter; SCFA, short chain fatty acid; SI, small intestine; SFH, sunflower hulls; VH, villus height

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* Corresponding author.
E-mail address: gonzalo.gmateos@upm.es (G.G. Mateos).

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1. Introduction

Current genetic selection programs for poultry aim to improve growth rate, feed to gain ratio (F:G) and meat yield in broilers and to maximize future egg production in pullets. Consequently, the two chicken lines differ not only in voluntary feed intake and body weight (BW) gain but also in basal metabolism (Kuenzel and Kuenzel, 1977), protein turnover rate (Jones et al., 1986; Saunderson and Leslie, 1988) and organ development (Lilburn and Loeffler, 2015; Kimiaeitalab et al., 2017).

Under commercial conditions, the inclusion of fibrous ingredients is limited in diets for young birds because of its negative impact on feed intake and nutrient utilization (Sklan et al., 2003; Rougiere and Carre, 2010). Recent researches, however, have shown that moderate amounts of certain insoluble fiber sources, such as oat hulls (OH) and sunflower hulls (SFH), stimulates the development and health of the gastrointestinal tract (GIT) in broilers (González-Alvarado et al., 2008; Svihus, 2011; Sacranie et al., 2012). However, few researches are available on the effects of fiber on growth performance, GIT traits and nutrient digestibility in pullets. Kimiaeitalab et al. (2017) reported that SFH inclusion had similar effects on growth, nutrient retention and villus development in both chicken lines. Walugembe et al. (2014), however, observed that the inclusion of 160 g/kg of a mixture of a wheat distiller's dried grains with solubles (DDGS) and wheat bran, reduced feed intake and BW gain in broilers but had no effects in pullets. The reasons for these discrepancies, however, are not well understood.

In commercial practice, pullet diets contain less energy and crude protein (CP) and more neutral detergent fiber (NDF) than broiler diets. Moreover, because of their lower energy requirements, pullets are fed often diets based on wheat and barley with limited use of maize. As a consequence, differences in chick growth and in the characteristics and ingredient composition of the diets, the two chicken lines might respond in different ways to additional fiber. The aim of this experiment was to compare the effects of the inclusion of moderate amount of an insoluble fiber source in the diet, on growth performance, nutrient retention and GIT development of broilers and pullets fed a pullet diet in mash form from 0 to 21 d of age. A second objective was to compare the data of the current research, using a pullet diet based on wheat and barley, with data of a previous research (Kimiaeitalab et al., 2017) in which both chicken lines were fed a broiler diet based on maize.

2. Materials and methods

2.1. Sunflower hulls and diets

The physico-chemical characteristics of the batch of the SFH were reported by Kimiaeitalab et al. (2017). Briefly, SFH contained 47 g CP and 700 g NDF/kg and had a geometric mean diameter ± geometric standard deviation of 675 ± 1.68 μm.

The control diet used in this experiment contained 11.94 MJ AME_n, 191 g crude protein, 9.8 g digestible Lys and 101 g NDF per kilogram, and included 20 g/kg of celite, an acid-washed diatomaceous earth (Celite Hispanica S.A., Alicante, Spain), to increase the acid insoluble ash content of feeds and excreta. The fiber containing diet was similar to the control diet but was diluted (wt:wt) with 30 g SFH/kg. Consequently, the experimental diet had less AME_n and CP and more NDF than the control diet (Table 1). Both diets, however, met or exceeded the nutritional requirements of pullets (FEDNA (Fundación Española Desarrollo Nutrición Animal), 2008).

2.2. Husbandry and experimental design

The husbandry and care of the chicks were similar to those reported by Kimiaeitalab et al. (2017). Briefly, 280 one day-old chicks, 140 Ross 308 female broilers and 140 Lohmann Brown Classic pullets were used. The birds were housed at random in groups of 10 according to chicken line, in 28 battery cages. The experiment was conducted as a completely randomized design with 4 treatments arranged as a 2 × 2 factorial with two chicken lines (female broilers vs. pullets) and two levels of dietary SFH (0 vs. 30 g/kg). Each treatment was replicated seven times and the experimental unit was a cage with 10 birds.

2.3. Growth performance and coefficients of total tract apparent retention of nutrients

Average daily feed intake (ADFI), BW gain and feed to gain ratio (F:G) were determined by period (0–9 d and 10–21 d) and for the entire experiment (0–21 d). The coefficient of total tract apparent retention (CTTAR) of dry matter (DM), organic matter (OM), nitrogen (N) and gross energy (GE) of the diets were determined at the end of the two experimental periods. Diets and excreta were analyzed for moisture by oven-drying (method 930.15), total ash by muffle furnace (method 942.05), and nitrogen (**N**) by Dumas (method 968.06), using a LECO analyzer (Model FP-528, Leco Corporation, St. Joseph, MI) as described by AOAC International (Association of Official Analytical Chemist Internatinal) (2000). Gross energy was measured using an isoperibol bomb calorimeter (model 1356, Parr Instrument Company, Moline, IL). Energy intake (EI; KJ AME_n/day) and energy conversion ratio (ECR; KJ AME_n ingested/g BW gain) were estimated, using the average AME_n content of the diets determined at 9 and 21 d of age as indicated by de Coca-Sinova et al. (2011). Briefly, clean plastic pans were placed beneath the cages at 7 and 19 d of age, and representative samples of the excreta were collected daily for 3 d. The samples were dried in oven at 60 °C for 72 h, ground with a laboratory mill (model Z-I, Retsch, Stuttgart, Germany) fitted with a 1-mm screen, mixed by replicate and stored at 4 °C until further analyses.

2.4. Gastrointestinal tract traits

Details on the procedures used for measuring the GIT traits were presented by Kimiaeitalab et al. (2017). Briefly, two birds per