Animal Feed Science and Technology 207 (2015) 140–149

Contents lists available at ScienceDirect

Animal Feed Science and Technology

journal homepage: www.elsevier.com/locate/anifeedsci

Effects of grinding and pelleting condition on efficiency of full-fat canola seed for replacing supplemental oil in broiler chicken diets

M.R. Barekatain*, S.B. Wu, M. Toghyani, R.A. Swick

School of Environmental and Rural Science, University of New England, Armidale, NSW 2351, Australia

ARTICLE INFO

Article history:
Received 26 November 2014
Received in revised form 1 May 2015
Accepted 29 May 2015

Keywords:
Full-fat canola seed
Processing
Grinding
Fat digestibility
Pelleting

ABSTRACT

Two experiments were conducted to investigate the effects of canola seed (CS) and processing including grinding and pelleting condition on bird performance and nutrient utilization. The first experiment examined the apparent metabolizable energy (AME) of CS. A reference and test diet containing 150 g/kg CS was used. AME and AMEn values of CS were 21.08 and 19.63 MJ/kg DM, respectively. The second experiment examined performance and digestibility and used a 2 × 3 factorial arrangement of treatments. Factors were: pelleting condition (cold-pelleted at 65 °C or steam-pelleted at 85 °C) and diet: canola meal plus oil, whole canola seed (WCS) or hammer-milled canola seed (HCS). A total of 672 male d-old Ross 308 broiler chicks were randomly assigned to treatments, each replicated eight times, with 14 birds per replicate. Birds received a common diet until d 10 when they were given test grower diets to d 24 followed by finisher diets from d 24 to d 35. Wheat-SBM based test diets were isoenergetic and isonitrogenous. Grower and finisher contained CS at 114 g/kg and 130 g/kg respectively, entirely replacing canola meal and canola oil in control diets. Inclusion of CS decreased feed intake (FI) relative to control diets from d 10 to 35 ($P < 0.01$). Regardless of pelleting, there was no difference in FI between birds fed either WCS or HCS. Weight gain (WG) was highest in control fed birds relative to WCS or HCS between d 10 and d 35 ($P < 0.01$). In the same period, HCS improved FCR of the birds compared to control ($P < 0.05$). From d 10 to d 24, an interaction between pelleting and diet was detected for FCR indicating that steam-pelleting increased FCR in the birds fed WCS ($P < 0.05$). On d 24, ileal fat digestibility was reduced in birds fed WCS in steam-pelleted diets resulting in an interaction between pellet condition and diet ($P < 0.01$). By same interaction on d 35, steam-pelleting reduced fat digestibility in birds fed WCS or HCS ($P < 0.001$). It can be concluded that although inclusion of CS resulted in a depression for FI and WG, FCR was improved in birds fed HCS in cold-pelleted diets. Prior grinding of CS did not benefit bird performance or nutrient utilization when compared with WCS.

Abbreviations: AME, apparent metabolizable energy; AMEn, apparent metabolizable energy corrected for nitrogen; CP, crude protein; CS, canola seed; DM, dry matter; FCR, feed conversion ratio; FI, feed intake; GE, gross energy; GEE, gross energy output of excreta; GEI, gross energy intake; HCS, hammer-milled canola seed; ME, metabolisable energy; NE, nitrogen output of excreta; NI, nitrogen intake; NSP, non-starch polysaccharides; Ti, titanium; WCS, whole canola seed; WG, weight gain.

* Corresponding author. Present address: South Australian Research and Development Institute, Roseworthy Campus, University of Adelaide, Roseworthy, SA 5371, Australia. Tel.: +61 883137793; fax: +61 883137977.

E-mail addresses: Reza.Barekatain@sa.gov.au, rezabetin@gmail.com (M.R. Barekatain).

http://dx.doi.org/10.1016/j.anifeedsci.2015.05.020
0377-8401/

1. Introduction

The price of fat and oil is increasing due to increased demand from the biofuel industry and food sector, and thus the costs of broiler feed have subsequently increased. Some broiler producers are including full-fat canola seed (CS) in broiler diets to reduce costs. Canola seed can contribute substantially more to the metabolizable energy (ME) than oil-extracted solvent or expeller canola meal. It contains approximately 400 g/kg oil and 210–230 g/kg protein (Fenwick and Curtis, 1980) making it an attractive feed ingredient for broilers. However, the level of inclusion is typically below the amount for complete removal of supplemental oil mainly due to concerns about residual glucosinolate and isothiocyanate. Research conducted by Summers et al. (1982) showed a reduction in weight gain and feed intake (FI) of broilers fed diets containing 175 g/kg or higher CS, but the quality of the diet was not a strong indicator of bird performance as the fat levels in the experimental diets were different. In another study conducted by Meng et al. (2006), inclusion of 150 g/kg CS in a mash diet from d 5 to 18 resulted in lower fat and protein digestibility and negatively affected apparent ME corrected for nitrogen (AMEn) of the diet. These reports suggest uncertainty in nutrient utilization, and complete substitution of supplemental oil with CS has not been fully practiced in the poultry industry.

Other reports have indicated that grinding and heat treatment of CS are beneficial in enhancing the nutrient utilization (Muztar et al., 1978; Salmon et al., 1988). It is believed that disruption of structure resulting in degradation of subcellular lipid globules may improve oil digestibility. In comparison to a mash diet, steam-pelleting was shown to enhance the nutritive value of whole CS in maize and soybean meal diets (Shen et al., 1983). However, to our knowledge, little is known about the influence of pre-pellet hammer-mill grinding on CS utilization. The role of pelleting process on fat utilization in broiler diets is still unclear. Furthermore, the effect of pelleting conditions, in particular temperature, for efficiency of CS is not fully understood. Thus, the present study was designed to determine AME of CS and examine performance and nutrient digestibility of broilers fed diets containing CS as the major supplemental fat source. The effect of grinding and pelleting conditions on nutrient utilization were examined.

2. Materials and methods

2.1. Analysis of test articles

Table 1 shows the chemical analysis of the test articles CS and canola meal. Each sample was analyzed in duplicate using AOAC (2005) methods of 982.30E for total lysine, 920.39 for crude fat, 975.44 for reactive lysine, 978.10 for crude fiber, 973.18 for NDF and ADF, and 942.05 for ash at the Agricultural Experiment Station Chemical Laboratory at University of Missouri with the exception of gross energy (GE) that was analyzed at University of New England using the method and equipment described in the AME section below.

2.2. Apparent metabolizable energy of CS

Two experimental diets were formulated as shown in Table 2. The reference treatment consisted of a common corn-soybean meal diet without enzyme supplementation, formulated to meet or exceed the nutrient requirements of broiler chickens as described in the Ross 308 manual (2007). The method of AME measurements was similar to the procedures described by Toghyani et al. (2014). Canola seed test diet contained 150 g/kg of the unground seed substituting the energy yielding ingredients of the reference diet. Both diets were fed in a pelleted form and fresh water and feed were available to all birds for ad libitum intake throughout the experiment. A total of 72 male broiler chickens were used in the AME measurement randomly assigned to 2 treatments each replicated 6 times. From d 1 to d 10 and d 10 to d 18, birds were fed conventional starter and grower diets respectively. From d 18, birds were fed the experimental diets (basal and CS test diets) for 4 d (adaptation period) followed by a 72-h energy balance assay from 22 to 25 d of age. During the 72-h collection period, feed consumption was recorded and the entire excreta were collected to calculate energy and nitrogen intake and excretion. The gross energy (GE) content of experimental diets and excreta were determined using an adiabatic bomb calorimeter (IKA® Werke, C7000, GMBH and Co., Staufen, Germany) with benzoic acid as the standard.

The AME and AMEn of the reference (basal) and test diets (DM basis) were determined using the following equations:

$$\mathrm{AME(MJ/kg)} = (\mathrm{GEI} - \mathrm{GEE})/\mathrm{FI}$$

$$\mathrm{AMEn} = \mathrm{AME} - \left[8.22 \times (\mathrm{NI} - \mathrm{NE})/\mathrm{FI}\right]$$

The AMEn of the CS sample was calculated using the following formula:

$$\mathrm{CS\ AMEn\ \ (MJ/kg\,DM)} = \mathrm{basal\ AMEn} - \left[(\mathrm{basal\ \ AMEn} - \mathrm{test\ \ diet\ \ AMEn})/\mathrm{percentage\ \ of\ \ inclusion\ \ rate}\right]$$

where GEI is gross energy intake and GEE is gross energy output of excreta (MJ/kg of DM); 8.22 is nitrogen correction factor (Hill and Anderson, 1958); NI is nitrogen intake from the diet and NE is the nitrogen output from the excreta (kg); FI is the feed intake (kg).