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Effects of high fiber ingredients on the performance, metabolizable energy and fiber digestibility of broiler and layer chicks

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ABSTRACT

An experiment was conducted to evaluate the effects of feeding various fiber contents on the performance of chickens bred for egg or meat production from 1 to 21 d of age. The lower fiber diet was based on a traditional corn-soybean meal (SBM) diet and the higher fiber diet was formulated by the addition of 60 g/kg of both dried distillers grains with solubles (DDGS) and wheat bran in the first period of feeding and 80 g/kg of both DDGS and wheat bran in the second period of feeding to the corn-SBM base. The diets were isocaloric and were formulated to meet or exceed NRC requirements. Two lines of male chicks, Ross 308 broilers and Hy-Line W36 layers, were randomly assigned to cages with 11 replicates of 8 chicks for each of the 4 treatments. The evaluation criteria consisted of average daily gain (ADG), average daily feed intake (ADFI), feed efficiency (FE), nitrogen corrected apparent metabolizable energy (AMEn) and neutral detergent fiber (aNDF) digestibility. The higher dietary fiber diet significantly reduced broiler ADG ($P \leq 0.01$) for the 1–12 d and 1–21 d periods but had no effect on layer chick ADG, resulting in a significant interaction. Increasing dietary fiber did not have significant effects on ADFI for the 1–12 d and 1–21 d periods. Neutral detergent fiber digestibility was higher in layer chicks than broiler chicks regardless of the diet ($P \leq 0.01$), and higher dietary fiber concentration resulted in increased ileal ($P \leq 0.01$) and total ($P \leq 0.02$) aNDF digestibility, across both lines. Apparent metabolizable energy was not different ($P=0.96$) between lines or dietary fiber content. These results suggest that layer chicks are able to better utilize feed ingredients rich in fiber content compared to broiler chicks, possibly due to decreased ADFI and increased fiber utilization.

1. Introduction

The recent increase in the price of corn and oil has led to an interest in dietary fiber as a method to reduce feed costs in poultry diets. According to the Renewable Fuels Standard, ethanol production is expected to increase through 2022, with corn based ethanol capped at about 15 billion gallons by 2015 (Renewable Fuel Standard, 2013). In reality, the 15 billion gallon mark was nearly achieved in 2011 and maintained or slightly lower in 2012. It appears that biofuel demand for corn will continue to pressure corn prices therefore, lower cost corn and wheat by-products have the potential to provide economical alternatives to traditional US feed ingredients in poultry (Waldroup et al., 1981; Shalash et al., 2009a). It is important to understand the effects of these alternative dietary feed ingredients on bird performance to allow for proper formulation into current poultry diets. Fiber has been regarded as nutrient diluent in poultry (Angkanaporn et al., 1994), and higher fiber in

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feed ingredients has been shown to have negative effects on digestion and absorption of nutrients in chickens (Krogdahl, 1986). However, previous experiments have indicated that performance does not decrease when feed ingredients high in fiber are included at moderate levels to both layer and broiler diets despite the reduction in nutrient concentration of the diet (Hetland and Svihus, 2001; Hetland et al., 2002).

In the past, poultry diets in the USA have been formulated with low fiber concentrations because of decreased feed efficiency (Longe and Ogedegbe, 1989). Dried distillers dried grains with solubles (DDGS) have been used in poultry diets for decades and were included in low levels in early broiler experiments (Day et al., 1972). Later experiments reported that DDGS could be incorporated at 250 g/kg in the diet without detrimental effects, if metabolizable energy is kept constant (Waldroup et al., 1981). Current ethanol production has resulted in a new DDGS product generated from corn and early work with corn DDGS has focused on broiler chicks. The use of 120 g/kg DDGS in broiler diets during the starter period resulted in reduced performance (Dale and Batal, 2003), but up to 80 g/kg DDGS during the starter phase had no effect on broiler performance through 14 or 28 d of age (Loar et al., 2010). Other reports resulted in acceptable performance with the use of DDGS at a concentration of 60 g/kg in broiler starter diets and 120–180 g/kg in broiler grower and finisher diets respectively (Lumpkins et al., 2004). Wheat bran was fed at 150 g/kg of the diet with negative effects on bird performance (Donkoh et al., 1999).

There have been several experiments involving the use of higher fiber ingredients in adult laying hens' diets and 50–200 g/kg of DDGS have been suggested to have no effects on production (Matterson et al., 1966; Lumpkins and Batal, 2005; Roberson et al., 2005). However, there are few reports concerning the use of high fiber ingredients in layer chicks. Masa'deh et al. (2012) fed layer chicks up to 125.0 g/kg of corn DDGS without negative performance results.

Previous experiments have utilized a single high fiber ingredient, but few have concentrated on a combination of high fiber ingredients. In this experiment, two high fiber feed ingredients (DDGS and wheat bran) were included in a traditional corn-soybean meal. The objective was to evaluate the performance, metabolizable energy and neutral detergent fiber (NDF) digestibility of broilers and layer chicks fed corn–soybean diet or higher fiber corn–soybean – DDGS-wheat bran based diet over a 21 d feeding period.

2. Materials and methods

All animal procedures were approved by the Institutional Animal Care and Use Committee of Iowa State University before the start of the experiment.

2.1. Dietary treatments

Starter diets for both broiler and layer chicks were formulated to be isocaloric and meet or exceed National Research Council (1994) nutrient recommendations. The lower fiber diet was formulated based on corn-soy bean meal (SBM) and the higher fiber diet was formulated based on corn- SBM-DDGS -wheat bran. The low fiber diet was formulated to contain 60.0 g/kg of both DDGS and wheat bran from 1 to 12 d and 80.0 g/kg of both DDGS and wheat bran from 13 to 21 d (Table 1). Birds had an *ad libitum* access to feed and water throughout the experimental period. Titanium dioxide, an inert marker, was added to all diets at a rate of 2500 mg/kg to determine nitrogen corrected apparent metabolizable energy (AMEn) and neutral detergent fiber (aNDF) digestibility.

2.2. Birds and experimental design

A total of 250 male Ross 308 broiler chicks (Aviagen Group, Huntsville, AL) and 250 male Hy-line W36 (Hy-Line International, Dallas Center, IA) layer chicks were secured from separate commercial hatcheries and transported to the ISU Poultry Research and Teaching Unit. On d 1, chicks were individually weighed, sorted by weight, wing banded and assigned to battery cages within line to minimize differences in mean cage bodyweight at the start of the experiment. Treatment groups were randomly assigned to battery cages in a completely randomized design. Chicks were maintained in raised wire battery cages (432 cm^2/chick) with continuous light in an environmentally controlled room where all chicks had initial access to a temperature of 32 °C plus supplemental heat with a 2 °C reduction in heat each week.

Treatments were arranged as a 2 × 2 factorial with two chicken lines (broiler and layer) and two dietary fiber concentrations (lower fiber and higher fiber). Each of the 4 treatments consisted of 11 experimental units of 8 chicks, resulting in 88 total chicks per treatment.

2.3. Data and sample collection

Feed intake was determined by cage as the difference between feed offered and refused over the 1–12 and 1–21 d periods and expressed as average daily feed intake (ADFI) in g per chick. Body weight gain was determined over 1–12 and 1–21 d periods expressed as average daily gain (ADG) in g per chick. Mortality corrected feed efficiency (FE) was expressed as body weight gain in g per kg of feed intake. All chicks were euthanized by carbon dioxide asphyxiation on d 21 for collection of ileal contents. The ileum was defined as the region between Meckel's diverticulum and the ileo-cecal junction. All ileal