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Effect of whole egg powder on growth performance, blood cell counts, nutrient digestibility, relative organ weights, and meat quality in broiler chickens

Y. Lei, I.H. Kim *

Department of Animal Resource and Science, Dankook University, Cheonan, Choongnam 330-714, South Korea

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ABSTRACT

A 5-week experiment using 660 male hatchling ROSS 308 broilers was conducted to investigate the effect of whole egg powder (EP) on the growth performance, blood cell counts, nutrient digestibility, relative organ weights, and meat quality in broiler chickens. Broilers were randomly allotted to four dietary treatments consisting of a typical basal diet and that diet with 1%, 2% or 3% EP substituted, isocalorically and isonitrogenously. During d 1–25, and d 1–35, BWG was linearly enhanced in broilers fed EP ($P=0.04$). Between d 1 and 25, and for the overall period to d 35, FCR was linearly increased ($P=0.01$) by adding EP. No significant effect of EP was observed on apparent digestibility of dry matter or nitrogen among treatments but energy digestibility was linearly enhanced by inclusion of EP ($P=0.04$).The white blood cell count was linearly higher ($P=0.04$) in birds fed with EP but there were no differences in red blood cells or percent lymphocytes. The drip loss of breast meat after 24 h, 48 h, and 72 h of refrigerated storage was linearly reduced 50–60% by feeding EP ($P=0.01$). In conclusion, inclusion of up to 3% whole egg powder in diets of broilers was shown to improve growth performance to d 35, energy digestibility and decreased drip loss of breast meat.

1. Introduction

With increasing price of the feed raw materials, it is very important to search for alternative protein sources to replace traditional ingredients (Van Nevel et al., 2000). Every year, approximately 2% of chicken eggs are rejected through the candling process and deemed inedible for humans (Harmon et al., 2001). This represents a considerable loss of a high energy, high protein source (Surai and Sparks, 2001; Watkins, 1995).

Spray-dried egg is a recent by-product generated by the egg layer industry (Norberg et al., 2004), and has been shown to be a good source of protein for pigs and chickens (Schmidt et al., 2003). Spray-dried egg products generally include a large proportion of egg albumen, with an excellent amino acid profile and relatively high level of methionine (Kats, 1994; Owen et al., 1995). The lipid constituents contribute to high digestibility and absorption (Scott et al., 1982). In addition, the egg yolk is a reservoir of immune globulins Y (IgY) (Anton et al., 2006; Li-Chan., 1998) and antioxidant pigments including carotenoids, lutein and zeaxanthin (Al-Harthi et al., 2010). We hypothesized that the egg by-product might modulate immune status as well as affect meat quality.

There are only limited studies on utilization of dried egg powder in chicken diets. Al-Harthi et al. (2010) showed that the growth performance of broilers was enhanced by supplementation with dried whole egg. In addition, El-Deek and Al-Harthi (2009) found that the supplementation with dried egg powder can increase

* Corresponding author. Tel.: +82 41 550 3652; fax: +82 41 565 2949.
E-mail address: inhokim@dankook.ac.kr (I.H. Kim).

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pullet performance. To extend this knowledge base, we have investigated the effect of dried whole egg powder on the growth performance, blood cell counts, nutrient digestibility, relative organ weights, and meat quality in broiler chickens.

2. Material and methods

All birds used in this trial were handled in accordance with the guidelines set forth by the Animal Care and Use Committee of Dankook University.

2.1. Preparation of egg by-product

Whole egg powder (EP) was prepared and provided by Modern Engineering Co., LTD (Korea). Microbiological tests indicate the absence of pathogens (such as *Escherichia coli* and *Salmonella*). The chemical compositions of this whole EP are shown in Table 1.

2.2. Birds and experimental treatments

Day-old male ROSS 308 broilers ($n=660$, BW$=39.2\pm0.1$ g) were obtained from a local commercial hatchery (Yang Ji Company, Cheonan, Choongnam, South Korea). All birds were raised in stainless steel pens of identical size (1.75×1.55 m^2) and provided with continuous light. The temperature of the room was maintained at 33 ± 1 °C for the first 3 d and decreased progressively to 24 °C by the end of the experiment (d 35). Broilers were randomly allotted to four treatments, each with 11 replicates (one pen of 15 birds per replicate). The dietary treatments consisted of a basal corn-soybean based ration and three levels (1, 2 and 3% by weight) of added EP. The basal diet was formulated to meet or slightly exceed the nutritional requirements of broilers during starter (d 1–25) and grower (d 26–35) phases, according to NRC (1994) recommendations for broiler chickens. Crude protein, metabolizeable energy, Ca, P, lysine and methionine levels in the four diets were adjusted to the same levels (Table 2). The broilers were allowed *ad libitum* access to water and feed.

2.3. Sampling and measurements

All birds were weighed at d 1, 25, and 35 and body weight gain (BWG), feed intake (FI) and feed conversion ratio (FCR) were calculated at the end of each growth phase.

Table 1
The nutrition composition of the whole egg powder.

Composition (%)	%
Crude protein	36.0
Crude fat	22.4
Crude ash	21.1
Calcium	11.6
Potassium	0.4
Lysine	2.1
Methionine	1.1
Threonine	1.6
Isoleucine	1.2
Arginine	2.6

As an indigestible marker (Fenton and Fenton, 1979), 0.2% chromium oxide (Cr_2O_3) (Duksan Pure Chemicals, Asan, South Korea) was added to the diets during the last week of the experiment and after feeding this for 4 d, fresh excreta samples were collected during the final 3 d of the experiment. All feed and fecal samples were stored immediately at −20 °C until analysis. Dry matter (DM) was determined after drying for 72 h at 60 °C, then chromium was analyzed by UV absorption spectrophotometry (Shimadzu, UV-1201, Kyoto, Japan) and N was measured using a Kjeltec 2300 analyzer (Foss Tecator AB, Hoeganaes, Sweden). Gross energy (GE) was determined using a bomb calorimeter (model 6100, Parr Instrument Co., Moline, IL USA). The coefficients of total tract apparent digestibility (CTTAD) of DM, N and GE were calculated using indirect methods, as described by Stein et al. (2006).

At d 25 and 35, one bird per replicate (pen) was selected at random and bled via the wing vein into a vacutainer tube (5 ml, EDTA-coated, Becton Dickinson Vacutainer Systems, Franklin Lakes, NJ). White blood cells (WBC) and red blood cells (RBC) were counted, and lymphocyte percentage determined using an automatic blood analyzer (ADVID 120, Bayer, USA). Blood samples were then centrifuged (3000*g*) for 15 min at 4 °C (Becton Dickinson Vacutainer Systems, Franklin Lakes, NJ) and plasma was stored at −20 °C. After blood collection, the same broilers were weighed individually and slaughtered by approved methods. The liver, spleen, bursa of Fabricius, whole left breast muscle, gizzard, and abdominal fat were then removed by trained personnel and weighed; organ weights were expressed as percentages of BW. The breast muscle was stored at −20 °C for subsequent analysis.

2.4. Meat quality analysis

Meat color values of lightness (L^*), redness (a^*), and yellowness (b^*) were determined using a Chromameter (Model CR-410, Minolta Co., Japan). A 2 cm thick subsample of the meat was weighed before and after 1, 2 and 3 d of storage in plastic bags at 4 °C to calculate drip loss. pH was determined using a needle electrode and pH meter (IstekNeoMet 77P, Istek Inc., Korea). The water holding capacity (WHC) was measured by the method of Kauffman and Eikelenboom (1986). In brief, a 0.2 g muscle sample was pressed at 3000 psi for 3 min on 125-mm-diameter discs of filter paper. The areas of the pressed sample and expressed moisture were delineated and then quantified with a digitizing area-line sensor (MT-10S; M.T. Precision Co. Ltd., 123 Tokyo, Japan). The ratio of water: meat areas was calculated, giving a measure of WHC (a smaller ratio indicates higher WHC).

2.5. Statistical analysis

For all analyses, replicate (pen) served as the experimental unit. Effects of treatment (0, 1, 2, 3% EP) were analyzed by ANOVA using the General Linear Models (GLM) procedure of SAS (SAS Institute, 2003). Because of the design, linear and quadratic effects of treatment were assessed. Results are presented as least squares mean and SEM, derived from the error mean square of each ANOVA.