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Comparison of gamma–Irradiation and enzyme supplementation to eliminate antinutritional factors in rice bran in broiler chicken diets

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ABSTRACT

A study was conducted to evaluate the effect of gamma irradiation and enzyme supplementation of crude rice bran in broiler chicken diet and their effects on growth performance, carcass characteristics, intestinal microbial population, and blood profile in broiler chickens. A total of 144 one–day–old Ross 308 broiler chickens were weighed and assigned to 3 dietary treatments with 4 replicates (floor pen) of 12 broiler chickens per pen. Dietary treatments consisted of a basal diet formulated to contain 15% crude rice bran (with or without enzyme supplementation) and the diet containing 15% gamma-irradiated rice bran. The chemical changes of crude and gamma-irradiated rice bran were determined before feeding experiment. At the end of the experiment (d 42), growth performance, ileum microflora, and blood profile in broiler chickens were determined. Proximate composition of rice bran was not affected by gamma irradiation, but the contents of phytic acid and trypsin inhibitor decreased (up to 98%; $P < 0.05$). The use of gamma-irradiated rice bran improved ($P < 0.05$) the body weight gain than crude rice bran. Moreover, broiler chickens on gamma-irradiated rice bran treatment had greater (14.9%) body weight gain compared to the enzyme supplementation. Although, none of the treatments had a major effect on the carcass percentage, the breast percentage (22.4%) increased ($P < 0.05$) because of the enzyme supplementation compared to those (18.5%) of broiler chickens on crude rice bran diet. The relative weight of liver and abdominal fat pad decreased ($P < 0.05$) by feeding of gamma–irradiated rice bran than the enzyme supplemented diet. Lower numbers ($P < 0.05$) of salmonella were found in the ileum of broiler chickens fed gamma-irradiated rice bran when compared to the use of the enzyme supplemented diet. Blood profile was not affected by the treatments. The results indicated that gamma irradiation could be a more effective method to reduce the content of antinutritional factors in crude rice bran than enzyme supplementation and improve growth performance and health of broiler chickens.

1. Introduction

Rice bran (RB) is an important agricultural byproduct in the north of Iran. The RB contains varying amounts of nutrients (Mujahid et al., 2003) and could be highly desirable in poultry diets after adequate processing. The use of rice bran in broiler chickens is limited because of the amount of high-fat and antinutritional factors. Addition of antioxidant is a method to slow rancidity in the RB (Cabel and Waldroup, 1989). On the other hand, compounds such as phytic acid (Mujahid et al., 2004) in rice bran, which is not available source of phosphorus, can bind to essential nutrients and minerals, making it completely or partially unavailable for absorption. Phytate chelates with certain metal ions such as calcium, magnesium, zinc, copper, and iron, forming insoluble complexes which are not readily broken down and may pass through the digestive tract in an unchanged manner (Gifford-Steffen and Clydesdale, 1993). Also, it is found that it forms strong bonds with proteins, and, in turn, decreases digestibility (Vidal-Valverde et al., 1994). Hemagglutinin and trypsin inhibitors are another antinutrient factor in RB (Borresen and Ryan, 2014; Mujahid et al., 2003). Hemagglutinin contains highly branched arabinoxylans which are rich in the hemicelluloses (Ebringerova et al., 1994; Shibuya and Iwasaki, 1985). Inducing of pancreatic hypertrophy because of trypsin inhibitors could suppress the proteolytic activity of the enzyme trypsin (Martin et al., 1998) and lead to reduced availability of amino acids, stunted growth (Liener and Kakada, 1980), and low intestinal amylase activity (Martin et al., 1998).

Treatments such as heating, extruding, and steaming (Mujahid et al., 2004; Raju et al., 2011) could inactivate or suppress the

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activity of the adverse compounds. But these methods are not completely ideal. For example, it is found that moisture in heating contributes greatly to lipases denaturation (Ramezanzadeh et al., 2000). According to the report of Wang et al. (1997) and Keshavarz (2000), enzyme supplements introduced as a suitable solution to decrease the content of antinutrition factors such as arabinoxylans, crude fiber, and phytic acid in poultry. Nevertheless, food irradiation is recognized as a reliable and safe method for food preservation and improvement of hygienic quality of foods as well as their nutritional value (Al-Kaisey et al., 2003; Farkas, 1998). According to the present knowledge, this study was aimed to assess the effect of gamma–irradiation on chemical and anti-nutritional changes of rice bran and comparison of its effect with enzyme supplementation on growth performance and gut microflora in broiler chickens.

2. Materials and methods

2.1. Broiler chickens and housing

A total of 144 one–day–old Ross 308 broiler chickens were obtained from a commercial hatchery and then weighed and assigned to 12 floor pens, based on their body weight. The floor pens were similar in design (1 × 1 m) and located in an environmentally controlled room on a 24-h light program. Each pen characterized with 1 bell drinker and 1 feed hopper per pen. The floor was cemented and covered in a 5 cm deep layer of fresh wood shavings. The room temperature was maintained at 32 ± 1 °C during the first week of the experiment and gradually decreased to 22 °C from the fourth week to the end of the study.

2.2. Diets and experimental

Basal diets were prepared separately for starter (d 1 to 10), grower (d 11 to 24), and finisher (d 25 to 42) periods on the basis of present or absent of RB (Table 1). The RB (Tarrom, Iranian rice variety) was obtained from Mazandran province of Iran. Experimental treatments were 3 diets comprised of: 1) 15% crude rice bran (CRB), 2) 15% crude rice bran plus 0.3 g/kg enzyme supplement (CRB–Ez), and 3) 15% gamma rays–irradiated rice bran (CRB–GI). Before the irradiation, sufficient water was added to the samples to elevate moisture content to 250 g/kg. Samples (18 kg) in triplicate were packed in paper bags (500 mL) and subjected to gamma irradiation with doses of 100 kGy using a Cobalt–60 gamma cell (AEOI, Tehran Irradiation Application Center, Iran). The dose rate was measured using Fricke dosimetry system (Holm and Berry, 1970) and recorded 3.7 kGy/h. The enzyme supplement (Natuzym; Bioproton Pty Ltd, Sunnybank, QLD, Australia) contained substantial amounts (U/g) of xylanase (10,000), phytase (500), cellulase (6000), protease (3000), β-glucanase (700), α-Amylase (700), pectinase (70), and lipase (30). For each pen, body weight and feed intake were obtained at 42 d of age. Mortality was recorded in a daily manner. The dead broiler chickens were weighed and feed conversion ratio calculated using the following formula: total feed consumption/(total final weight − total initial weight + total mortality weight).

2.3. Carcass characteristics and blood profile

On d 42 of the experiment, 3 broiler chickens from each pen with a body weight compared to the pen average weight were selected and slaughtered. Carcass characteristics were determined as mentioned by Huyghebaret and Pack (1996). Eviscerated carcass was weighed and expressed as a percentage of the live body weight. Also, before the slaughter, 5 mL of blood samples (with EDTA) were collected from the selected broiler chickens via their wing vein. Sera were collected after centrifugation at 2000 × *g* for 10 min at 4 °C and then stored at 21 °C until further analysis. The concentrations of serum metabolites, including calcium, phosphorus, total cholesterol, triglycerides, and high density lipoprotein (HDL) were analyzed with an automatic biochemical analyzer (Abbott Alcyon 300; Abbot Laboratories, Abbott Park, IL, US) using commercial laboratory kits (Pars Azmoon Kits; Pars Azmoon, Tehran, Iran).

Table 1
Composition of the experimental diet (as–fed basis).

Item	d 1 to 10	d 11 to 24	d 25 to 42
Ingredient (%)			
Maize	41.55	44.33	49.36
Soybean meal	35.16	33.23	26.79
Rice bran	15	15	15
Soybean oil	3.88	4.62	5.21
Limestone	1.18	0.96	0.94
Di-calcium phosphate	1.72	1.47	1.42
Salt	0.43	0.43	0.43
Vitamin mixture[a]	0.25	0.25	0.25
Mineral mixture[b]	0.25	0.25	0.25
DL–Met	0.34	0.24	0.22
L–Lys	0.27	0.12	0.14
Calculated content			
ME (kcal/kg)	2850	2950	3050
Crude protein (%)	21	20	18
Ca (%)	0.98	0.84	0.81
Available P (%)	0.47	0.42	0.40
Na (%)	0.21	0.21	0.19
Lys (%)	1.34	1.16	1.03
Met + Cys (%)	1.00	0.88	0.81
Arg (%)	1.36	1.18	1.07
Thr (%)	0.22	0.18	0.17

[a] Contained per kilogram of diet: vitamin A (trans–retinyl acetate), 10,000 IU; vitamin D_3 (cholecalciferol), 2,000 IU; vitamin E (DL–α-tocopherol acetate), 10 mg; vitamin K (bisulfate menadione complex), 1 mg; vitamin B_1 (thiamin mononitrate), 1 mg; vitamin B_2 (riboflavin), 5 mg; vitamine B_3 (Niacin), 30 mg; vitamine B_6 (pyridoxine–hydrochloride), 1.5 mg; vitamine B_8 (biotin), 0.05 mg; vitamin B_5 (D–calcium pantothenate), 10 mg; vitamine B_9 (folic acid), 1 mg; and antioxidant (butylated hydroxytoluene), 10 mg.

[b] Contained per kilogram of diet: Mn (manganese sulfate), 60 mg; Zn (zinc sulfate), 50 mg; Fe (ferrous sulfate), 30 mg; Cu (copper sulfate), 4 mg; I (potassium iodide), 3 mg; Se (sodium selenite), 0.1 mg; and Co (cobalt carbonate), 0.1 mg.

2.4. Microbial enumeration

At the end of the growing period (d 24), 2 broiler chickens in each replicate were selected and slaughtered by the cervical dislocation. After disinfection of the abdominal surface of the carcass and the areas around it, the internal organs were removed. About 5-cm of the length of the ileum middle part (from the Meckel's diverticulum to cecal junction) was placed into a sterile plate and its content was used to make serial 10 fold dilutions using 0.85% saline solution. Then, 0.1 mL of the appropriate dilutions was spread respectively on plate count agar (to detect total anaerobic bacteria), Violet red bile agar (to detect coliforms), MacConkey agar (to detect *E. coli*), and Brilliant-green Phenol-red Lactose Sucrose Agar (to detect salmonella) (Abdel-Wareth et al., 2012; Engberg et al., 2000; Izat et al., 1990). The culture of coliforms bacteria was incubated anaerobically at 37.5 °C for 24 to 48 h. Other cultures were incubated aerobically at 37.5 °C for 48 h. After counting the number of colonies on each plate, the number so obtained was multiplied by the inverse of the dilution and the result was stated as the number of colony forming unit (cfu) in 1 g of the sample (Downes and Ito, 2001).