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Influence of feed form on growth performance, ileal nutrient digestibility, and energy utilisation in broiler starters fed a sorghum-based diet

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ABSTRACT

A broiler starter (1–21 d) diet based on a finely ground red sorghum was used to develop 3 feed forms: (1) unprocessed mash, (2) pellets steam-conditioned at 70 °C, and (3) re-ground pellets following steam-conditioning at 70 °C. The influence of dietary treatments on the growth performance, coefficient of apparent ileal digestibility (CAID) of N, starch, fat, Ca, and P, and apparent metabolisable energy (AME) in broiler starters was evaluated. A total of 144 one-day-old male broilers (Ross 308) were individually weighed and allocated to 18 cages (8 broilers/cage), and cages were randomly assigned to 3 dietary treatments. Broilers fed the pelleted diet gained more ($P<0.05$) weight and had a greater ($P<0.05$) feed intake (FI) than those fed mash and re-ground pellet diets. Re-grinding the pellets resulted in similar weight gain and FI to the mash diet. Nitrogen digestibility tended ($P=0.10$) to be greater in broilers fed the mash diet compared to pellet and re-ground pellet diets. Pellet-feeding reduced ($P<0.05$) starch digestibility compared to the mash diet and re-ground pellet. Pellet feeding also reduced ($P<0.05$) CAID of fat compared to mash diet but re-grinding the pellets restored fat digestibility. Pelleting reduced ($P<0.05$) the CAID of Ca and re-grinding the pellets further decreased ($P<0.05$) Ca digestibility. Pelleting had no influence on the CAID of P, but re-grinding the pellets resulted in lower ($P<0.05$) P digestibility than that of the mash and pelleted diets. Feeding intact pellets reduced ($P<0.05$) the AME of the diet compared to the mash diet and the depression was maintained in re-ground pellets. Based on the greater nutrient intake of broilers offered intact pellets coupled with the lack of positive effect of pellet feeding on digestibility of nutrients, it can be suggested that an enhanced feed consumption was primarily responsible for the better performance of broilers fed sorghum-based pellets.

1. Introduction

There is a general belief that enhanced nutrient digestibility by pelleting is partly responsible for the improved performance of broilers fed pelleted diets. However, few studies have been undertaken to delineate the true impact of pellet feeding on the utilisation of nutrients in broilers. Some studies indicated that pelleting may decrease nutrient utilisation under some conditions, whereas other studies indicated that the effect of feed form on digestibility of nutrients depends on the cereal used and the nutrient considered (Abdollahi et al., 2013).

Most of the studies comparing nutrient utilisation in broilers fed mash and pelleted diets have been investigated

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in wheat-based diets. Svihus (2001) reported apparent ileal starch digestibility coefficients of less than 0.83 in cold-pelleted wheat diets and indicated that high starch digestibility usually coincides with mash feeding, whereas low starch digestibility is associated with feeding cold-pelleted diets (Hetland and Svihus, 2001; Svihus, 2001). An overload of wheat starch in the small intestine, because of feed over-consumption, has been accounted for the major cause of low starch digestibility in wheat-based pelleted diet (Svihus and Hetland, 2001). In contrast, Lundblad et al. (2011) reported greater starch digestibility (0.94–0.97) in broilers fed hydro-thermal processed diets containing wheat, fish meal, and soybean meal compared to the unprocessed mash (0.92). Decreases in starch digestibility of wheat-based diets from 0.959 in mash diets to 0.834 in diets pelleted at 90 °C in broilers have been reported by Abdollahi et al. (2011). These researchers also reported lower N digestibility (0.822) in wheat-based pellets (pelleted at 90 °C) compared to mash diets (0.847). A previous study in our laboratory (Abdollahi et al., 2013) showed that feeding pelleted diets either had no effect (N and starch) or improved (fat, Ca, and P) the ileal digestibility of nutrients in maize-based diets, whereas pellet feeding reduced the digestibility of all nutrients in wheat-based diets.

Limited published data are available on the effect of pelleting on nutrient utilisation in sorghum-based diets (Selle et al., 2012, 2013). Abdollahi et al. (2010) reported that increasing conditioning temperatures in sorghum-based broiler diets reduced coefficient of apparent ileal digestibility (CAID) of N, starch, and apparent metabolisable energy (AME) of the diet, especially at 90 °C. Selle et al. (2012) showed that pelleting had no effect on ileal N and starch digestibility of sorghum-based diets, but depressed N retention coefficient in broilers. The depression in N retention was partly attributed to the pelleting inducing the formation of disulphide linkages. The main objective of the present study was to further investigate whether feed form (mash, pellet, and re-ground pellet) influences the CAID of N, starch, fat, Ca, and P, and AME in broiler starters fed sorghum-based diets.

2. Materials and methods

2.1. Diets

Red sorghum, imported from Australia, was obtained from a commercial supplier. The sample was purchased in finely ground (2.0 mm sieve size) form to meet the quarantine requirements for import into New Zealand. A broiler starter diet, based on sorghum plus soybean meal, was formulated to meet or exceed the Ross 308 recommendations for major nutrients for broiler starters (Ross, 2007; Table 1). Following mixing, the basal diet was divided into 3 equal batches. The first batch was retained as unprocessed mash. The second and third batches were steam-conditioned at 70 °C and pelleted using a pellet mill (Model Orbit 15; Richard Sizer Ltd., Kingston-upon-Hull, UK) capable of manufacturing 180 kg of feed/h and equipped with a die ring with 3-mm holes and 35-mm thickness. Conditioning time of the mash was 30 s and the conditioning temperature was measured at the outlet (close to the exit point) of the conditioner before the mash feed entered the die. The pelleted diets were run in sequence with no change in the feeder rate, die rotation speed, or number of knives. After pelleting, the second batch was retained as intact pellets and the third batch was re-ground using a 2.0-mm screen. The diet different forms (mash, pellet, and re-ground pellet) were manufactured and stored for 2 wk prior to the start of the trial. Prior to feeding, dry matter (DM) content of all diets was determined to ensure that feed intake (FI) measurements were not biased by differences in DM content. Feed samples were collected before conditioning, after conditioning, after pelleting (before cooling), and after cooling for the determination of moisture content.

Table 1
Composition and calculated analysis of the basal diet (as-fed-basis) [a].

Item	Composition
Ingredient (g/kg)	
Sorghum	613.2
Soybean meal (48% CP)	262.5
Meat and bone meal	80.0
Soybean oil	27.8
Limestone	2.6
Sodium chloride	1.5
Sodium bicarbonate	0.3
Lys. HCl	3.3
DL-MET	2.5
L-Thr	0.3
Trace mineral-vitamin premix[b]	3.0
Titanium dioxide (TiO_2)	3.0
Calculated analysis[c]	
Apparent metabolisable energy (MJ/kg)	12.6
CP (g/kg)	230
Lys (g/kg)	13.8
Met (g/kg)	5.6
Met+Cys (g/kg)	9.2
Thr (g/kg)	8.5
Ca (g/kg)	10.0
Available P (g/kg)	5.3
Na (g/kg)	1.6
Cl (g/kg)	1.9
K (g/kg)	8.1

[a] CP=crude protein.
[b] Supplied per kilogram of diet: antioxidant, 100 mg; biotin, 0.2 mg; calcium pantothenate, 12.8 mg; cholecalciferol, 60 μg; cyanocobalamin, 0.017 mg; folic acid, 5.2 mg; menadione, 4 mg; niacin, 35 mg; pyridoxine, 10 mg; trans-retinol, 3.33 mg; riboflavin, 12 mg; thiamine, 3.0 mg; dl-α-tocopheryl acetate, 60 mg; choline chloride, 638 mg; Co, 0.3 mg; Cu, 3.0 mg; Fe, 25 mg; I, 1 mg; Mn, 125 mg; Mo, 0.5 mg; Se, 200 μg; and Zn, 60 mg.
[c] NRC (1994) feed ingredient tables were used for calculation.

2.2. Broilers and housing

Experimental procedures were conducted in accordance with the Massey University Animal Ethics Committee guidelines. One-day-old male broilers (Ross 308), obtained from a commercial hatchery, were individually weighed and allocated to 18 cages (8 chicks/cage) in electrically heated battery brooders so that the average broiler weight per cage was similar. Cages were then randomly assigned to 3 dietary treatments with 6 cages per treatment. The broilers were transferred to grower

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