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Effect of Extrusion of Corn on Nutrient Digestibility, Metabolizable Energy, and Performance in Poultry under Tropical Environment

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Abstract

Two experiments were conducted to determine the effect of extrusion of corn on nutrient digestibility, metabolizable energy and performance in poultry under tropical environment. In experiment 1, twenty one male broilers were allotted in an individual metabolic cage and fed mash diets with: 1) basal diet containing 45.7% dextrose; 2) 40% substitution of normal corn for dextrose and 3) 40% substitution of extruded corn for dextrose. There was no difference in GE and N digestibility, however, significant decrease in ME was observed in chicks fed extruded corn diet. In experiment 2, a total of 1,600 broilers were used in a 42-days growth assay. There were 50 chicks per pen and 8 pens per treatment. Treatments were arranged in a 2x2 factorial arrangement with the main effect of feed form and corn type. Treatments were: 1) normal corn mash 2) normal corn pellet 3) +25% extruded corn pellet and 4) +25% extruded corn mash. Chicks fed pelleted feed, regardless of normal or extruded corn, had greater BW of 8.8% ($P<0.001$) and better feed conversion of 3.8% ($P<0.001$) than those fed mash feed diet. There was an interaction between feed form and corn type ($P<0.01$) in feed conversion with the improvement of 6.2% in chicks fed extruded pelleted diet compared to those fed normal pelleted diet. Extruded corn mash decreased the growth performance. These results suggested optimum growth rate and feed conversion in the extruded corn diet may be overcome by steam pelleting.

Introduction

Corn is the most important feed ingredient of dietary energy. The nutritional improvement of corn is of interested by animal producers. Extrusion process might be the method to improve digestible quality of corn such as enzyme susceptibility, resulting in improvement of energy utilization. A.F.E. Van Der Poel et al (1989 and 1990) determined starch availability in extruded corn compared to infrared corn and showed that in vitro starch availability, ileal digestibility coefficient of dry matter and nitrogen-free extract in young pigs were higher for extruded corn compared to infrared corn. In addition, Herkelman et al (1990) suggested extruded corn improved energy utilization in nursery pigs. While several researchers (A.F.E. Van Der Poel et al., 1989 and 1990 and Herkelman et al., 1990) have studied the effect of feed extrusion in young pig, little research has been done in poultry, especially under tropical conditions, such as in Thailand. The purpose of this study was, therefore, to determine the effect of extrusion of corn on metabolizable energy and nutrient digestibility in poultry (Experiment 1) and the effect of extruded corn and feed form on the growth performance in poultry raised under tropical environment (Experiment 2).

Materials and Methods

Extruded corn was manufactured through a single screw extruder⁵ with the length of a barrel of 0.81 m, 24 die openings and the die diameter of 6 mm. Extruded corn was reground through a 125 horsepower hammer mill equipped with 1.7 mm screen and used in experiment 1 and 2. Samples were taken and analyzed for proximate analysis and enzyme susceptibility.

⁵ Model PHG 135, Wuhan Machinery, china

Experiment 1: Twenty one male broilers (Ross×Ross) at the 35-days old were allotted to an individual metabolism cage. There were 7 cages per treatment. Treatments were the mash feed with: 1) basal diet containing 45.7% dextrose; 2) 40% substitution of normal corn for dextrose and 3) 40% substitution of extruded corn for dextrose. Chicks were fed ad libitum with experimental diets twice a day for 12 days period. (7 days for pre-feeding and 5 days for faecal collection). Fecal samples were collected in the morning and in the evening after feeding. Concentration of Cr₂O₃, nitrogen (N), and gross energy (GE) in the feed and feces were determined to allow the calculation of apparent digestibility of GE, N, and metabolizable energy (ME).

Experiment 2: A total of 1,600 broilers were used in a 42-days growth assay. One-day-old broilers male and female (average initial BW of 41 g) were allotted to dietary treatments based on sex. There were 50 birds per pen and eight pens per treatment. Treatments were a corn soybean meal-based diet with: 1) normal corn mash; 2) normal corn pellets; 3) +25% extruded corn mash; and 4) +25% extruded corn pellets. Chicks were fed a common starter corn-soybean meal based diet (3,100 kcalME/kg; 22.0%Crude Protein; 1.30% Lysine) from 1 to 21d of age, a grower diet (3,150 kcal ME/kg; 20.0% Crude Protein; 1.2% Lysine) from 21 to 42 day of age. Chicks and feeder were weighted on day 0, 21, and 42 to allow the calculation of weight gain, feed intake, and feed conversion. Experimental diets were either mixed and manufactured as a mash feed or steamed conditioned to approximately 57-72°C and then pelleted with a 125-horsepower pellet mill⁶ using die pellet openings of 4 mm. Pellets were cooled and crumbled.

All experimental data were analyzed as a randomized complete block design using the GLM procedure of SAS (1985). Treatment comparisons were made using the orthogonal contrasts.

Results and Discussion

Extrusion process significantly affected moisture, crude fiber, and ether extract content of corn (P<0.01). Moisture content was significantly decreased (P<0.01) in extruded corn compared to native corn (10.8% vs 6.6%). Additionally, there was a significant decrease (P <0.01) of ether extract in extruded corn compared to native corn (4.7% vs 2.7%). Crude fiber of extruded corn decreased (P<0.01) from 1.8% in native corn to 0.98% in extruded corn. As for enzyme susceptibilities of normal corn and extruded corn were 3.5% and 51.8% respectively.

Experiment 1: Apparent nutrient digestibility of GE and N was not significantly different for chicks fed diets containing 40% of normal corn and 40% of extruded corn. However, ME was significantly decreased from 3,127 kcal/kg feed in the normal corn diet to 2,716 kcal/kg feed.

Table 1 Effect of extrusion of corn on nutrient digestibility and metabolizable energy in broilers¹

Items	Normal Corn	Extruded Corn	SE	Contrast 2
Apparent digestibility,%				
GE	78.91	78.39	0.36	NS
N	79.68	80.74	0.72	NS
ME, kcal/kg feed	3,127	2,716	28	***

¹ 21 male broilers at 35-days old were used in a 12-day digestibility assay (7 cages per treatment).

² Contrast was: normal corn vs extruded corn.

*** = p < 0.001 ; NS = not significant(p > 0.15).

⁶ Model SZLH40, Jiang Zhengchang, China

Experiment 2: Under the tropical environment of 31°C average temperature, and 70% relative humidity, the overall performance from d 1 to 42 showed that pelleting effect improved body weight of chick by 8.8% ($P < 0.001$). Chick fed pelleted feed consumed more feed than those fed mash diet ($P < 0.001$). Overall, feed conversion in chicks fed pelleted feed was better ($P < 0.001$). There was an interaction between feed form and corn type ($P < 0.01$) in feed conversion with greater improvement of 6.2% favor in chicks fed extruded pelleted diet compared to those fed normal pelleted diet with the smaller improvement of 1.5%. Also mortality was affected by pelleted feed ($P < 0.05$).

Table 2 Effects of corn type and feed form on growth performance and mortality in broilers¹

Items	Normal corn		Extruded corn		SE	Contrasts ²		
	Mash	Pellet	Mash	Pellet		1	2	3
Weight gain intake, g	1,958	2,098	1,920	2,122	23	***	NS	NS
Feed intake, g	3,517	3,713	3,529	3,659	47	***	NS	NS
Feed conversion	1.799	1.773	1.840	1.726	0.157	***	NS	**
Mortality, %	7.3	12.8	8.3	10.0	1.7	*	NS	NS

¹ A total of 1,600 male and female broilers at one-day old was used in a 42-days growth assay (50 birds per pen and 8 pen per treatment).

² Contrasts were 1) mash vs pellet; 2) normal corn vs extruded corn; and 3) Feed form extruded corn interaction.

*** = $p < 0.001$; ** = $p < 0.01$; * = $p < 0.05$; NS = not significant ($p > 0.15$).

Results showed that ME of extruded corn was lower than that of normal corn. This might result from lower ether extract for extruded corn compared to normal. Feeding pellets to improve body weight and feed conversion were generally in agreement with earlier reports. The beneficial effects of pelleting attributed to decrease feed waste, reduce selective feeding and decrease ingredient selection (Hancock and Behnke, 2001). However, once extruded corn was in the diet, mash extrude corn feed decreased growth rate, decreased feed consumption and eventually decreased feed conversion. Less feed consumption was the critical issue in chicks raised in the tropical environment. The possible explanation to the negative response was less bulk density and less ME in extruded corn compared to those in normal corn. This caused chick used more energy expended for prehension. Therefore, the steam conditioning pelleting may be necessary to overcome less bulk density and less ME of extruded corn, resulting in optimization of growth in chicks fed the extruded corn diet.

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