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Effects of Feed Form on Development of Digestive Tract, Performance and Carcass Traits of Broiler Chickens

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Abstract: An experiment was conducted to assess the effect of feed form on performance, gastrointestinal development and carcass traits of broiler chickens. A total of 270 days old male Ross 308 broiler chicks were assigned to three dietary physical forms with six replicates of 15 birds each. The physical forms of diets including: mash and pelleted forms fed from 1-42 days of age, whereas the third treatment received crumbled and pelleted during 1-14 and 14-42 days of age, respectively. Feed intake, body weight gain, feed conversion ratio, performance index and production number were significantly ($p<0.05$) improved in pelleted or crumblepellet diets fed birds over mash fed birds. The survivability was significantly ($p<0.05$) higher in mash fed birds, as compared with pelleted fed birds (94.9 vs. 88.1%), but not differed with crumble-pellet fed birds. Carcass yield, breast, thigh, liver, heart, pancreas and abdominal fat weights as a percentage of live body weight were not affected by physical form of diets. Gizzard and caeca weight as a percent of body weight, were significantly ($p<0.05$) heavier in mash fed birds, over pellet or crumble-pellet fed birds, whereas crop, proventriculus and small intestinal weights were similar in all birds.

Key words: Broiler chicken, pellet, performance, digestive tract, carcass traits

INTRODUCTION

Now-a-days, various commercial feed mills are producing different forms of broiler feed for different age group of birds. Pelleting is a processing method that is employed by the feed manufactures to improve farm animal performance. Improved performance in pellet feeding is attributed to a decrease in feed wastage, reduced selective feeding, destruction of pathogenic organism and improved palatability. The physical form of feed (mash, pellet) is a crucial factor in meat yield of broiler. Ground feed is not so palatable and does not retain their nutritive value as well as ungrounded feed. The greatest advantage in feeding pellets reported to be little wastage of feed. The disadvantage is that pellets are about 10% more expensive than that of mash feeds. Bolton and Blair (1977) reported that feed intake of broiler diets was be up to 10% greater as compared with mash. Crumble also is a type of feed prepared at the mill by the crushing the pelleted feeds to a consistency coarser than mash.

Recently, this form of feed is becoming popular in broiler production due to its convenience of feeding. Reece *et al.* (1984) observed that best feed conversion was obtained with a feeding of high energy and high protein crumble form of feed. Choi *et al.* (1986) reported that chicks fed the crumbled starter diet consumed more feed. The anticipated ban on the use of antibiotic growth promoters in animal feeds has encouraged nutritionists to explore alternative feed management strategies to improve the health and digestive efficiency of broiler chickens. Promotion of gizzard development is one such nutritional strategy, which can be achieved by manipulating feed particle size (Engberg *et al.*, 2002). A well-developed gizzard is associated with improvement of gut motility (Ferket, 2000) and may prevent pathogenic bacteria from entering the small intestine (Bjerrum *et al.*, 2005), thus, reducing the risk of coccidiosis and other enteric diseases (Engberg *et al.*, 2002, 2004; Bjerrum *et al.*, 2005). This experiment was conducted to assess the effect of physical form of diet on bird performance and gut development.

MATERIALS AND METHODS

A total of 270 commercial broilers (Ross 308) were used in a completely randomized design with 3 treatments and 6 replications of 15 birds each. One-day-old male broiler chickens (average initial BW of 45 g) were

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allocated to dietary treatments. Uniformity in the management practices was maintained as much as possible. The birds were always exposed to a continuous lighting of 24 h of photoperiod. Initial room temperature was 32°C and was then gradually decreased according to usual practices. The relative humidity was recorded with the help of dry and wet bulb hygrometer. Waterers were fixed in such a way that the birds were able to eat and drink conveniently. Fresh and dried rice husk was used as litter at a depth of about 5 cm. A total 270 medium size birds were selected from a large population of same hatch, by discarding extreme large and small ones. All diets were corn-soybean based. Feed and water were given ad libitum and were supplied to the experimental birds daily once in the morning and again in the afternoon. Treatments were T_1) mash diet in all periods (control diet), T_2) pellet diets in all periods, T_3) crumble diet in starter and pelleted from 14-42 days. The birds were fed a commercial diet formulated according to the AVIAGEN recommendations for Ross 308 broilers (Table 1). All forms of feeds were of identical composition. During the experimental period, performance criteria such as feed consumption, body weight gain, feed conversion ratio and survivability, were recorded weekly and data on Performance Index (PI) and Production Number (PN) were calculated from the following formula:

$$\text{Performance Index (PI)} = \frac{\text{Live weight (g)}}{\text{Feed intake (g)}} \times 100$$

$$\text{Production Number (PN)} = \text{Average live weight (g)} \times \frac{\text{Survivability (\%)}}{\text{days}} \times \frac{\text{FCR}}{10}$$

One bird with an average pen weight was selected on 21 and 42 days and after killing, digestive organs such as crop, proventriculus, gizzard, small intestine and caeca separated, emptied and wet weighed. Two birds with an average live body weight of each replicate group were selected on 42nd day, fasted, weighed and then killed to determine carcass traits such as eviscerated carcass, abdominal fat, pancreas, breast, thigh and heart weights. All birds that died during the trial were weighed and feed conversion ratio was corrected for mortality by including the weight of the dead birds in the body weight gain.

Statistical analysis: The performance data were analyzed by variance analysis using the procedure described by the SAS Institute (1999). Duncan (1955) mean separation test was used to determine significant differences between treatment mean values ($p<0.05$).

Table 1: Composition (%) of experimental diets (0-42 days)

	Days		
Ingredients	0-14	15-28	29-42
Corn grain	51.600	56.600	60.300
Soybean meal	37.700	32.300	27.800
Wheat grain	5.000	5.000	5.000
Soybean oil	1.400	2.030	2.840
Dical. phosphate	1.560	1.470	1.390
Oyster shells	1.170	1.130	1.080
DL-methionine	0.300	0.290	0.270
L-lysine	0.130	0.130	0.300
Common salt	0.260	0.240	0.140
Coccidiostat	0.100	0.100	0.100
Sodium bicarbonate	0.100	0.100	0.100
Vit + Min premix[1]	0.600	0.600	0.600
Calculated nutrient content			
ME (kcal kg^{-1})	2.850	2.950	3.050
Crude protein (%)	22.000	20.000	18.500
Calcium (%)	0.900	0.850	0.800
Available P (%)	0.450	0.420	0.400
Sodium (%)	0.160	0.150	0.150
Lysine (%)	1.350	1.200	1.160
Met + Cys (%)	0.970	0.870	0.850

[1]Vitamin and mineral content of diets was as follows per kilogram of diet: Vitamin A -8000 IU; Vitamin D -1200 IU; Vitamin E -10 IU; Vitamin K3 -2 mg; Thiamine -2 mg; Riboflavin -5 mg; 0.2 mg; Vitamin B1 -0.03 mg; Pantothenic acid -10 mg; Niacin -50 mg; Biotin -0.1 mg; Folic acid -0.5 mg. 2; Iron -80 mg; Zinc -40 mg; Manganese -60 mg; Iodine -0.8 mg; Copper -8 mg; Selenium -0.2 mg; Cobalt -0.4 mg

RESULTS AND DISCUSSION

Different growth performance parameters such as body weight gain, feed consumption, feed conversion ratio, performance index, production number and survivability percent are shown in the Table 2 and 3. There were significant differences ($p<0.05$) in weekly feed consumption among birds fed mash with birds fed pelleted or crumble-pellet form diets (Table 3). The differences were observed in starter, grower, finisher and whole period. The highest (4418.63 g) and the lowest (3833.62 g) feed consumption were observed in birds fed crumble-pellet and mash diets, respectively and the lowest ($p<0.05$) feed consumption occurred in mash group (Fig. 1). It was observed that the significantly higher feed consumption occurred in both pellet and crumble-pellet feeds group during the whole trial period. Similar results were found by Bolton and Blair (1977) who reported that 10% greater feed intake may happen with crumble or pellet than with mash feeding. There were significant differences ($p<0.05$) in weekly body weight gain among all treated birds (Table 3). The differences were observed in starter, grower, finisher and whole period. The highest (2198.69 g) and lowest (1623.82 g) body weight gain were observed in crumble-pellet and mash, respectively. The lowest body weight gain was observed in mash group which differed significantly ($p<0.05$) from both pellet and crumble-pellet group (Fig. 2). These results agreed with the findings of

Table 2: Effect of feed form on performance criteria in chickens[1]

	Starter (0-14 days)			Grower (15-28 days)			Finisher (29-42 days)		
Feed forms[2]	FI (g)	WG (g)	FCR	FI (g)	WG (g)	FCR	FI (g)	WG (g)	FCR
Mash	518.330^{b}	222.630^{b}	2.340^{a}	1487.45^{b}	714.440^{b}	2.090^{a}	1846.240^{b}	691.400^{b}	2.68^{a}
Pellet	568.070^{a}	286.280^{a}	2.000^{b}	1573.56^{a}	832.220^{a}	1.890^{b}	2310.990^{a}	1013.430^{a}	2.28^{b}
Crumble-pellet	561.300^{a}	300.410^{a}	1.880^{b}	1593.29	844.440^{a}	1.890^{b}	2308.280^{a}	1070.500^{a}	2.16^{b}
SEM	1.870	2.100	0.190	3.03	4.280	4.400	0.210	6.000	0.24
p-value	0.002	0.003	0.006	0.01	0.002	0.016	0.001	0.001	0.004

[1]270 chicks (6 treatments with 15 bird per each pen) with initial BW of 45.5 g; [2]Mash: Mash diet in whole period (0-42 days); ellet: Pellet diet in whole period (0-42 days); Crumble-pellet: Crumble diet during 0-14 days and pelleted diet from 14-42 days; ^{a,b}Values in the same row and variable with no common superscript differ significantly ($p<0.05$)

Table 3: Effects of feed form on production performance of broiler chickens in whole period (0-42 days)

Feed form	FI (g)	WG (g)	FCR	Performance index (%)	Survivability (%)	Production No.
Mash	3833.620^{b}	1623.820^{b}	2.370^{a}	42.9800^{b}	94.910^{a}	160.9600^{b}
Pellet	4390.250^{a}	2108.740^{a}	2.080^{b}	48.8000^{a}	88.090^{b}	217.7200^{a}
Crumble-pellet	4418.630^{a}	2198.690^{a}	2.010^{b}	50.8600^{a}	90.790^{ab}	241.8000^{a}
SEM	4.950	4.040	0.140	0.7700	0.900	2.0600
p-value	0.001	0.001	0.003	0.0048	0.008	0.0002

^{a,b}Values in the same row and variable with no common superscript differ significantly ($p<0.05$)

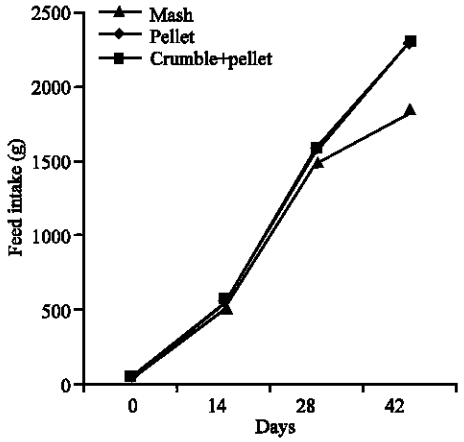

Fig. 1: Effects of feed form on feed intake of chickens in 3 periods

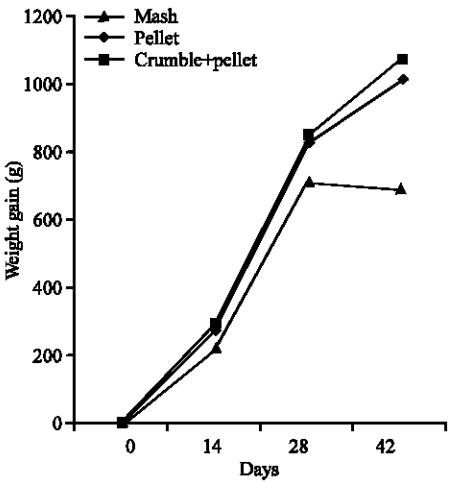

Fig. 2: Effects of feed form on body weight gain of chickens in 3 periods

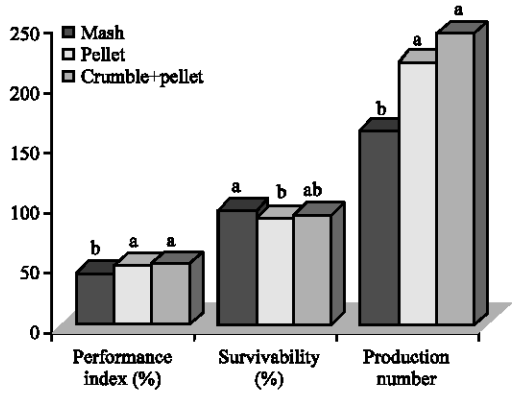

Fig. 3: Effects of feed form on production performance in whole experimental period

Sinha *et al.* (1994) and Reece *et al.* (1984), who reported that mash diets gave significantly ($p<0.05$) lower body weight gain than did crumble fed birds. Deaton *et al.* (1992) reported that pellet fed birds gain heavier body weight than that of mash. Such as feed intake and body weight gain, the feed conversion ratio differed significantly between all treatments and the highest FCR (2.37) was observed in mash fed birds and the lowest in crumble-pellet fed birds (2.01). (1995). Reece *et al.* (1984) reported that pellets had a better feed efficiency over mash. Howlider and Rose (1992) found that pelleting of diets decreased feed conversion by 5.9%. Reece *et al.* (1984) reported that crumbling improved feed conversion 1.5%. Production Index (PI) was similar in birds fed pelleted or crumble-pelleted diets, but was significantly different ($p<0.05$) from mash fed birds. The highest average (241.80) production number was obtained from pellet-crumble group and this was statistically similar with pellet group (217.72) (Fig. 3). These data differed

Table 4: Effect of feed form on carcass traits of broiler chicks at 42 days of age (% of live bird weight)

Feed form	Carcass yield	Breast	Thigh	Liver	Pancreas	Heart	Abdominal fat
Mash	66.34	24.500	37.00	2.29	0.30	0.50	1.80
Pellet	67.48	24.660	37.60	2.41	0.30	0.56	2.29
Crumble-pellet	67.96	24.500	37.33	2.27	0.26	0.51	2.19
SEM	1.60	0.660	0.69	0.25	0.12	0.11	0.28
P-value	0.99	0.990	0.97	0.73	0.57	0.60	0.12

[a,b]Values in the same row and variable with no common superscript differ significantly ($p<0.05$)

Table 5: Effect of feed form on digestive tracts at 21 days of age (g kg^{-1} of body weight)

Feed form	Crop	Proventriculus	Gizzard	Small intestine	Caeca
Mash	2.56	4.48	20.06[a]	22.28	1.96[a]
Pellet	2.67	4.45	17.86[b]	21.91	1.79[b]
Crumble-pellet	2.60	4.12	17.32[b]	22.06	1.74[b]
SEM	0.16	0.24	0.36	0.38	0.12
P-value	0.46	0.21	0.001	0.76	0.004

[a,b]Values in the same row and variable with no common superscript differ significantly ($p<0.05$)

Table 6: Effect of feed form on digestive tracts at 42 days of age (g kg^{-1} of body weight)

Feed form	Crop	Proventriculus	Gizzard	Small intestine	Caeca
Mash	3.80	4.76	13.910[a]	18.51	3.720[a]
Pellet	3.69	4.91	11.870[b]	19.21	2.690[b]
Crumble-pellet	3.78	4.73	11.140[c]	17.82	2.400[b]
SEM	0.14	0.22	0.310	0.29	0.110
P-value	0.53	0.39	0.001	0.40	0.001

[a,b]Values in the same row and variable with no common superscript differ significantly ($p<0.05$)

significantly ($p<0.05$) from mash fed birds (160.96). The survivability percent did not differ significantly between pelleted or crumble-pelleted fed birds. These results suggest that physical form of feed as pellet or crumble had no or little effect on health condition of birds. This result is supported by Deaton (1992) who observed no significant difference in mortality between mash and pellet type. Survivability was significantly higher in pelleted or crumble-pelleted fed birds as compared to mash fed birds (Table 3). Adversely, Deaton (1992) did not observe any differences in survivability of birds fed mash or pelleted diets. The carcass yield values (Table 4), based on the carcass weight after removal of feet and head, was similar in all treatments and ranged from 66.34-67.96%. Also, other carcass traits such as breast, thigh, liver and abdominal fat percent were similar ($p>0.05$). Among the relative weights of digestive tract segments, only the gizzard and caeca weight of pelleted or crumble-pelleted fed birds were significantly ($p<0.05$) different over mash fed birds measured on day 21 or 42 (Table 5 and 6). These results are in agreement with Amerah *et al.* (2007). Promotion of gizzard development is one nutritional strategy, which can be achieved by manipulating feed particle size (Engberg *et al.*, 2002). A well-developed gizzard is associated with improvement in gut motility (Ferket, 2000) and may prevent pathogenic bacteria from entering the small intestine (Bjerrum *et al.*, 2005), thus reducing the risk of coccidiosis and other enteric diseases (Engberg *et al.*, 2002, 2004; Bjerrum *et al.*, 2005).

CONCLUSION

Feeding pelleted or crumble-pelleted diets caused a significant increase in feed intake and weight gain of chickens with lowering feed conversion efficiency over mash fed birds in whole experimental periods. The highest differences in performance criteria were observed in finisher period. Performance index and production number was highly improved with pelleted or crumble-pelleted diet fed birds means more dollar benefit as compared to mash fed birds. Weight of gizzard and caeca increased with pelleted or crumble-pelleted fed birds over mash fed birds, whereas other gastrointestinal segment weights and carcass yield and cuts were not affected by feeding different physical form of diet.

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