International Journal of Poultry Science 5 (3): 265-270, 2006
ISSN 1682-8356

Performance of Broiler Fed on Mash, Pellet and Crumble

M.S. Jahan, M. Asaduzzaman and A.K. Sarkar
Department of Poultry Science, Bangladesh Agricultural University, Mymensingh, Bangladesh

Abstract: A total of 144 ISA-i757 broiler chicks were fed on mash, pellet and crumble diet in the age duration of 21 to 56 days to compare the performance of broiler on different dietary groups. All the forms of feed were of identical composition as well as same environment and management were provided for all the treatments. The body weight of birds fed on mash, pellet and crumble group from 4th to 8th weeks of age differed significantly ($P<0.01$). The highest, intermediate and the lowest body weight were observed for crumble, pellet and mash group respectively. The body weight gain also highest in crumble group ($P<0.01$). Feed consumption of the 3 treatments differed significantly ($P<0.01$). Crumble group showed high trend of feed consumption. Higher FCR value ($P<0.01$) was observed for mash group, which indicated low feed conversion efficiency. On the other hand crumble and pellet group showed better fed conversion efficiency. Significantly high ($P<0.01$) performance index and production number were observed for crumble group. Survivability percent of all treatments did not differ significantly ($P>0.01$). Total cost of production was significantly ($P<0.01$) less for crumble and this was statistically similar with pellet group. The results of this experiment give an impression that crumble form of feed is better than mash and pellet form for the production of commercial broiler for the age duration of 21 to 56 days.

Key words: Broiler, mash, pellet, crumble and growth

Introduction

Nowadays, various commercial feed mills are producing different forms of broiler feed for different age group of bird. The physical form of feed (mash, pellet and crumble) is a crucial factor in meat yield of broiler. Feed constitutes about 60-70 per cent of the total cost of broiler production (Banerjee, 1988). Different types of feed forms have been evolved in broiler production at the present time. Various feed forms i.e., pellet, mash or crumble that to be supplied to broiler are the most important factor which directly influence the cost of mixed feed and production performance of broiler.

The major objective of poultry feeding is the conversion of feedstuff into human food. The economic importance of poultry feeding becomes apparent when it is realized that 60-70% of the total production cost of poultry is feed cost. For this reason, the efficient use of feed is extremely important in broiler production. Generally, pellet or crumble costs slightly more than the same ration in mash form.

Mash is a form of a complete feed that is finely ground and mixed so that birds cannot easily separate out ingredients; each mouthful provides a well balanced diet. Simple manufacturing procedure is needed for mash form of feed. Mash diet gives greater unification of growth, less death loss and more economical. However, ground feed is not so palatable and does not retain their nutritive value so well as ungrounded feed. Mendes *et al*. (1995) showed that birds fed mash diets had a better feed conversion efficiency than those given the pellet. Proudfoot and Hulan (1982) observed that the incidence of sudden death syndrome (SDS) was significantly higher for broilers fed on crumble-pellet or ground crumble-pellet form diet than for birds fed on mash. There were no significant differences in live weight gain between birds fed on mash diet and those given a complete pelleted diets (McAllister *et al.,* 2000).

Pellet system of feeding is really a modification of the mash system. It consists of mechanically pressing the mash into hard dry pellets or "artificial grains". Pellet is a form of complete feed that is compacted and extruded to about 1/8 inch in diameter and 1/4 inch in long (Banerjee, 1988). The greatest advantage in using pellets is that there is little waste in feeding. The disadvantage is that pellets are expensive-about 10 percent more expensive than that of feeds not pelleted. Asha Rajini *et al*. (1998a,b) reported that pellets had better-feed efficiency up to six-week age of birds. On the other had Moran (1990) observed that pelleting of feed improves the body weight of poultry. Bolton and Blair (1977) reported that feed intake of broilers could be up to 10 per cent greater with crumble or pellets compared with mash.

Crumble also is a type of feed prepared at the mill by pelleting of the mixed ingredients and then crushing the pellet 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 level with high protein profile in crumble form of feed. Choi *et al.* (1986) reported that chicks fed the crumbled starter diet consumed more feed.

Table 1: Lay out of the experiment

Dietary Treatment	Age of birds (days)	Replication wise number of chicks				Total No. of birds
		R1	R2	R3	R4	
T1 (Mash)	22	12	12	12	12	48
T2 (Pellet)	22	12	12	12	12	48
T3 (Crumble)	22	12	12	12	12	48

Table 2: Composition of the experimental diet (supplied by Aftab Feed Mills Limited)

Ingredients (kg)	Broiler Grower (22-42days age)	Broiler Finisher (43-56days age)
Wheat	13.83	16.85
Maize	20.00	20.00
Rice polish	20.00	22.00
Mustard oilcake	5.00	6.00
Full fat soybean	26.00	25.00
Soybean meal	4.0	-
Fish meal	7.0	5.00
Soybean oil	1.50	2.00
Bone meal	2.0	2.50
Salt	0.30	0.30
Methionine	0.12	0.10
Vitamin-mineral premix	0.25	0.25
Calculated composition		
Metabolizable energy (kcal/kg)	3100	3200
Crude protein (%)	22	20
Methionine (%)	0.55	0.50
Methionine+ Cystine (%)	0.90	0.85
Lysine (%)	1.2	1.10
Calcium (%)	1.1-1.5	0.09-1.0
Av. Phosphorus (%)	0.48	0.40

Feeding of each form of feed has its advantages and disadvantages. The effectiveness, digestibility and conversion efficiency of different forms of feed are also different. But limited research work has been performed to investigate the effect of feeding different forms of feed (mash, pellet and crumble) on the productive performance of broiler in Bangladesh. In this situation the present study has been undertaken to compare the effect of feeding mash, pellet and crumble feeds on growth rate, feed efficiency and other productive characters of broiler and to find out the most economic and suitable form of feed considering the productive performance of broiler.

Materials and Methods

The research work was conducted at Bangladesh Agricultural University Poultry Farm. Mymensingh to compare the performance of Grower (22-42 days) and Finisher (43-56 days) broilers fed on mash, pellet and crumble form of feed under Bangladesh condition.

The experimental room of the broiler house was properly washed and cleaned by using tap water. Ceiling, walls and floor were thoroughly cleaned and disinfected using diluted losan solution. After drying, the experimental room was divided into twelve separated pens of equal size by using bamboo materials and wire net. The height of each wire net partition was 90 cm.

A total of 144 ISA-i757 broiler chicks of 21 day-old were used for the experiment. The chicks were procured from Poultry Development Project, under the department of Poultry Science, BAU, Mymensingh, Bangladesh.

The experiment was designed in three (3) dietary treatments having four (4) replications of each. The layout of the experiment is shown in Table 1.

Mash, pellet and crumble form diets were collected from Aftab Bahumukhi Farm Ltd. Bangladesh. All of the forms of the feed were of identical composition. Table 2 is presenting the composition of feed.

Uniformity in the management practices was maintained as much as possible. A total 144 medium size birds were selected from a large population of same hatch, by discarding extreme large and small one's. They were randomly distributed in 12 equal size pens, which were previously cleaned and disinfected. A 100-watt electric bulb was hanged at a height of 2.8 metre in the middle of room. Each pen was 200 cm x 90 cm and was allotted for 12 birds. Therefore floor space for each bird was 1500 cm^2. One feeder (60cm x 8 cm x 5 cm) and one round waterer with a capacity of 2.5 liter were provided in each pen. The feeders and 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 5cm. After fifth weeks of age, droppings were cleaned from the surface level of litter.

Feed and water were supplied *ad libitum* to the birds throughout the experimental period. Feed and fresh drinking water were supplied to the experimental birds daily once in the morning and again in the afternoon. The birds were always exposed to a continuous lighting of 23 hours and 30 minutes and a dark period of 30 minutes in each 24 hours of photoperiod. During night, electric bulb was used to provide necessary light.

For the treatment of Mycoplasmosis and secondary bacterial infections, Micronid (Renata Limited) was added @ 1g powder per liter drinking water as per manufacturers recommendation during 5th weeks of age. Waterers were washed and cleaned daily in the morning and feeders were cleaned weekly before being used. Strict sanitary measures were followed during the experimental period. And the temperature of the experimental house was recorded four times a day (6 A.M., 12 P.M., 6 P.M. and 12 A.M.) using a thermometer. The relative humidity was recorded with the help of dry and wet bulb hygrometer. Dead birds were sent to the

Table 3: Average performance of broiler fed on mash, pellet and crumble (From 4th-8th weeks of age)

Variable	Dietary treatment group			Level of significance
	Mash	Pellet	Crumble	
Body weight at 8th week	1495.24[b]	1647.15[ab]	1729.76[a]	**
Feed consumption (g/bird/wk)	638.27[b]	660.37[a]	660.53[a]	**
Body weight gain (g/bird/wk)	244.5[c]	290.37[b]	292[a]	**
FCR/week	2.58[a]	2.25[b]	2.24[b]	**
Performance index (%)	36.17[b]	47.15[a]	47.58[a]	**
Survivability (%)	98.33	98.33	100.00	NS
Production number	253.06[b]	329.96[a]	340.04[a]	**

Values bearing different superscripts in a row differ significantly. NS = Non significant, ** P<0.01

Table 4: Weekly average body weight (g/bird/week) of birds of different dietary treatments

Variable	Dietary treatment group			Level of significance
	Mash	Pellet	Crumble	
Initial	271.24	271.77	269.72	NS
4th	443.99[b]	469.3[a]	472.98[a]	**
5th	683.74[b]	765.67[a]	768.3[a]	**
6th	941.24[b]	1079.25[a]	1084.13[a]	**
7th	1209.49[b]	1398.41[a]	1404.19[a]	**
8th	1495.24[b]	1647.15[ab]	1729.76[a]	**

Values bearing different superscripts in a row differ significantly. NS= Non significant ,** P<0.01

Table 5: Weekly average body weight gain (g/bird/week) of birds of different dietary treatments

Age in week	Dietary treatment group			Level of significance
	Mash	Pellet	Crumble	
4th	172.75[c]	197.53[b]	203.25[a]	**
5th	239.5[b]	296.36[a]	395.32[a]	**
6th	257.75[b]	313.58[a]	315.82[a]	**
7th	268.25[b]	319.16[a]	320.06[a]	**
8th	284.25[b]	325.23[a]	325.57[a]	**

Values bearing different superscripts in a row differ significantly. NS = Non significant, ** P<0.01

Table 6: Weekly average feed consumption (g/bird/week) of the broilers of different dietary treatments

Age in week	Dietary treatment group			Level of significance
	Mash	Pellet	Crumble	
4th	407.75[b]	423.6[a]	424.0[a]	**
5th	575.5[b]	605.17[a]	607.25[a]	**
6th	674.75[b]	706.82[a]	707.9[a]	**
7th	735.5[b]	756.75[a]	756.5[a]	**
8th	797.85[b]	809.5[a]	807.0[a]	**

Pathology laboratory, B.A.U., Mymensingh to carry out post-mortem examinations. Reports were collected and evaluated in time.

During the experimental period treatment and replication wise data on live weight, feed consumption, survivability, temperature and relative humidity were recorded. And data on body weight gain, feed conversion ratio, performance index (PI), production number (PN) and production cost were calculated following the below mentioned formulae;

$$\text{Feed Conversion Ratio (FCR)} = \frac{\text{Feed intake (g)}}{\text{Live weight (g)}}$$

$$\text{Performance Index (PI)} = \frac{\text{Live weight in kg}}{\text{Feed conversion ratio}} \times 100$$

The Production Number (PN) of different were calculated following the formula given by Euribrid (1994).

PN = Average live weight× % survivability/days (duration of fattening) × FCR ÷ 10

All recorded and calculated data were statistically analyzed using analysis of variance technique by a computer using a MSTAT statistical computer package programme in accordance with the principle of Completely Randomized Design (CRD). Least Significant Differences (LSD) were calculated to compare variation between treatment where ANOVA showed significant differences.

Results and Discussion

Different growth performance parameters average weekly body weight, body weight gain, feed consumption, feed conversion ratio, performance index, production number and survivability per cent were presented in the Table 3. At the same time week wise table of the above mentioned parameters also presented and discussed subsequently.

Body weight: Body weight of birds of mash, pellet and crumble group from 4th to 8th weeks of age showed significant differences (P<0.01) (Table 4). But the initial body weight of the birds did not differ significantly. The highest body weight throughout all of the weeks was observed in crumble group. Intermediate and the lowest body weight in different weeks were observed in pellet and mash group respectively. From 4th to 8th weeks of age the body weight of crumble and pellet were statistically similar. But there was significant differences (P<0.01) between mash as well as both pellet and crumble group from 4th to 7th weeks of age except 8th week of age at which the body weight of mash (1495.24g) and pellet (1647.15g) group were statistically similar, But body weight between crumble (1729.76g) and mash (1495.24g) group at 8th week differed

Table 7: Cumulative feed consumption (g/bird) of broilers at different dietary treatments

Age in week	Dietary treatment group			Level of significance
	Mash	Pellet	Crumble	
4th	407.75[b]	423.6[a]	424.0[a]	**
5th	983.25[b]	1028.77[a]	1031.25[a]	**
6th	1658.0[b]	1735.59[a]	1739.15[a]	**
7th	2393.5[b]	2492.29[a]	2495.65[a]	**
8th	3191.3[b]	3301.7[a]	3302.65[a]	**

Values bearing different superscripts in a row differ significantly. NS= Non significant

Table 8: Weekly Feed Conversion Ratio (FCR) of broilers of different dietary treatments

Age in week	Dietary treatment group			Level of significance
	Mash	Pellet	Crumble	
4th	2.35[a]	2.14[b]	2.08[b]	**
5th	2.4[a]	2.04[b]	2.05[b]	**
6th	2.61[a]	2.25[b]	2.4[b]	**
7th	2.74[a]	2.36[b]	2.36[b]	**
8th	2.8[a]	2.48[b]	2.47[b]	**

Values bearing different superscripts in a row differ significantly. NS= Non significant, ** P<0.01

Table 9: Mean performance index (%) of the broilers of different dietary treatments

Age in week	Dietary treatment group			Level of significance
	Mash	Pellet	Crumble	
4th	19.08[b]	21.88[a]	22.67[a]	**
5th	28.45[b]	37.53[a]	37.43[a]	**
6th	35.95[b]	47.91[a]	48.4[a]	**
7th	44.1[b]	59.06[a]	59.49[a]	**
8th	53.29[b]	69.36[a]	69.9[a]	**

Values bearing different superscripts in a row differ significantly. NS= Non significant, ** P<0.01

significantly (P<0.01). This result might be supported by Preston *et al*. (2000) and Munt *et al*. (1995) who showed significantly poorer performance of mash-fed birds. Kim and Chung (1994) showed that mash-fed bird had lower body weight at 41 days than birds fed on crumble and pellet. Reece *et al.* (1985), Auckland and Fulton (1972) and Runnels *et al.* (1976) also agreed that crumble feed increased body weight than other forms. The present studies also agreed with Choi *et al.* (1986) who showed that the chicks fed crumbled diet gained more weight and pelleting diet also significantly improved weight gain compared to those fed on mash diet.

Body weight gain: Body weight gain per week of different dietary treatments differed significantly (P<0.01) (Table 3). The highest (292 g/bird/week), intermediate (290.37 g/bird/week) and the lowest (244.5 g/bird/week) body weight gain were observed in crumble, pellet and mash group respectively. Week wise (4th-8th) data on body weight gain (Table 5) also differed significantly (P<0.01). The highest body weight gain was observed in the

Table 10: Production Number of birds of different dietary treatments

Age in week	Dietary treatment group			Level of signific-ance
	Mash	Pellet	Crumble	
4th	134.95	156.6	162.42	**
5th	204.2	268.9	267.7	**
6th	258.5	342.6	347.2	**
7th	302.15	405.5	424.9	**
8th	365.5	475.7	500.2	**
Mean±S.E.	253.06[b]± 8.82	329.96[a]± 13.12	340.4[a]± 7.69	

Values bearing different superscripts in a row differ significantly. NS= Non significant, ** P<0.01

crumble group throughout the experimental period but these data were statistically similar with pellet group from 5th to 8th weeks of age. The lowest body weight gain was observed in mash group which differed significantly (P<0.01) from both pellet and crumble group. These results agreed with the findings of Sinha *et al.* (1994) and Reece *et al.* (1985) who reported that mash gave significantly (P<0.05) lower body weight gain than did crumble. Asha Rajini *et al*. (1998a,b), Deaton *et al.* (1992), Kamar *et al.* (1974) and Bertechini *et al.* (1992) reported that pellet fed birds gain heavier body weight than that of mash. Allred *et al.* (1996) also reported that chicks grew faster when fed pellets or crumbles than when the same diets fed as mash.

Feed consumption: There were significant differences (P<0.01) in weekly feed consumption among the three dietary groups (Table 3). The highest (660.53 g/bird/wk) and the lowest (638.27 g/bird/week) feed consumption were observed in crumble and pellet group as well as mash group respectively. Week wise feed consumption data were presented in the Table 6. It was observed that the highest feed consumption was occurred in crumble group in all the weeks of age and these data were statistically similar to pellet group. Significantly (P<0.01) the lowest feed consumption occurred in mash group.
Cumulative feed consumption of different dietary treatments were presented in the Table 7. Here it was obvious that significantly higher feed consumption occurred in both pellet (3301.7g) and crumble (3302.65g) group than that of mash (3191.3g) group during the whole trial period. Similar results were found by Bolton and Blair (1977) who reported that 10 per cent greater feed intake could be happened with crumble or pellets than with mash. Bertechini *et al.* (1992) reported that pelleted diets gave greater feed intake than did mash forms. At the similar way Moran (1990) and Nir *et al.* (1995) showed that pellet diet increased feed intake in broilers. Hamm and Stephenson (1959) also reported that pelleted or crumble diet increased voluntary feed intake.

Feed conversion ratio (FCR): Feed conversion ratio (FCR) during the whole experimental period differed

Table 11: Cost and benefit analysis of different dietary treatments (From 4th-8th weeks of age)

Variable	Dietary treatment group			Level of significance
	Mash	Pellet	Crumble	
Live weight (g/broiler)	1473.33[b]	1706.46[a]	1716.84[a]	**
Survivability (no.)	46	46	48	NS
Feed cost (BDT/broiler)	37.24[b]	43.2[a]	43.2[a]	**
Chick cost (BDT/broiler)	22	22	22	NS
Other cost(BDT/broiler)	9.02	9.02	8.64	NS
Total cost of production(Tk/broiler)	68.26[b]	74.22[a]	73.84[a]	**
Market price(BDT/kg broiler)	65.0	65.0	65.0	NS
Av. market price of live broiler(BDT/broiler)	95.74[b]	110.89[a]	111.54[a]	**
Profit (BDT/broiler)	27.48[b]	36.67[a]	37.7[a]	**
Total cost of production (BDT/kg live broiler)	46.34[b]	43.50[a]	43.03[a]	**
Profit (BDT/kg live broiler)	18.66[b]	21.5[a]	21.7[a]	**

Values bearing different superscripts in a row differ significantly. NS= Non significant, ** P<0.01

significantly (P<0.01) (Table 3). The highest (2.58) FCR value was observed in mash group, which indicated low feed conversion efficiency. On the other hand comparatively low and statistically similar FCR values were observed in pellet (2.25) and crumble (2.24) group, which indicated high feed conversion efficiency. From the week wise FCR value (Table 8) it was observed that statistically similar FCR values were for pellet and crumble group from 4th to 8th weeks of age. One the contrary FCR value of mash group was high and differed significantly (P<0.01) from the other groups. Similar results were obtained by Asha Rajini *et al.* (1998a,b), Mendes *et al.* (1995). Moran (1990) and Reece *et al.* (1986) who reported that pellets had a better feed efficiency over mash. Howlider and Rose (1992) found that pelleting increase feed conversion by 5.9%. Kim and Chung (1996) concluded that crumble-pellet treatment significantly improved feed conversion. In the same way Reece *et al*. (1984) reported that crumbling improved feed conversion 1.5 per cent.

Performance index: The highest (47.58) and statistically similar to pellet (47.15) performance index was observed in crumble group (Table 3). They differed significantly (P<0.01) from mash group (36.17). From the week wise data (Table 9) it is clear that the performance index data of pellet and crumble group were high and statistically similar and they differed significantly (P<0.01) from mash group, which were low at all the weeks of age.

Production number: The average highest (340.4) production number was obtained from crumble group and this was statistically similar with pellet group (329.96) (Table 3 and 10). These data differed significantly (P<0.01) from mash group (253.06), which were too low.

Survivability: The data on survivability percent did not differ significantly. Only 2 birds from mash group and 2 birds from pellet group died due to vitamin E deficiency. This death was not due to dietary treatment effect. These results suggest that physical form of feed had no or little effect on health condition of bird. This result might be supported by Deaton (1992) who observed no significant difference in mortality between mash and pellet type. These results agreed with Heuser (1955) who reported that vitamin content of pelleted ration may be affected and Banerjee (1988) also reported that ground feeds did not retain their nutritive value so well as ungrounded feeds.

Cost of production: The data on cost of production was presented in Table 11. Statistically similar and significantly high (P<0.01) feed cost was provided for pellet and crumble group. But total cost of production (BDT/Kg live broiler) was significantly (P<0.01) less for crumble and this cost was statistically similar with the pellet group. Statistically similar and significantly (P<0.01) high profit was obtained from pellet and crumble group. Similar results were obtained By Kim and Chung (1994) who reported that production cost almost similar between crumble and crumble-pellet treatments. Garcia Pestana (1975) also reported that pelleted diet decreased production cost of meat.

Acknowledgements

The author expressed his deep sense of gratitude and indebtedness to his reverend thesis supervisor professor Dr. S. M. Bulbul for his constant help and scholastic supervision. She also desires to acknowledge his co-supervisor professor Dr. Safiuddin Ahmed, Dr. S.D. Choudhury and M. Asaduzzaman for their kind help. The author is also grateful to the Ministry of Science and Technology for giving a fellowship for this research work.

References

Allred, J.B., L.S. Jensen and J. Mc Ginnis, 1996. Studies on the growth promoting effect induced by pelleting feed. Poult. Sci., 35: 1130-1133.

Asha Rajini, R., S. Thanabalan, D. Narahari and R. Kumararaj, 1998a. Influence of season, form of feed and dietary energy levels on broiler performance. Ind. J. Poult. Sci., 33: 36-41.

Asha Rajini, R., R. Kumararaj, D. Narahari, R. Ravindran, and K. Sundaresan, 1998b. Influence of season, form of feed, dietary energy, age and sex on carcass traits of broilers. Ind. J. Poult. Sci., 33: 346-348.

Auckland, J.M. and R.B. Fulton, 1972. The effect of dietary nutrient concentration, crumbles versus mash and age of dam on the growth of broiler chicks. Poult. Sci., 51: 1968-1975.

Banerjee, G.C., 1998. Poultry. Third edition, Oxford and IBH Publishing Co. Pvt. Ltd. Calcutta, pp: 120-121.

Bertechini, A.G., H.S. Rostagno and A.I.G. Oliveira, 1992. Effect of nutrient concentration on performance of broilers. Poult. Abst., 18: 2965.

Bertechini, A.G., H.S. Rostagno, J.B. Fonseca and A.I.G. Oliveira, 1992. Effect of environmental temperature and physical form of diet on performance and carcass quality of broiler fowl. Poult. Abst., 18: 3066.

Bolton, W. and R. Blair, 1977. Poultry Nutrition. Ministry of Agriculture, Fisheries and Food. Bulletin 174 (London, H.M.S.O.).

Choi, J.H., B.S. So, K.S. Ryu and S.L. Kang, 1986. Effects of pelleted or crumbled diets on the performance and the development of the digestive organs of broilers. Poult. Sci., 65: 594-597.

Deaton, J.W., 1992. The effect of meal feeding on small intestine weight. Poult. Sci., 71: 1807-1810.

Euribrid, B.V., 1994. Technical information for Hybro broilers, pp.22 (Boxmeer, The Netherlands, Euribrid Poultry Breeding Farm).

Garcia Pestana, A., 1975. Study of some of the technical factors determining production costs for one kilo poultry meat. Poult. Abst., 1: 370.

Hamm, D. and E.L. Stephenson, 1959. The pelleting response in broiler feeding. Poult. Sci., 38:1211-1215.

Heuser, G.F., 1955. Poultry feeding. Second edition. John Wiley and Sons, New York, pp: 632-638.

Howlider, M.A.R. and S.P. Rose, 1992. The Response of growing male and female broiler chickens kept at different temperatures to dietary energy concentration and feed from. Anim. Feed Sci. Tec., 39: 71-78.

Kamar, G.A.R., M.A. Akheireldin, A.F. EL-Difrawi and M. Chany, 1974. A comparison between pelleted and mash feeding for growing chicks. Egyp. J. Anim. Prod. 14: 129-135.

Kim, Hyoung Ho and Chung, Yuen Hoo, 1996. Effects of dietary feed form regimes on broiler chicken performance. Journal of Agricultural Science, Livest., 35: 554-558.

Kim, Hyoung Ho and Chung, Yuen Hoo, 1994. The effects of crumbles, pelleted and extruded feed on the performance of broiler chicken. Sustainable Animal Production and the Environment, 3: 211-212.

McAllister, A., K.J. McCracken and F.A. Magee, 2000. Influence of grinding, rolling and pelleting on the nutritional value of grain sorghums and yellow corn for broilers. World's Poult. Sci. J., 56: 215-222.

Mendes, A.A., E.S. Polity, E.A. Garcia and J.R. Sartori, 1995. Effect of ground of pelleted diets on performance and carcass yield of broiler chicken. Veterinaria-e-zootecnia, 7: 31-40.

Moran, E.T., Jr., 1990. Effect of pellet quality on the performance of meat birds. Poult. Abst., 16: 2875.

Munt, R.H.C., J.G. Dingle and M.G. Sumpa, 1995. Growth, carcass composition and profitability of meat chickens given pellets, mash or free choice diet. Br. Poult. Sci., 36: 277-284.

Nir, I., R. Hillel, I. Ptichi and G. Shefet, 1995. Effect of particle size on performance of grinding and pelleting interactions, Poult. Sci., 74: 771-783.

Preston, C.M., R.J. Mc Cracken and A. Mc Allister, 2000. Effect of diet form and enzyme supplementation on growth, efficiency and energy utilization of wheat based diets for broilers. Br. Poult. Sci., 41: 324-331.

Proudfoot, F.G. and H.W. Hulan, 1982. Effect of reduced feeding time using all mash or crumble-pellet dietary regimes on chicken broiler performance, including the incidence of acute death syndrome. Poult. Sci., 61: 750-754.

Reece, F.N., B.D. Lott and J.N. Deaton, 1985. The effect of feed form, grinding method, energy level, and gender on broiler performance in a moderate (21^{0}C) temperature. Poult. Sci. 64: 1834-1839.

Reece, F.N., B.D. Lott and J.N. Deaton, 1986. Effects of environmental temperature and corn particle size on response of broilers to pelleted feed. Poult. Sci., 65: 636-641.

Reece, F.N., B.D. Lott and J.W. Deaton, 1984. The effects of feed form, Protein profile, energy level and gender on broiler performance in warm (26.7^{0}C) environment. Poult. Sci., 63: 1906-1911.

Runnels, T.D., G.W. Malone and S. Klopp, 1976. The influence of feed texture on broiler performance. Poult. Sci., 55: 1958-1961.

Sinha, S.C. and N.N. Digvijoi Singh, Pandita, 1994. Effect of feeding grower mash ration on the performance of broilers. Poultry Today and Tomorrow, 4: 26-30.