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Effect of Sodium Bentonite and Comparison of Pellet vs Mash on Performance of Broiler Chickens

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Abstract: An experiment was conducted to study the effect of Sodium Bentonite (SB) and comparison of feed forms (pellet *vs* mash) on broiler performance. 320 day-old Cobb strain male broiler chickens were allocated to 8 experimental diets with 4*2 factorial arrangements in a completely randomized design. Treatments were 0, 1, 2 and 3 percent of SB and two forms of diets (pellet and mash). At 49 days of age, chickens that fed pelleted diets, consumed more feeds and showed better weight gain and feed conversion ratio ($P<0.05$). Pelleting the diets also significantly increased weight of abdominal fat and decreased thigh percentage ($P<0.05$). Chickens fed diets containing 1-2 % SB consumed more feed, had more weight gain and less feed conversion ratio ($P<0.05$). Under the conditions of this study, it seems that pelleting the diets and 1-2% of SB, improves performance of broiler chickens.

Key words: Sodium Bentonite, pellet, mash, broiler chickens, performance

Introduction

Pelleting is a processing method that is employed by the feed manufacturing industry to improve farm animal performance. Poultry generally respond to the greatest extent, and pelleted feed is in widespread commercial use in the poultry industry. The improvements of pellet in performance have been attributed to 1) decrease feed wastage 2) reduced selective feeding 3) destruction of pathogenic organisms 4) improved palatability. Totally birds prefer to consume pellet rather than mash that such changes conform with dimension of the oral cavity. Moran (1989) suggested that these birds would consume additional water. Patten *et al*. (1937) reported that chickens fed pelleted diets gained more weight and consumed less feed than chickens fed mash diets. An increased feed efficiency with the pelleted diet was also observed. The increased use of pelleted feeds has prompted feed manufacturers to become vitally interested in efficiency of pelleting and pellet durability. To increase the durability of pellets, manufacturers have used various types of pellet binders. Colloidal binders, molasses, and fats have been used for many years and their effect on pellet durability and pelleting efficiency has been reported (Young and Pfost, 1962; Blakely *et al*., 1955). The bentonite type of binders would supply little nutritive value. Bentonite is tri-layered aluminium silicate having sodium or calcium as its exchangeable cation. Feed inclusion is about 1-2%, and this mineral must be hydrated to be functional. The sodium form is the best, and hydration of the mineral results in a five-fold increase in weight. During this change, the aluminium silicate layers become separated, and water is attracted to their ionic surfaces creating a 12 to 15 fold increase in volume. The ingredients of bentonite are SiO_2, 66%; Al_2O_3, 16.3%; H_2O (Crystal), 60%; Fe_2O_3, 3.3%; Na_2O, 2.6%; CaO, 1.8%; MgO, 1.5%; K_2O, 0.48%; TiO_2, 0.12%. This experiment was conducted to study the effect of a local Sodium Bentonite (SB) source and comparison of pelleted and mash diets upon the performance of broiler chickens under the conditions of feed manufacturing plant.

Materials and Methods

In this study, 320 day-old male broiler chickens (Cobb strain) were allocated to eight experimental diets with 4*2 factorial arrangements in a completely randomized design to evaluate the effect of SB and comparison of pellet and mash on the performance of chickens fed the commercial corn-soybean meal based diets for 7 weeks. Treatments were 0, 1, 2 and 3 percent of SB and mash and pellet forms of the feeds for starter (1-21 days) and grower phases (22-49 days). Feed and water were given *ad libitum*. Table 1 and 2 show the composition of the diets. All the diets were made up with essential ingredients to meet the requirements of the birds as suggested by NRC (1994). The diets of starter phase calculated to contain 20.5% CP and 2850 kcal of ME per kg of diet. They also contained 18.12% CP and 2970 kcal of ME per kg of diet for the grower phase. Body weight gain and feed consumption were recorded weekly.

At the end of the experiment, the weight of abdominal fat, thigh, breast and gastro-intestinal tract were measured. Data for all parameters were subjected to an analysis of variance, using the general linear model procedure of SAS (SAS Institute, 1988). The treatment means with significant differences at $p<0.05$ were compared using Duncan´s new multiple range procedure.

Table 1: Composition of experimental diets at the starter phase

Ingredients (Kg)	Sodium Bentonite levels (%)			
	0	1	2	3
Corn	594.8	582.5	561.5	540.5
Soybean meal	351.3	353.8	358	362.2
Fish meal	10	10	10	10
Di-calcium phosphate	13.5	13.5	13.5	13.5
Limestone	11.4	11	10.5	10
Prermix [1]	5	5	5	5
Iodized salt	2.7	2	1.5	0.8
Soybean oil	10	10.9	18.7	26.5
DL-Methionine	1.3	1.3	1.3	1.4
Calculated chemical composition:				
Crude protein	20.5	20.5	20.5	20.5
ME (Kcal/kg)	2850	2850	2850	2850

[1]Supplied per kilogram of diet: vitamin A, 10000 IU; vitamin D_3,9790 IU; vitamin E, 121 IU; B_{12}, 20 μg; riboflavin, 4.4 mg; calcium pantothenate, 40 mg; niacin, 22 mg; choline, 840 mg; biotin, 30 μg; thiamine, 4 mg; zinc sulphate, 60 mg; manganese oxide, 60 mg.

Table 2: Composition of experimental diets at the finisher phase

Ingredients (Kg)	Sodium Bentonite levels (%)			
	0	1	2	3
Corn	669.6	658.4	647.3	628.7
Soybean meal	281	283.3	285.5	289.2
Fish meal	10	10	10	10
Di-calcium phosphate	9.2	9.2	9.2	9.2
Limestone	12.3	11.8	11.3	10.9
Prermix [1]	5	5	5	5
Iodized salt	2.7	2.1	1.5	0.8
Soybean oil	10	10	10	16
DL-Methionine	0.2	0.2	0.2	0.2
Calculated chemical composition:				
Crude protein	18.12	18.12	18.12	18.12
ME (Kcal/kg)	2970	2970	2970	2970

[1]Supplied per kilogram of diet: vitamin A, 10000 IU; vitamin D_3, 9790 IU; vitamin E, 121 IU; B_{12}, 20 µg; riboflavin, 4.4 mg; calcium pantothenate, 40 mg; niacin, 22 mg; choline, 840 mg; biotin, 30 µg; thiamin, 4 mg; zinc sulfate, 60 mg; manganese oxide, 60 mg.

Results

Results of feed intake, weight gain and feed conversion ratio (FCR) are shown in Table 3, 4 and 5. There was not any significant interaction between feed form and various levels of SB for feed intake, weight gain and feed conversion ratio. Feed form and feed intake in weeks 3, 4, 5, and 6 were significantly ($P<0.05$) higher in birds receiving the pellet form of the diets than those receiving the mash diets. Levels of SB, had a significant effect on feed intake in weeks 2, 4, 6 and 7. Feed intake was higher when SB added to the diets.

Weight gain of birds that consumed pellet diets was significantly ($P<0.05$) higher than those consumed mash diets in weeks 2, 3, 4, 5, and 6. Levels of SB, had a significant effect on weight gain only in weeks 3 and 6. FCR did not significantly change during the experimental period except weeks 1, 2 and 4 for the various levels of SB but about feed form, in every week except week 1 and 7, the FCR was significantly ($P<0.05$) improved.

The results of organ weights (relative to body weights) are shown in Table 6. Birds consumed pelleted diet had significantly ($P<0.05$) higher abdominal fat and lower thigh percentage than those of the mash diets. Organ weights were not significantly affected by adding SB to the diets.

Discussion

At the starter phase, it was necessary to make crumble for birds because the pellets obtained were too large for day-old chicks to eat. It has been suggested by several workers that the growth response to pelleting is due largely to the physical form (Allred *et al.*, 1957). They also suggested that some chemical changes which pelleting accounts for the growth stimulation. The nature of these chemical changes is of interest. It is possible that the high pressure and the steam used in the pelleting process alters the ingredients so that more energy or protein is made available to the animal. According to Reimer and Beggs (1993), The purpose of heat in conditioning is to gelatinize the starch portion of the feed. Other benefits of heat are to destroy pathogens and other microorganisms, and to promote drying of pellets in the cooler. Smallman (1996) explains that the moisture contribution from steam forms a cohesive bridge between particles and has a profound effect on pelleting. This moisture soaks into materials to soften them, and has been found to act as a lubricant to reduce friction between the mash and the walls of the die (Skoch *et al.*, 1981). To optimize the conditioning process, the proper balance of heat and moisture must be obtained.

Perhaps a more logical explanation for the chemical effect brought about by pelleting would be the destruction of some toxic substances or inhibitors naturally present in feed ingredients. Considerable evidences have accumulated that certain feed ingredients used in poultry feeds contain various types of growth inhibitors. Evidence for an inhibitor in alfalfa has been reported by Cooney *et al.* (1948). There has also been evidence for growth inhibitors in vegetable protein concentrates such as the trypsin inhibitor in raw soybean meal (Ham *et al.*, 1945), gossypol in cottonseed meal (reviewed by Milligan and Bird, 1951), and a toxic substance in linseed meal (Heuser *et al.*, 1946). It has been observed that birds fed feed in pellet form can consume their feed more rapidly than birds fed feed in mash form. Some of the growth increase, therefore, maybe brought about by an increase in feed consumption when pellets are fed.

In this experiment, pelleting reduced relative digestive tract weights. This is in accordance with the results of Choi *et al.* (1986) and Nir *et al.* (1994b). They indicated by the lower feed content in the gizzards of pellet-fed

Table 3: Effect of feed form and various levels of Sodium Bentonite (SB) in feed intake of broiler chickens

Feed form	Feed intake (g)									
	Week 1	Week 2	Week 3	Starter phase	Week 4	Week 5	Week 6	Finisher phase	Week 7	1-7 week
Crumble	119.063	293.375^{a}	534.31	948.65^{a}	900.75^{a}	1151.31^{a}	1291.38^{a}	33339.81^{a}	1407.75	5566.4^{a}
Mash	111.375	274.000^{b}	521.50	901.81^{b}	774.81^{b}	1030.56^{b}	1186.13^{b}	2988.56^{b}	1368.81	5252.6^{b}
SE	2.80	5.46	7.78	11.08	8.57	12.6	14.04	31.60	25.73	85.58
SB levels (%)										
0	116.500	278.75^{ab}	514.00	906.50	809.63^{b}	1063.63	1243.50^{ab}	3113.5	1397.13^{ab}	5370.1
1	122.750	267.75^{b}	534.25	934.88	830.13^{b}	1089.63	1218.75^{ab}	3137.88	1373.75^{ab}	5260.0
2	111.125	294.63^{a}	524.38	918.00	840.75^{ab}	1098.38	1214.25^{b}	3151.38	1314.63^{b}	5393.4
3	110.500	293.63^{a}	539.00	941.38	870.63^{a}	1112.13	1278.50^{a}	3254.00	1467.63^{a}	5614.49
SE	3.97	7.72	11.01	15.67	12.12	17.82	19.86	44.68	36.40	121.03

Note: values with different superscripts in each column are significantly different (P<0.05).

Table 4: Effect of feed form and various levels of Sodium Bentonite (SB) in weight gain of broiler chickens

Feed form	Weight gain (g)									
	Week 1	Week 2	Week 3	Starter phase	Week 4	Week 5	Week 6	Finisher phase	Week 7	1-7 week
Crumble	76.250	178.875^{a}	317.563^{a}	578.31^{a}	455.05^{a}	585.13^{a}	596.375^{a}	1629.56^{a}	557.31	2764.38^{a}
Mash	70.688	155.563^{b}	287.438^{b}	514.13^{b}	348.25^{b}	482.31^{b}	496.500^{b}	1327.50^{b}	513.06	2355.19^{b}
SE	2.56	3.43	5.06	7.65	7.32	8.75	7.00	17.81	19.35	33.28
SB levels (%)										
0	69.750	163.750	280.38^{b}	514.38^{b}	404.00	523.88	546.25^{ab}	1470.13	557.00	2546.50
1	70.125	171.500	307.88^{a}	549.63^{a}	394.75	533.38	548.50^{ab}	1477.00	545.75	2572.50
2	72.875	169.00	306.50^{a}	548.75^{a}	405.25	542.88	521.00^{b}	1469.13	492.50	2510.50
3	81.125	164.625	315.25^{a}	572.13^{a}	403.50	534.75	570.00^{a}	1497.88	545.50	2609.63
SE	3.62	4.86	7.16	10.83	10.36	12.38	9.9	25.19	27.37	47.07

Note: values with different superscripts in each column are significantly different (P<0.05).

Table 5: Effect of feed form and various levels of Sodium Bentonite (SB) in feed conversion rate of broiler chickens

Feed form	Weight gain (g)									
	Week 1	Week 2	Week 3	Starter phase	Week 4	Week 5	Week 6	Finisher phase	Week 7	1-7 week
Crumble	1.57	1.64^{b}	1.69^{b}	1.64^{b}	1.98^{b}	1.96^{b}	2.16^{b}	2.05^{b}	2.56	2.01^{b}
Mash	1.60	1.77^{a}	1.81^{a}	1.75^{a}	2.22^{a}	2.14^{a}	2.39^{a}	2.24^{a}	2.69	2.22^{a}
SE	0.049	0.038	0.033	0.020	0.025	0.028	0.028	0.016	0.068	0.024
SB levels (%)										
0	1.68^{ab}	1.72^{a}	1.84	1.77^{a}	2.03^{b}	2.03	2.29	2.12	2.53	2.11
1	1.75^{a}	1.56^{b}	1.74	1.70^{ab}	2.11^{ab}	2.05	2.23	2.13	2.53	2.06
2	1.53^{bc}	1.74^{a}	1.71	1.67^{b}	2.10^{ab}	2.03	2.33	2.15	2.68	2.15
3	1.39^{c}	1.79^{a}	1.71	1.65^{b}	2.16^{a}	2.10	2.25	2.18	2.75	2.16
SE	0.069	0.054	0.047	0.028	0.036	0.040	0.039	0.023	0.096	0.034

Note: values with different superscripts in each column are significantly different(P<0.05).

birds. The reduction of gizzard weight is mainly due to the lack of mechanical stimulation by the feed. The length of the jejunum and ileum increased in the mash diets (Nir *et al.*, 1994b). Pellets disintegrate in the crop and oesophagus and pass directly through the proventriculus and gizzard to enter the duodenum. This explains the increased luminal content in the upper small intestine (duodenum and jejunum) observed in pellet-fed birds.

Results of this study clearly showed indicate that chickens fed diets in pellet form ate more fed and had more body weight gain. The results are in agreement with those of Calet (1965); Choi *et al.* (1986) and Nir *et al.* (1994a, b, 1995). They showed that feeding of pellets improved broiler growth rate, which was associated with an increased feed intake and an improved feed conversion efficiency. The efficiency of feed utilization was higher than that of the controls for the chickens consuming the diets containing SB as a binder. This experimental group also had the highest growth rate, which is in accordance with previous results (Havenstein *et al.*, 1994; Nir *et al.*, 1995). Jensen *et al.* (1962) who showed mash fed birds spent more time for feeding than those receiving pellets and suggested that chickens utilize pellets more efficiency than mash. In pelleted feed, chickens spend less energy for eating.

Table 6: Effect of feed form and various levels of Sodium Bentonite (SB) in carcass characteristics of broiler chickens

Treatment	Breast	Thigh	Abdominal fat (%)	Digestive tract
Pellet	22.23	9.80[b]	2.14[a]	9.18
Mash	21.52	10.32[a]	1.56[b]	9.41
SE	0.496	0.150	0.095	0.257
Levels of SB (%)				
0	21.88	10.07	2.10	9.27
1	22.38	10.14	1.72	9.37
2	21.32	9.98	1.91	9.11
3	21.94	10.06	1.67	9.43
SE	0.702	0.212	0.135	0.364

Note: values with different superscripts in each column are significantly different (P<0.05).

Combs (1959) has shown that broilers started on crumbles followed by pellets were significantly heavier at market age than those fed mash. Under the conditions of this study, it was concluded that Sodium Bentonite at the level of 1-2% can be used in mash and pelleted diets without any adverse effect on the performance of the chickens.

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