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Effect of Feed Fines Level on Broilers Fed Two Concentrations of Dietary Lysine from 14 to 30 Days of Age

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Abstract: A study was conducted to determine if increasing dietary lysine would improve body weight gain and feed efficiency (FE) of male broilers from 14 to 30 d when fed diets containing high proportion of feed fines. A 2x5 factorial treatment arrangement was achieved by feeding diets containing two concentrations of total lysine (1.00 and 1.15% of the diet) with five levels of feed fines (20, 30, 40, 50 and 60% of the diet). Feed fines represented a blend of fines created and scalped during manufacturing, and intact pellets ground with a hammermill. Subsequently, proportions of pellets and fines were blended to obtain desired levels of feed fines. Eight grower cages of 5 male broiler chicks were fed each dietary treatment from 14 to 30 d. Body weight gain was depressed for birds fed 1.00% lysine when the diet contained in excess of 20% fines. Birds fed 1.15% lysine diets containing 20% fines did not significantly differ in weight gain from birds fed the same lysine concentration regardless of fines level. At fines levels greater than 20%, feeding 1.15% lysine resulted in a significant improvement (P=0.0324) in FE at each level of fines. Birds fed 1.00% lysine at the lowest level of fines displayed a significantly greater average feed intake (P=0.05) than any other treatment. Lack of a feed intake response at increasing levels of fines suggests that birds received a growth benefit independent of feed intake. Results demonstrated that increasing dietary lysine concentrations may compensate for inferior performance obtained with diets of poor pellet quality.

Key words: Broiler, feed fines, pellet quality

Introduction

The physical presence of a pellet appears to be necessary in order to elicit a growth response from pelleted feed (Hamm and Stephenson, 1959; Brue and Latshaw, 1981). Excessive generation of feed fines from pellets of poor durability will eliminate the response typically reported with pelleted diets, as well as result in feed displaying handling and storage characteristics similar to that of mash. Although the number of field reports on fines levels in finished feed is limited, the common observations are that the prevalence of fines is high, and even under conditions of minimal handling, generation of fines can be excessive. In a survey of four U.S. broiler integrators, Scheideler (1995) observed that feed fines present at the pellet cooler in feed mills averaged 33% of the diet. Loading feed trucks and transporting the feed to farms increased the fines level in the diet to approximately 59%. Fines increased further by auguring or chain dragging feed to feeding pans within the broiler houses, with the final feed presented to birds containing 63 to 72% fines.

Demands of live production for finished feed can apply pressure on pellet mill operators and mill managers to increase feed throughput, often at the expense of pellet quality. Changes in processing conditions to maximize throughput may reduce the extent of starch gelatinization and protein denaturation that is responsible for the pellet's degree of durability and for its propensity to generate fines. Influence of feed fines level on bird performance is an issue with substantial economic bearing for feed manufacturers and integrated poultry producers. Jensen (2000) reported that past research has suggested a 10% increase in fines would increase feed conversion by approximately one point. Proudfoot and Sefton (1978) reported that monetary returns were inversely related to fines level in the diet, observing with each percentage increase in fines that monetary return decreased by an estimated $0.004 (U.S. dollars) per broiler.

Diet formulation has a significant impact on pellet durability (Briggs *et al*., 1999). Under conditions of least-cost formulation, fluctuations in feedstuff costs may encourage the use of ingredients that do not contribute to or negatively impact pellet durability. Under conditions that are not conducive to achieve a desired level of pellet durability, formulation strategies to increase dietary nutrient density in order to overcome a depression in bird performance may prove beneficial. Increasing dietary lysine concentrations provides a potential opportunity to increase weight gain and improve breast yields (Han and Baker, 1994), as lysine has a substantial effect on the partitioning of energy in monogastric species. Therefore, a study was conducted to determine if increasing dietary lysine would improve body weight gain (BWG) and feed efficiency (FE) of male broilers from 14 to 30 d fed diets containing increasing levels of feed fines.

Table1: Composition (%) and calculated nutrient content of experimental basals

Ingredients	Low Lysine	High Lysine
Yellow Corn	62.836	62.448
Soybean Meal (48%)	27.644	28.771
Soy Oil	3.105	3.420
Corn Gluten Meal (60%)	1.756	-
Limestone	1.242	1.158
Monocalcium Phosphate	1.150	1.036
Porcine Meat and Bone Meal (50%)	0.750	1.000
Menhaden Fish Meal	0.500	1.000
Salt	0.406	0.394
Vitamin/Mineral Premix[1]	0.250	0.250
DL-Methionine	0.194	0.211
L-Lysine Hcl	-	0.145
Coban-80[2]	0.059	0.059
Sodium Bicarbonate	0.050	0.050
BMD-50[3]	0.050	0.050
Thiamine Premix[4]	0.005	0.005
L-Threonine	0.004	0.004
Calculated Analysis		
ME, kcal/kg	3168	3168
CP, %	20.50	20.50
Digestible Lys, %	0.88	1.03
Total Lys, %	1.00	1.15
Total TSAA, %	0.87	0.87
Total Thr, %	0.76	0.76
Total Arg, %	1.26	1.28
Calcium, %	0.83	0.83
Av. Phosphorus, %	0.40	0.40

[1]Supplied per kg of premix: biotin, 0.03mg; choline, 385.55mg; copper, 24.8mg; folic acid, 0.69mg; iodine, 3.31mg; iron, 110.25mg; manganese, 220.5mg; niacin, 27.56mg; pantothenic acid, 6.62mg; selenium, 0.33mg; thiamin 2.21mg; vitamin A, 7717.5 IU; vitamin B_{12}, 0.01 mg; vitamin B_6, 1.38mg; vitamin D_3, 2103.75 ICU; vitamin E, 16.54 IU; vitamin K, 0.83mg; zinc 220.5mg.

[2]Monensin sodium, 80 g/lb (110g/ton inclusion), Elanco Animal Health, Indianapolis, IN 46285.

[3]Bacitracin methylene disalicylate, 50 g/lb (50 g/ton inclusion), Alpharma, Fort Lee, NJ 07024.

[4]Supplied per kg of premix: thiamin, 22.050 mg.

Materials and Methods

Experimental Treatments: Treatment structure was a 2 x 5 factorial with two dietary lysine levels (1.00 and 1.15% of the diet) and five levels feed fines (20, 30, 40, 50, and 60% of the finished diet) for a total of ten dietary treatments. Two isocaloric and isonitrogenous corn-soybean meal based grower diets were formulated to provide two levels of dietary lysine (Table 1). Diets were conditioned with a short-term conditioner (0.31 x 0.91 m) set for a retention time of approximately 20-s, with a constant temperature of 82.2°C. Pellets were subsequently formed using a California Pellet Mill (Model HD Series 1000) with a 3.97 x 31.75 mm (5/32 x 1.25 in) die. Under industry conditions, feed fines typically represent fines generated from pellets with poor durability and from friction and shear occurring during handling and transportation. Therefore, a source of feed fines was obtained by blending fines screened from pellets during the manufacturing process, with pellets reground through a 0.34 cm hammermill screen. Graded levels of fines and pellets were blended for approximately 10 s in order to obtain the desired levels of feed fines.

Birds and Housing: The experiment was conducted in accordance with guidelines established by the Kansas State University Institutional Animal Care and Use Committee. Day-old Cobb-Vantress[1] male broiler chicks were randomly distributed to floor pens and maintained on a corn-soybean meal based pelleted and crumbled starter (21.5% CP and 3103 kcal ME/kg) until 14 d. At 14 d, 5 birds were randomly allotted to each of 80 raised-wire grower cages in a curtain-sided, positive-pressure ventilated house. Eight replicate pens were assigned to each dietary treatment. Each pen contained two nipple drinkers and a feed trough. Feed and water were provided *ad libitum*. Birds were maintained on a lighting schedule of 16 h L: 8h D during the test period. Mortalities were collected and recorded as they occurred.

Measurements: Body weight gain, total feed intake (TFI) and FE were measured from 14 to 30 d. Feed efficiency was corrected for the weight of mortality. Average feed intake (AFI) was calculated from TFI on a chick-day basis (Greenwood *et al.*, 2004). Digestible lysine intake, digestible lysine intake:unit of BWG (lysine conversion ratio, or LCR), and calories consumed per bird were calculated from AFI (Greenwood *et al.*, 2004) to determine the effect of treatments on dietary lysine and energy intake and efficiency of utilization.

Statistical Analysis: Experimental design was a randomized complete block. Pen means served as the experimental unit. All data were analyzed using the General Linear Models (GLM) procedure of SAS (1996). The model considered the main effects of feed fines level and dietary lysine and possible interactions between the factors. Level of significance was fixed at $P \leq 0.05$. Significant differences among means were separated by repeated t-tests using the lsmeans option of SAS (1996).

Results

The effects of feed fines level on growth performance of male broilers fed two concentrations of dietary lysine from 14 to 30 d is described in Table 2. An interaction between fines level and dietary lysine was

Table 2: Effects of feed fines level on lysine intake and utilization by broilers fed two lysine concentrations from 14 to 30 days of age

Lys (%)	Fines (%)	BWG (kg)	FE (g:g)	AFI (kg)	Lys Intake (g/bird)	LCR (g/100g)
1.00	-	1.008^{b}	0.6433^{b}	1.563	15.6^{b}	1.55^{b}
1.15	-	1.051^{a}	0.6746^{a}	1.546	17.7^{a}	1.69^{a}
-	20	1.067^{a}	0.6605	1.601^{a}	17.1^{a}	1.61
-	30	1.041^{ab}	0.6663	1.557^{b}	16.7^{b}	1.60
-	40	1.033^{b}	0.6580	1.566^{ab}	16.8^{ab}	1.62
-	50	1.022^{b}	0.6601	1.541^{b}	16.5^{bc}	1.61
-	60	0.983^{c}	0.6498	1.508^{c}	16.2^{c}	1.64
1.00	20	1.078^{a}	0.6516^{cd}	1.646^{a}	16.4	1.52^{c}
1.00	30	1.010^{cd}	0.6529^{bcd}	1.546^{bcd}	15.4	1.53^{c}
1.00	40	1.024^{bcd}	0.6487^{d}	1.579^{b}	15.7	1.54^{c}
1.00	50	0.983^{de}	0.6395^{de}	1.527^{bcd}	15.2	1.55^{c}
1.00	60	0.945^{e}	0.6236^{e}	1.516^{cd}	15.1	1.60^{b}
1.15	20	1.057^{ab}	0.6694^{abc}	1.556^{bcd}	17.9	1.69^{a}
1.15	30	1.071^{a}	0.6797^{a}	1.569^{bc}	18.0	1.68^{a}
1.15	40	1.042^{abc}	0.6673^{ab}	1.552^{bcd}	17.8	1.71^{a}
1.15	50	1.062^{ab}	0.6807^{a}	1.554^{bcd}	17.8	1.68^{a}
1.15	60	1.021^{bcd}	0.6760^{a}	1.500^{d}	17.2	1.68^{a}

	P	SEM	P	SEM	P	SEM	P	SEM	P	SEM
Lysine	***	0.007	***	0.003	NS	0.009	***	0.009	***	0.0007
Feed Fines	***	0.011	NS	0.004	***	0.015	***	0.015	NS	0.0011
Lys x Fines	**	0.016	*	0.006	*	0.021	NS	0.021	*	0.0016*

P≤0.05, ** P≤0.01, ***P≤0.001, NS=Non significant (P>0.05)

^{a,b,c,d,e} Within columns, means with no common letter differ significantly (P<0.05)

observed for BWG (P=0.0142). At 20% fines, there was no difference in BWG between lysine concentrations. Weight gain was depressed for birds fed 1.00% lysine when the diet contained in excess of 20% fines. Bird fed 1.15% lysine diets containing 20% fines did not significantly differ in weight gain from any high lysine treatment, regardless of fines level. A similar interaction was observed for FE, with no significant difference existing between lysine concentrations at 20% fines.

At fines levels greater than 20%, feeding higher lysine concentrations resulted in a significant improvement (P=0.0324) in FE at each level of fines. Birds fed 1.00% lysine at the lowest fines level had significantly greater (P=0.05) AFI than any other treatment. Lack of a feed intake response at subsequent levels of fines suggests that birds fed the high lysine diets received a growth response independent of feed intake. Birds fed 1.15% lysine consumed significantly more lysine (P<.0001) than birds fed 1.00% lysine. Lysine intake appeared to exhibit an inverse relationship with fines level in the diet. Lysine conversion ratio was significantly increased (P=0.05) at each level of fines by increasing dietary lysine, resulting in the birds fed high lysine diets converting lysine less efficiently to BWG than birds fed the low lysine diets.

Discussion

Lack of an appreciable difference in AFI between the two lysine concentrations with increasing levels of fines implies that observed BWG and FE responses were primarily independent of feed intake. Investigating the main effects of fines level on AFI suggests that increasing fines levels are associated with a gradual depression in performance rather than a sharp decline at each 10% increase in feed fines. Based on feed intake observations, benefits from feeding pelleted diets low in fines may have resulted from a repartitioning of NE from maintenance (NE_m) to production (NE_p). Jensen *et al.* (1962) documented that pellet-fed birds spend less time consuming meals than mash-fed birds, therefore expend less energy on meal consumption. A greater proportion of pellets in a diet should reduce energy expenditure during consumption, thus resulting in a greater quantity of energy available for protein synthesis and accretion. At 20% fines, birds fed the lowest lysine concentration exhibited a substantial increase in AFI, suggesting that inadequate lysine was available for maximum growth due to a possible increase in NE_p of the diet. Lysine then became the first-limiting nutrient, thus was responsible for initiating the increase in feed intake. Therefore, a higher concentration of dietary lysine should improve performance, as was observed in the present study.

Birds fed 1.15% lysine generally out-performed birds fed 1.00% lysine, even in the presence of high levels of fines. Greenwood *et al.* (2003, 2004) observed that birds fed pelleted diets low in feed fines, displayed greater lysine needs for maximum BWG and FE than mash-fed birds. In the aforementioned studies, increasing lysine concentrations in mash diets did not improve bird performance. Based on a digestible basis (Table 1), the lysine levels examined in the present study, 0.88% and 1.03%, were in close approximation with the concentrations reported by Greenwood *et al.* (2003) as the estimated digestible lysine needs for BWG of mash- and pellet-fed birds, respectively. In the present study, increasing lysine improved performance even in the presence of high fines levels, suggesting responses obtained with feed fines are not synonymous with those observed with mash.

While birds in the present study appeared to receive an 'extra-caloric' benefit from consuming pelleted diets in spite of high proportions of fines, differences in individual bird behavior and preferential selection of certain particulate sizes may be responsible for the lack of a distinct response at each level of fines. Fines level may not be a factor affecting bird performance at early ages or when switching from crumbles to pellets, but may become increasingly important as the dimension of the bird's oral cavity increases with age and a desire to select larger particle sizes becomes more pronounced. Results suggest that responses obtained with mash diets cannot be assumed to be similar to those achieved with diets containing high proportions of feed fines. Feeding increasing levels of fines did prove detrimental to BWG and FE, therefore efforts to improve pellet durability should be made. When conditions are not sufficient to minimize fines generation, increasing nutrient density of the diet to improve bird performance may be necessary. Results of the present study demonstrated that increasing dietary lysine concentrations compensated for inferior performance obtained with diet of poor pellet quality.

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