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Starter Dietary Lysine Level and Strain Cross Effects on Performance and Carcass Traits of Broiler Females[1,2]

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ABSTRACT

Dietary lysine has been shown to impact the performance of broilers, particularly with aspect of breast meat accretion and yield. There have been studies that suggest that early dietary lysine has an effect on breast meat yield in male broilers. A study was designed to evaluate starter dietary lysine (1.20 *vs* 1.35% of diet as achieved by the addition of L-lysine at the expense of a filler) effect on performance of female broilers from three different genetic strain crosses, and monitor subsequent effects at 41 and 56 d of age.

Body weight and feed consumption were higher for birds consuming the high lysine starter diet, but feed conversions were similar when compared to the low lysine diet. Body weight and feed conversion were similar among strains. Mortality was unaffected by lysine level and strain cross. Carcass and breast meat weight, but not yields, were higher in birds fed the high lysine diet. At 56 d differences in carcass yield, abdominal fat, and breast meat yield were seen among strains, such that the strain with highest yield had the least amount of abdominal fat in terms of absolute weight and percentage. No effect on processing yields by dietary lysine was observed at any time regardless of the growing characteristics of the broilers. However, for early slaughter ages, feeding high levels of dietary lysine during the starter phase could prove to be convenient when maximum live performance or breast meat absolute values are desiredin order to maintain the commercial quality of final products.

INTRODUCTION

Lysine needs of starting chicks (up to Day 21) have been studied extensively (Schwartz *et al.,* 1958; Hewitt & Lewis, 1972; McNaughton *et al.,* 1977; Han & Baker, 1991; Han & Baker, 1993). Different recommended levels of dietary lysine have been determined across laboratories because numerous variations have existed among experiments (e.g., genetic strain, environmental temperature, feed ingredients, protein source and quality, and sex (Han & Baker, 1991; Han & Baker, 1993). It has been shown that current NRC (1994) recommendations for lysine up to d 21 are too low for today's commercial broiler (Han & Baker, 1991; Vasquez & Pesti, 1997; Kidd & Fancher, 2001). Furthermore, recent studies have shown an increase in performance when dietary lysine during the starter phase is higher than recommended levels (Kidd *et al.,* 1998; Kidd & Fancher, 2001). Such effects were observed for the Ross x Ross 508 male (Kidd & Fancher, 2001) and the Avian 34 x Avian male (Kidd *et al.,* 1998). Carcass traits in the former studies were also improved by early dietary lysine. It was concluded that optimum performance was obtained when birds were fed high dietary lysine levels not only during the starter period, but when increasing lysine levels were maintained in subsequent feeding phases. Feeding aggressive dietary lysine when the bird is young and feed intake is low may prove beneficial and economically advantageous provided breast meat accretion is heightened at processing.

There has been, however, little research evaluating the effect of increased dietary lysine during the starter phase on live performance and carcass traits of female broilers. If effects were to occur it could be due to the broiler strain employed (i.e. early versus late developing bird). Since the level of dietary lysine in starter diets is known to affect live performance, carcass and breast meat yield of late-finishing broilers, this study was conducted to determine if such effects are sustained in female broilers across varying genetic strain crosses.

MATERIALS AND METHODS

Bird Husbandry and Experimental Facility

Commercial female day-old chicks from three different commercial strains were obtained from an experimental hatchery. All strains were slow-feathering types; the first strain (A) can be defined as a multi-purpose and early developing broiler, while the two remaining strains (B & C) were high-yield birds with late developing characteristics. All strains were hatched from the same hatchery and received *in-ovo* vaccination for Marek's disease at 18 d of incubation. In addition, all chicks were vaccinated for Newcastle and infectious bronchitis at 1 d of age via coarse spray. Upon arrival at Poultry Science Research Farm at Mississippi State University all broilers were neck-banded and randomly allocated into floor pens.

Chicks were randomly allocated to 48 pens of a closed-curtain sided house with negative pressure ventilation (10 chicks per pen; 0.10m^2/bird). The house had thermostatically controlled heating and ventilation. Each pen had a nipple line with 3 nipples and a tube feeder. Supplemental feed pans were provided during the first five days post-hatch to ensure appropriate feed consumption. Birds had free access to feed and water. The lighting regimen consisted of 23 hours of light and 1 hour of darkness. Environmental temperature was regulated to provide thermoneutral conditions.

Diets

Feed ingredients used during the study were analyzed for bound-protein amino acid content (Llames & Fontaine, 1994). Upon formulation and mixing, starter experimental diets were re-analyzed for supplemented dietary lysine (Llames & Fontaine, 1994). Dietary treatments consisted of two lysine levels (8 pens per treatment) administered during the starter phase (0 to 21 d) in mash form. The basal diet had a lysine level formulated to be at 1.20% while the additional diet had a lysine level of 1.35%, supplemented in the form of L-Lysine-HCl at the expense of an inert filler (sand). Diets were composed primarily of corn and soybean meal, and all other essential amino acids were formulated to be at least at 05% of NRC (1994) recommendations (Table 1). Common grower (21-41d) and finisher (41-56d) diets were fed to all birds in mash form, and were formulated to meet NRC (1994) recommendations. Throughout the study all birds consumed feed and water *ad-libitum.*

Table 1 - Composition of experimental diets (%).

Ingredient	Starter (0-21d)	Grower (21-41d)	Finisher (41-56d)
Yellow corn	56.000	63.590	70.310
Soybean meal, 48%	35.500	28.050	22.120
Poultry oil	4.300	4.400	3.940
Dicalcium phosphate	1.880	1.820	1.300
Limestone	1.000	1.080	1.150
Salt	0.510	0.460	0.450
Vitamin/mineral premix[1]	0.250	0.250	0.250
DL-Methionine	0.210	0.150	0.190
Filler[2]	0.200	———	———
Coban-60[3]	0.075	0.075	0.075
Choline chloride (60%)	0.034	0.057	0.006
L-Lysine HCL	0.003	0.069	0.133
L-Threonine	———	———	0.067
Total	100.00	100.00	100.00
Calculated composition			
ME, kcal/kg	3,075	3,150	3,225
Crude protein, %	22.0	19.0	17.00
Calcium, %	0.90	0.90	0.75
Available phosphorus	0.45	0.45	0.35
Lysine, %	1.20	1.05	0.90
Total sulfur AA, %	0.90	0.80	0.75
Threonine, %	0.83	0.78	0.68
Analyzed composition			
Crude protein, %	21.99	———	———
Supplemented lysine, %	0.0[4], 0.15[5]	———	———

1 - The vitamin and mineral premix contained per kg of diet: retinyl acetate, 7,715.12 IU; cholecalciferol, 4,400 IU; dl-á-tocopherol acetate, 9.9 mg; menadione, 0.9 mg; B_{12}, 0.01 mg; folic acid, 0.6 µg; choline, 379 mg; d-pantothenic acid, 8.8 mg; riboflavin, 5.0 mg; niacin, 33 mg; thiamin, 1.0 mg; d-biotin, 0.1 mg; pyridoxine, 0.9 mg; ethoxiquin, 28 mg; manganese, 55 mg; zinc, 50 mg; iron, 28 mg; copper, 4 mg; iodine, 0.5 mg; selenium, 0.1 mg. 2 - Filler represent inert space (sand) in the diet to which L-lysine HCl was added at its expense. 3 - Elanco Animal Health Division of Eli Lilly & Co., Indianapolis, IN. 4 - Treatment 1 (1.20% lysine) analyzed L-lysine addition. 5 - Treatment 2 (1.35% lysine) analyzed L-lysine addition.

Measurements and Statistical Analysis

Pen weights and feed consumption values were obtained at 1, 21, 41, and 56 d. The weight of birds that died was recorded daily and used to correct feed consumption data. Feed conversion was corrected for mortality. Measurements from 0 to 21, 0 to 41, and 0 to 56 d included body weight (BW), feed consumption, feed conversion, and livability. Three and remaining birds (approx. 6) from each pen were selected at random at Days 41 and 56, respectively, placed into transportation coops, and held 2 h prior to processing at the pilot processing plant. Broilers were stunned with an electric knife, bled for 2 min, scalded for an additional 2 min, and then defeathered in a rotary picker. Shanks and heads were removed prior to hanging on the processing line. Remaining pin feathers were singed with flames, followed by a wash. Viscera were manually removed, and then abdominal fat and hot carcass weights were recorded. Carcasses were then transferred back to the processing line for an additional wash, followed by submersion into slush-ice containers where they remained for 4 h. Carcasses were then pulled out and taken to a deboning line where both *pectoralis major* and *minor* muscles were manually removed and weights recorded.

All data were analyzed as a completely randomized design by the general linear models procedure of SAS (1996). Two-way interactions for the main contrasts as well as their main effects were tested. Differences among means (p<0.05) were separated with repeated t-test using the LSMEANS procedure of SAS (1996).

RESULTS AND DISCUSSION

Analysis of supplemented lysine levels were as expected (Table 1, footnote). Environmental conditions were favorable throughout the study, characterized by a low incidence of mortality (Table 2). In contrast with previously reported findings (Kidd *et al.,* 1998; Latshaw, 1993), this study did not exhibit elevated mortality with increasing dietary lysine levels. The differences in mortality noted from previous research concerned with variations of lysine in the starter period (Kidd *et al.,* 1998) may have been due to gender and environmental differences.

Performance at the end of the starter feeding phase (Day 21) showed no differences between birds consuming the lysine diets, or between strains crosses. It was not until the end of the grower phase (Day 41) that differences occurred. Even though there were no differences among strain crosses for live performance and carcass trait measurements, birds consuming the high lysine starter diet had higher BW and feed intake. Feed conversion, however, was similar for all treatments.

In parallel with BW, carcass and breast meat weights were higher when birds had consumed the high lysine diet (Table 3); however, such improvement did not have any effect on their respective yields. An interaction with increasing amounts of abdominal fat deposition at 41 d was observed for most strains when high lysine was fed, with the exception of strain A, which tended to have a lower content of abdominal fat. However, proportion of fat relative to the carcass was similar between all treatments. Overall, performance at Day 41 resulted in no major differences among strain crosses.

Improvements in absolute body weight, carcass, and breast meat weights for birds fed the high lysine starter diet may have occurred in part due to a higher feed consumption. In spite of this, feed consumption during the starter phase was similar between the two lysine treatments. Perhaps such differences in feed intake that only happened during the grower and not the starter

Table 2 - Effects of strain cross and starter-lysine level on BW, feed intake, feed conversion, and livability of female broilers at 21, 41 and 56 d of age.

		BW (g)[1]			Feed consumption (g)			Feed:gain[2]			Livability (%)		
Strain	**Lysine %**	**21 d**	**41 d**	**56 d**	**0-21d**	**0-41d**	**0-56d**	**0-21d**	**0-41d**	**0-56d**	**0-21d**	**0-41d**	**0-56d**
	1.35	582	1,750[A]	2,710[A]	803	3,207[A]	5,726[A]	1.38	1.84	2.12	97.2	95.0	94.9
	1.20	567	1,675[B]	2,632[B]	777	3,046[B]	5,491[B]	1.37	1.82	2.09	97.1	96.6	96.6
A	1.35	586	1,736	2,699	785	3,229	5,714	1.33	1.88	2.12	97.2	94.5	94.5
A	1.20	590	1,709	2,640	795	3,125	5,573	1.35	1.83	2.11	97.5	97.3	97.3
B	1.35	574	1,750	2,750	809	3,197	5,855	1.41	1.83	2.13	97.2	94.3	94.1
B	1.20	563	1,675	2,628	758	2,976	5,436	1.34	1.78	2.07	96.4	95.7	95.7
C	1.35	585	1,765	2,682	816	3,194	5,608	1.39	1.82	2.09	97.3	96.3	96.3
C	1.20	549	1,642	2,630	777	3,038	5,464	1.42	1.86	2.08	97.5	96.9	96.9
Source of Variance							**Probability**						
Strain		0.08	0.86	0.72	0.84	0.28	0.37	0.29	0.53	0.68	0.94	0.81	0.83
Lysine		0.09	0.01	0.02	0.16	0.01	0.01	0.85	0.53	0.38	0.96	0.42	0.49
Strain x Lysine		0.18	0.40	0.64	0.38	0.58	0.20	0.59	0.57	0.80	0.94	0.90	0.91
SEM		10.2	34.9	40.7	22.9	56.2	87.3	0.060	0.055	0.039	0.92	1.31	1.30

1 - Values within comparisons with different superscripts differ (p = 0.05). 2 - Values adjusted for mortality.

Table 3 - Effects of strain cross and starter-lysine level on carcass, abdominal fat, and breast meat of female broilers at 41 and 56 d of age.

		Carcass w/o fat and giblets[1,2]				Abdominal fat[3]				Breast meat[4]			
Strain	Lysine%	41d (g)	41d (%)	56d (g)	56d (%)	41d (g)	41d (%)	56d (g)	56d (%)	41d (g)	41d (%)	56d (g)	56d (%)
A		1,225	68.9	2,013	75.1^{A}	22.6	1.80	64.1^{A}	3.08^{A}	315	25.7	545	27.0^{A}
B		1,192	68.1	2,035	75.4^{A}	24.4	2.01	65.8^{A}	3.12^{A}	292	24.4	549	26.9^{A}
C		1,204	69.2	2,014	77.1^{B}	21.4	1.74	55.6^{B}	2.67^{B}	310	25.6	562	27.9^{B}
	1.35	1,248^{a}	68.5	2,059^{A}	75.9	24.5	1.92	64.4	3.01	320^{A}	25.6	561	27.2
	1.20	1,116^{b}	68.9	1,983^{B}	75.9	21.2	1.78	59.3	2.89	291^{B}	24.9	543	27.3
A	1.35	1,222	67.9	2,045	75.3	20.9^{BC}	1.68	64.8	3.06	313^{AB}	25.6	559	27.3
A	1.20	1,227	69.9	1,982	75.0	24.1^{AB}	1.92	63.3	3.10	317^{AB}	25.8	531	26.7
B	1.35	1,226	67.6	2,079	74.8	27.1^{A}	2.16	70.7	3.27	301^{B}	24.5	553	26.6
B	1.20	1,158	68.5	1,991	75.9	21.7^{ABC}	1.85	61.0	2.97	282^{B}	24.3	544	27.3
C	1.35	1,294	69.9	2,053	77.5	25.4^{AB}	1.92	57.6	2.72	345^{A}	26.5	571	27.8
C	1.20	1,112	68.4	1,975	76.6	17.5^{C}	1.55	53.6	2.61	274^{B}	24.5	553	27.9
Source of Variance			**Probability**										
Strain		0.71	0.45	0.82	0.03	0.43	0.27	0.01	0.01	0.28	0.11	0.50	0.01
Lysine		0.02	0.54	0.02	0.97	0.07	0.30	0.07	0.26	0.02	0.26	0.10	0.58
Strain x Lysine		0.07	0.14	0.95	0.39	0.04	0.16	0.47	0.42	0.05	0.21	0.82	0.17
SEM		39.8	0.90	39.0	0.75	2.28	0.173	3.34	0.130	14.9	0.64	15.2	0.31

1 - Values within comparisons with different superscripts differ ($p = 0.05$). 2 - Carcass without abdominal fat and giblets, before chilling, expressed on an absolute basis and relative to the full-fed live weight. 3 - Depot fat removed from the abdominal cavity of carcasses before chilling, expressed on absolute basis and relative to the carcass weight. 4 - Boneless-skineless breast meat after 4 h of slush-ice chilling expressed on an absolute basis and relative to the carcass weight.

phase could be attributed to the birds' attempt to compensate for the drastic reduction in lysine density experienced when feed was replaced from the starter to the grower phase; such effect could be due to a higher need to maintain and support the accelerated lean tissue growth stimulated by the high lysine starter phase feed.

At the end of the finisher phase (Day 56) feed consumption was still higher for birds that consumed the high lysine diet during the starter phase. In turn, BW remained higher in birds that received high-lysine-starter diets, replicating what occurred at the end of the grower phase. Carcass weight of high-lysine birds exhibited the same effect that occurred at 41 d, but breast meat even though numerically was not statistically superior. Strain C displayed higher carcass and breast meat yields when compared to the other two strains, and also a reduction in absolute and relative abdominal fat depot. Explanation for such improvement only at Day 56 can be attributed to the characteristics of the strain, which is classified as a late-developing line.

Findings in the present experimentation did not reflect those observed with Ross 508 males (Kidd & Fancher, 2001) and Avian 34 males (Kidd *et al.,* 1998); perhaps the use of females, because of their genetic predisposition to accrete more relative body fat than males, diminishes the potential for improvement in yield parameters with early lysine fortification. Nevertheless, further research is warranted in order to validate present findings. Furthermore, poultry companies should consider potential advantages of early lysine supplementation above recommended levels in order to maximize absolute weights of broilers and carcass traits while concomitantly minimizing cost relative to labor employed per pound of final product. Evidently, existing differences between male and female broilers with early lysine supplementation may provide a considerable advantage to nutritionists in order to reduce costs associated with feed, particularly if the two genders are fed separately.

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