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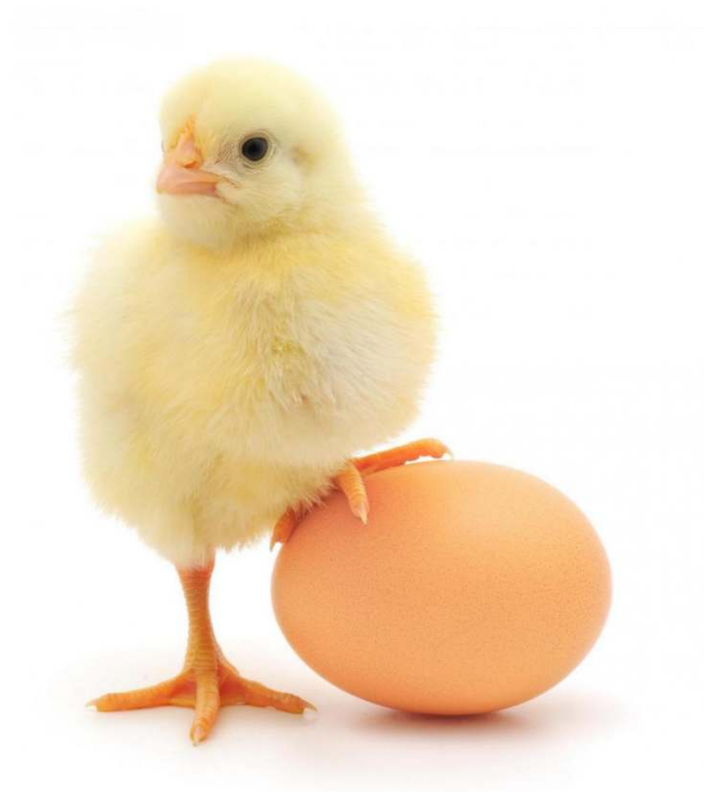

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Interactions Between Levels of Methionine and Lysine in Broiler Diets Changed at Typical Industry Intervals[1]

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Abstract: This study was conducted to evaluate the use of Met and Lys levels in excess of NRC (1994) recommendations adapted to feeding periods more consistent with current industry applications. Diets were formulated to provide a minimum of 110% of NRC recommended levels for amino acids other than Met and Lys. Aliquots of the diets were fortified with DL-methionine and Lysine HCl to provide three levels of Met (100, 115 and 130% of NRC) and four levels of Lys (100, 110, 120 and 130% of NRC) in a factorial arrangement. Feeding times were 1-16 d for starter, 16-35 d for grower, and 42-49 d for finisher. Eight pens of 65 male birds were fed each test diet. Birds were weighed and feed consumption determined at 16, 35, 42, and 49 d. Samples of birds were processed at 35, 42, and 49 d for parts yield. In general, responses to Met and Lys were independent with few interactions. Increasing Met above NRC recommendation improved BW only at 35 d but significantly improved feed conversion at 35, 42, and 49 d. Increasing Lys resulted in significant BW improvement at all ages with improved feed conversion at 16 and 42 d. Breast yield at 35, 42, and 49 d was significantly improved by levels of Met in excess of NRC recommendations. At 35 d breast yield was first increased and then decreased as Lys was increased above NRC. Breast yield at 42 and 49 d was not significantly influenced by dietary Lys content. The results of this study indicate that when fed at time intervals more consistent with current industry practice that Lys and Met levels are more critical than when fed at intervals on which NRC recommendations are based.

Key words: Broilers, lysine, methionine, carcass yield, feeding programs

Introduction

Met and Lys are universally recognized as the most two limiting amino acids in broiler diets based on corn and soybean meal. The supplementation of broiler feeds with these amino acids in their crystalline forms is very common in the poultry industry. This action makes possible the reduction of protein level of the diet, reducing nitrogen excretion, and can typically reduce the cost of feed. Met and Lys are undoubtedly the most studied amino acids in poultry nutrition. In the most recent edition of the NRC (1994) 64 references were related to Met or total sulfur amino acid needs of poultry, with 30 references related to Lys needs.

Some recent research has suggested that increased levels of Lys may result in enhanced performance, especially in regard to breast meat yield (Moran and Bilgili, 1990; Kidd *et al.*, 1998; Kerr *et al.*, 1999; Barboza *et al.*, 2000a, 2000b; Labadan *et al.*, 2001). Others studies have reported that Met levels should be above the NRC (1994) recommendations (Gorman and Balnave, 1995; Schutte and Pack, 1995; Nadeem *et al.*, 1999; Wallis, 1999). However, the relationship and interaction between Met and Lys has not been extensively investigated. Lee *et al.* (1991), Chen *et al.* (1997) and Si *et al.* (2001, 2004) studied the relationship between Met and Lys and showed no interactions between these amino acids. Si *et al.* (2004) concluded that there were no significant interactions between Met and Lys levels in broiler diets for any parameter studied when both were fed equal to or in excess of NRC recommendations.

The nutrient requirements suggested by the NRC (1994) are presented for specific age periods; namely, 0 to 21 d, 22 to 42 d, and 43 to 56 d. As noted by NRC (1994), these age periods are based on the chronology for which research data were available. Current feeding practices in the commercial poultry industry in the United States consider different feeding periods than noted in the NRC. The objective of this study was to evaluate the requirements for Met and Lys in broiler diets adapted to feeding periods more consistent with current industry applications.

Materials and Methods

Diet formulation: Nutritionally complete diets were formulated for starter, grower, and finisher periods (Table 1). The corn, soybean meal, and corn gluten meal used in the study were analyzed for crude protein and moisture content before formulating the diets, and nutrient content in the computer matrix was adjusted accordingly. Use of the corn gluten meal allowed for a reduction in the dietary Lys content. For each age period, a basal diet was formulated in which essential amino acids other than Lys and Met were at a minimum

Table 1: Composition (g/kg) and nutrient analysis of diets

Ingredient	1-16 d	16-35 d	35-49 d
Yellow corn	604.50	646.60	699.51
Soybean meal (48.2% CP)	279.31	252.89	212.75
Corn gluten meal (62% CP)	46.30	40.44	25.64
Poultry oil	20.03	19.72	22.63
Dicalcium phosphate	16.90	12.22	10.21
Ground limestone	14.37	12.27	13.85
Coban 60[1]	0.75	0.75	0.75
Choline chloride 60%	1.00	1.00	1.00
Trace mineral mix[2]	1.00	1.00	1.00
Vitamin premix[3]	2.00	2.00	2.00
DL-Methionine (98%)	0.87	0.00	0.00
L-Threonine	0.00	0.00	0.40
Sodium chloride	2.50	3.14	3.18
Sodium bicarbonate	2.00	2.00	2.00
Potassium sulfate	2.47	0.97	0.08
Variable ingredients[4]	6.00	5.00	5.00
Total	1000.00	1000.00	1000.00
Nutrient analysis[5]			
ME kcal/kg	3050.00	3100.00	3150.00
CP, %	21.15	19.82	17.46
Ca, %	0.95	0.88	0.79
P, nonphytate, %	0.43	0.34	0.30
Met, %	0.48	0.37	0.32
Lys, %	1.05	0.97	0.84
TSAA, %	0.81	0.68	0.59
Trp, %	0.23	0.22	0.19
Thr, %	0.84	0.78	0.74
Arg, %	1.43	1.34	1.19

[1]Elanco Animal Health division of Eli Lilly & Co., Indianapolis, IN 46825. [2]Provides per kg: 100 mg Mn; 100 mg Zn; 50 mg Fe; 10 mg Cu; 1 mg I. [3]Provides per kg: 7,714 IU vitamin A; 2,204 IU cholecalciferol; 16.53 IU vitamin E; 0.013 mg vitamin B12; 6.6 mg riboflavin; 39 mg niacin; 10 mg pantothenic acid; 1.5 mg menadione; 0.9 mg folic acid; 1.54 mg thiamin; 2.76 mg pyridoxine; 0.66 mg d-biotin; 125 mg ethoxyquin; 0.1 mg Se. [4]Variable levels of corn starch, DL-methionine, and L-Lysine HCl. [5]Metabolizable energy and nonphytate P values calculated from NRC (1994). All other values were determined by analysis.

of 110% of NRC (1994) recommended levels. These two amino acids were formulated to be at 100% of their recommended levels. The dietary electrolyte balance [(Na+K) - Cl] was maintained at 250 (starter), 225 (grower), and 200 (finisher) meq/kg by manipulating levels of sodium chloride, sodium bicarbonate, and potassium sulfate. Diets were fortified with complete vitamin and trace mineral mixes obtained from a commercial integrated poultry company.

For each age period, a large batch of basal diet was prepared and aliquots used for mixing the experimental diets. Twelve experimental diets were derived by additions of L-Lysine HCl and DL methionine to provide a factorial arrangement with three levels of Met (100, 115, and 130% of NRC) and four levels of Lys (100, 110, 120, and 130%). All diets were provided in mash form for ad libitum consumption. Time of feeding the diets was adjusted to 1 to 16 d for starter, 16 to 35 d for grower, and 35 to 49 d for finisher in order to conform more closely to current industry feeding practices. At the time this trial was conducted, the average time of feeding the starter diet was 16.6 d followed by feeding the grower to 34.7 d, based on a popular agricultural survey[3].

Birds and housing: Male chicks of a commercial broiler strain[4] with an average weight of 43.7 g were obtained from a local hatchery where they had been vaccinated *in ovo* for Marek's disease and had received vaccinations for Newcastle Disease and Infectious Bronchitis post hatch via a coarse spray. They were randomly allocated to pens in a poultry house of commercial design. Supplemental feeders and water fountains were used during the first seven days. Each pen was equipped with two tube feeders and an automatic water fount. Temperature and air flow were controlled by thermostatically controlled gas brooders and ventilation fans. Incandescent lamps supplemented natural daylight to provide 23 hr light daily. The test feeds and tap water were provided for *ad libitum* consumption. Sixty-five birds were placed in each of 96 pens (5.04 m^2) with new softwood shavings over concrete floors. Each of the twelve diets was fed to 8 replicate pens of birds for the study. Care and management of the birds followed recommended guidelines (FASS, 1999).

Measurements: Mean body weights by pen were obtained at 16, 35, 42, and 49 d with feed consumption obtained at the same time intervals. Birds were checked twice daily and the weight of dead birds used to adjust the feed conversion ratio (FCR; g feed/g gain). At 35, 42, and 49 d, five representative birds per pen were processed using automatic evisceration to determine dressing percentages and parts yields as described by Izat *et al.* (1990).

Statistical analysis: Pen means served as the experimental unit for statistical analysis. Data were subjected to ANOVA using the General Linear Models procedure of the SAS Institute (1991). When significant differences among treatments were found, means were separated using repeated t-tests using the LSMEANS option of the GLM procedure. Main effects of Met and Lys levels were examined along with the interaction of Lys and Met levels. Mortality data were transformed to $\sqrt{n+1}$ prior to analysis; data are presented as natural numbers.

Results and Discussion

The effect of levels of Met and Lys on body weight of male broilers at different ages is shown in Table 2. Level of Met had a significant effect on BW only at 35 d; at this time BW was significantly improved with the Met level was increased from 100 to 115% of NRC (1994) but not when the Met content was increased to 130% of NRC (1994). Significant effects of Lys level were observed at each age period; increasing the Lys to 110% of NRC

Table 2: Effect of levels of methionine and lysine on body weight of male broilers at different ages (means of eight replicate pens of 65 males per treatment)

Methionine % of NRC	Lysine (% of NRC)				Average
	100	110	120	130	
16 d BW (g)					
100	428	490	475	478	468
115	442	484	476	487	472
130	432	481	483	461	464
Average	434[b]	485[a]	478[a]	475[a]	
35 d BW (g)					
100	1683	1801	1786	1776	1762[y]
115	1729	1816	1802	1844	1798[x]
130	1726	1773	1775	1758	1758[y]
Average	1713[b]	1797[a]	1788[a]	1792[a]	
42 d BW (g)					
100	2138	2233	2208	2235	2203
115	2162	2213	2247	2273	2224
130	2200	2239	2248	2227	2228
Average	2167[b]	2228[a]	2234[a]	2245[a]	
49 d BW (g)					
100	2639	2759	2762	2734	2724
115	2715	2764	2736	2757	2743
130	2681	2741	2739	2690	2713
Average	2678[b]	2754[a]	2746[a]	2727[ab]	

Probability > F	Met	Lys	Met x Lys	CV
16 d	0.5284	0.0001	0.6925	6.02
35 d	0.0188	0.0001	0.4079	3.40
42 d	0.1639	0.0001	0.2402	2.51
49 d	0.4866	0.0503	0.8103	3.74

[ab]Means with common superscript do not differ significantly (P<0.05). [xy]Means with common superscript do not differ significantly (P<0.05).

(1994) recommendations significantly improved BW with no further increase from use of higher levels of Lys. At 49 d of age, the BW of birds that had been feed 130% of NRC (1994) Lys recommendations did not differ significantly from that of birds fed 100%, suggesting an adverse effect from feeding this higher level. There were no significant interactions between levels of Met and Lys in regard to body weight at any age.

The effects of levels of Met and Lys of feed conversion by male broilers at different time intervals are shown in Table 3. The Met level had no significant effect on feed conversion at 16 d of age; however at 35, 42, and 49 d of age increasing the level of Met above that suggested by NRC (1994) improved feed conversion. At 35 d a level of 115% of NRC (1994) produced a significant increase in feed conversion that was not improved further by increasing methionine to 130% of NRC (1994). At 42 and 49 d of age a level of 130% of NRC (1994) recommendation was needed to produce a significant difference in feed conversion. The Lys level of the diet had a significant effect on feed conversion at 16 d of age; birds fed a Lys level of 110% or more of NRC (1994) recommendation had significantly improved feed conversion compared to those fed 100% of the recommendation. There were no significant main effects of Lys on feed conversion at other ages. However, there was a significant interaction of Lys and Met on feed conversion at 42 d. As shown in Fig. 1, increasing the level of Met in diets with 100 or 110% of NRC (1994) Lys recommendations actually resulted in deterioration in feed conversion; in diets with 120 or 130% of NRC (1994) Lys recommendations, higher levels of Met improved feed conversion.

The mortality of this experiment was not affected by Met and Lys level (data not shown). At the end of study the overall mortality rate was 2.21%.

The effects of the dietary treatments on dressing percentage are shown in Table 4. At 35 d of age, increasing the Met level improved the dressing percentage, with birds fed 130% of NRC (1994) having significantly higher dressing percentage than those fed the diet with 100%; dressing percentage of birds fed 115% was intermediate between that of birds fed 100 or 130%. At 42 d of age, birds fed diets with 115% of NRC (1994) Met had significantly better dressing percentage than birds fed 100% of NRC (1994); however, no significant differences were noted in dressing percentage between birds fed 100 or 130% of NRC (1994) Met levels. No significant differences in dressing percentage were observed at 49 d related to dietary Met levels. Dietary Lys levels had no significant effect on dressing percentage at any age. There were no significant interactions between levels of Met and Lys for dressing percentage at any age.

The effects of dietary treatments on breast yield are shown in Table 5. Increasing the dietary Met level resulted in increased breast yield at 35, 42, and 49 d of age. At 35 d, breast yield of birds fed diets with 115 or 130% of NRC (1994) Met levels was significantly greater than that of birds fed 100%. At 42 and 49 d, breast yield was numerically but not significantly improved by increasing Met to 115% of NRC (1994) but was significantly improved by increasing Met to 130% of NRC (1994). At 35 d of age, increasing Lys to 110% of NRC (1994) resulted in a numerical increase in breast yield compared to birds fed 100%; breast yield of birds fed 120% of NRC (1994) Lys was significantly greater than that of birds fed 100%. When the Lys was increased to 130% of NRC (1994) Lys, breast yield did not differ significantly from that of birds fed the diets with 100% of NRC (1994) Lys levels. At 42 d and 49 d, numerical improvements in breast yield were observed when dietary Lys was increased over NRC (1994) but the differences were not statistically significant. No significant interactions between Met and Lys levels on breast yield were observed at any time.

The effects of dietary treatments on abdominal fat content are shown in Table 6. Dietary treatments had only limited influence on abdominal fat content. At 42 d of age, there was a reduction in abdominal fat as dietary Lys increased, with a significant reduction in birds fed

Table 3: Effect of levels of methionine and lysine on feed conversion by male broilers at different ages (means of eight replicate pens of 65 males per treatment)

Methionine % of NRC	Lysine (% of NRC)				Average
	100	110	120	130	
0-16 d Feed:Gain Ratio					
100	1.310	1.230	1.243	1.221	1.251
115	1.252	1.213	1.210	1.239	1.229
130	1.256	1.222	1.221	1.249	1.273
Average	1.273^{b}	1.222^{a}	1.225^{a}	1.236^{a}	
0-35 d Feed:Gain Ratio					
100	1.607	1.619	1.619	1.627	1.618^{y}
115	1.616	1.600	1.571	1.584	1.593^{x}
130	1.591	1.586	1.581	1.576	1.584^{x}
Average	1.605	1.601	1.590	1.596	
0-42 d Feed:Gain Ratio					
100	1.885^{bcde}	1.911^{abc}	1.927^{a}	1.906^{abcd}	1.907^{y}
115	1.923^{bc}	1.926^{ab}	1.863^{e}	1.882^{cde}	1.899^{y}
130	1.868^{de}	1.871^{de}	1.865^{de}	1.852^{e}	1.864^{x}
Average	1.892	1.902	1.885	1.880	
0-49 d Feed:Gain Ratio					
100	2.129	2.150	2.155	2.151	2.146^{y}
115	2.147	2.139	2.123	2.115	2.131^{y}
130	2.118	2.111	2.086	2.112	2.107^{x}
Average	2.131	2.134	2.121	2.126	
Probability > F	Met	Lys	Met x Lys	CV	
16 d	0.0826	0.0001	0.1028	3.23	
35 d	0.0001	0.3137	0.1039	1.71	
42 d	0.0003	0.2958	0.0451	2.22	
49 d	0.0017	0.7651	0.4148	1.96	

^{abcde}Means with common superscript do not differ significantly (P<0.05).
^{xy}Means with common superscript do not differ significantly (P<0.05).

120% of NRC (1994) Lys as compared to those fed 100%; however, abdominal fat of birds fed 130% of NRC (1994) Lys did not differ significantly from that of birds fed diets with 100% of NRC (1994) Lys.

The effects of Met levels on body weight in the present study are in agreement with a several papers that reported that Met levels above NRC (1994) recommendations did not affect body weight (Hickling *et al.*, 1990; Moran, 1994; Schutte and Pack, 1995; Kalinowski *et al.*, 2003a,b). The positive effects of dietary Met level on breast meat yield were also observed by Schutte and Pack (1995), Huyghebaert and Pack (1996) and Wallis (1999).

The effect of dietary Lys levels on body weight showed consistently that NRC (1994) recommendations are low and do not meet the needs of modern broilers when diets are adapted to commercial feeding intervals. This is in agreement with the reports of several authors (Bilgili *et al.*, 1992; Han and Baker, 1993; Kidd *et al.*, 1998; Leclercq, 1998; Mack *et al.*, 1999; Barboza *et al.*, 2000a, b; Labadan *et al.*, 2001; Kidd and Fancher, 2001).

One of the first reports suggesting that amino acid levels in excess of NRC recommendations improved breast meat yield was that of Hickling *et al.* (1990), who fed broilers a combination of two Met levels (100 or 116% of 1984 NRC) with four levels of Lys (100, 106, 112, or 118 of 1984 NRC). Increasing Met, but not Lys, significantly improved BW and FCR at 6 wk but not at 3 wk. It is interesting that increasing Lys levels did not improve FCR, as some have suggested that the requirement of Lys or Met for maximum breast yield is equal or greater than that for maximum FCR (Han and Baker, 1993; Schutte and Pack, 1995). Hickling *et al.* (1990) noted “the effects of Lys on breast meat yield were inconclusive”. Increasing Lys in diets containing the NRC level of Met did not influence breast meat yield; increasing Lys in diets with 116% NRC Met first increased and then decreased breast yield.

Although it has been demonstrated that the level of Lys needed to optimize feed conversion and breast yield is greater than that required for growth, there is little indication that NRC (1994) recommended levels are inadequate when fed during the time periods indicated by NRC. Moran and Bilgili (1990) fed male and female birds of a commercial strain cross (not identified) from 28 to 42 d on a low-Lys (0.85%) diet based on sesame meal, or fortified with Lys to provide diets with 0.95 or 1.05% Lys compared to the NRC (1994) recommendation of 1.0% for this period. Both sexes responded similarly to Lys fortification. Body weight gain between 28 and 42 d was not influenced by Lys level; however FCR was reduced in a linear manner as Lys increased. As there was no quadratic response it is

Table 4: Effect of levels of methionine and lysine on processing characteristics of male broilers at 35 d of age (means of eight replicate pens of 5 males per treatment)

Methionine % of NRC	Lysine (% of NRC)				Average
	100	110	120	130	
Dressing percentage (%)					
100	68.83	69.39	69.70	69.69	69.40[y]
115	69.45	70.47	69.28	69.50	69.69[xy]
130	69.63	71.40	70.81	69.80	70.41[x]
Average	69.30	70.42	69.93	69.67	
Breast yield (% of dressed weight)					
100	21.49	21.60	21.72	21.96	21.69[y]
115	22.06	22.62	22.80	22.57	22.57[x]
130	22.02	22.47	23.00	22.03	22.38[x]
Average	21.86[b]	22.23[ab]	22.51[a]	22.19[ab]	
Leg quarter yield (% of dressed weight)					
100	35.07	35.39	35.34	34.81	35.15
115	34.65	34.70	34.98	34.39	34.68
130	35.36	34.99	34.47	34.29	34.78
Average	35.03	35.02	34.93	34.50	
Wing yield (% of dressed weight)					
100	12.39	12.30	12.16	12.23	12.27[x]
115	12.14	12.06	12.11	11.94	12.06[y]
130	12.14	12.33	12.29	12.17	12.23[x]
Average	12.23	12.23	12.19	12.11	
Abdominal fat (% of dressed weight)					
100	2.47	2.50	2.48	2.51	2.49
115	2.68	2.64	2.08	2.32	2.43
130	2.50	3.11	2.45	2.48	2.64
Average	2.55	2.75	2.34	2.44	
Probability > F	Met	Lys	Met x Lys	CV	
Dressing percentage	0.0383	0.1097	0.5855	2.27	
Breast yield	0.0002	0.0486	0.4918	3.55	
Leg quarter yield	0.1847	0.2652	0.7133	3.06	
Wing yield	0.0201	0.5432	0.6213	2.54	
Abdominal fat	0.5210	0.2687	0.7018	29.76	

[ab]Means with common superscript do not differ significantly ($P<0.05$).
[xy]Means with common superscript do not differ significantly ($P<0.05$).

difficult to ascertain as to whether levels in excess of 1.05% Lys were required to minimize FCR. Breast meat as percent of either chilled or cooked carcass was increased linearly as Lys increased; again one is not able to determine if Lys in excess of 1.05% would result in further increases. This paper demonstrates that breast meat yield is influenced by Lys level, but does not necessarily provide evidence that levels in excess of NRC requirement of 1.0% are necessary to maximize yield as there was no intermediate level between 0.95 and 1.05%.

Han and Baker (1993) examined the digestible Lys requirement of male and female broilers from 22 to 43 d post hatch. Their estimates of digestible amino acid needs were 0.85 and 0.78% for BW gain and 0.89 and 0.85% for optimum FCR for males and females, respectively. They concluded that the Lys requirement for maximal breast meat yield was not greatly different from that predicted for FCR. They translated the digestible requirement for optimal FCR and breast yield on a corn-soybean meal type diet to a total Lys requirement of 1.01 % for males, 0.97% for females, or 0.99% for mixed sexes, in close agreement with the NRC (1994) recommendation of 1.0% total Lys.

Fewer reports have examined the role of methionine in breast meat yield. The study by Hickling *et al.* (1990) indicated that Lys above NRC levels did not improve breast meat yield unless Met was also greater than suggested by NRC. However, only two Met levels were compared (NRC, and 116%). Moran (1994) fed two strains of broilers (Ross x Ross; Steggles x Arbor Acres) diets either "deficient" or "adequate" in methionine from 0 to 8 wk with processing at both 6 and 8 wk. The low methionine diets reduced BW and breast yield and increased abdominal fat at 6 wk but not at 8 wk of age. The "deficient" diets fed from 6 to 8 wk were very near to the NRC (1994) requirement. Wallis (1999) demonstrated a response in breast meat yield to Met supplementation of a deficient diet but did not make any estimates about requirements for maximum yield.

One of the few reports that attempt to titrate a Met requirement to optimize breast yield was that of Schutte and Pack (1995). Feeding a range of Met or TSAA levels from 14 to 38 d, they estimated a TSAA requirement of

Table 5: Effect of levels of methionine and lysine on processing characteristics of male broilers at 42 d of age (means of eight replicate pens of 5 males per treatment)

Methionine % of NRC	Lysine (% of NRC)				Average
	100	110	120	130	
Dressing percentage (%)					
100	69.15	70.64	70.81	70.20	70.20^{y}
115	71.71	70.68	70.90	71.55	71.21^{x}
130	71.09	70.83	69.75	70.30	70.49^{y}
Average	70.65	70.72	70.49	70.69	
Breast yield (% of dressed weight)					
100	20.13	21.05	20.99	21.37	20.89^{y}
115	21.13	22.14	21.65	21.89	21.70^{xy}
130	21.94	22.11	21.95	21.97	21.99^{x}
Average	21.07	21.77	21.53	21.74	
Leg quarter yield (% of dressed weight)					
100	32.87^{ab}	32.87^{ab}	33.64^{a}	32.91^{ab}	33.07
115	33.74^{a}	33.03^{ab}	33.20^{ab}	33.14^{ab}	33.28
130	33.44^{a}	32.50^{b}	32.43^{b}	33.74^{a}	33.03
Average	33.35	32.80	33.09	33.26	
Wing yield (% of dressed weight)					
100	12.42	12.11	12.10	11.97	12.15
115	12.06	11.89	12.06	11.94	11.99
130	11.89	12.04	12.05	12.05	12.00
Average	12.12	12.01	12.07	11.98	Abdominal
fat (% of dressed weight)					
100	2.47	2.40	2.40	2.39	2.41
115	2.43	2.24	2.26	2.37	2.32
130	2.55	2.28	2.10	2.35	2.32
Average	2.48^{a}	2.31^{ab}	2.25^{b}	2.37^{ab}	
Probability > F	Met	Lys	Met x Lys	CV	
Dressing percentage	0.0580	0.9665	0.1765	2.42	
Breast yield	0.0002	0.0818	0.7450	4.85	
Leg quarter yield	0.5331	0.2025	0.0477	2.85	
Wing yield	0.1868	0.6076	0.3982	3.20	
Abdominal fat	0.1974	0.0066	0.3510	9.87	

[ab]Means with common superscript do not differ significantly ($P<0.05$).

[xy]Means with common superscript do not differ significantly ($P<0.05$).

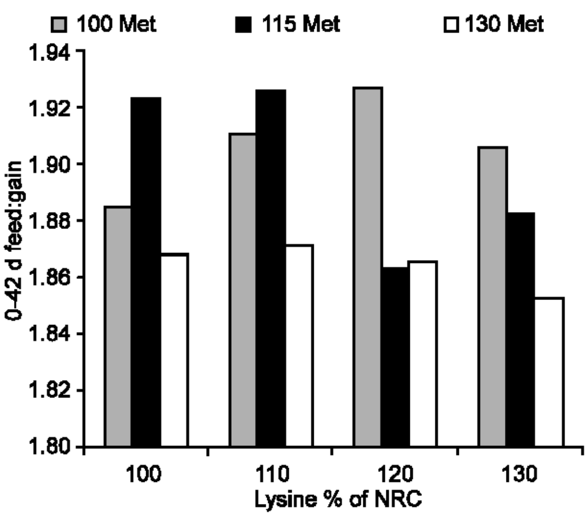

Fig. 1: Interaction of lysine and methionine on 0-42 d feed:gain ratio.

0.84% for BW gain, 0.88% for FCR, and 0.89% for breast yield. This again points out that feeding for optimum FCR should optimize breast yield, in agreement with Han and Baker (1993). It is difficult to compare the recommendations of Schutte and Pack (1995) to NRC (1994) as different time periods are involved. As birds grown in the U. S. for further processing are typically grown to ages beyond 38 d, the application of these results to commercial U. S. Broiler production is minimal.

There is no question that breast meat yield, representing a major portion of the protein synthesis in the body, is sensitive to amino acid status of the diet. Broiler strains that emphasize breast meat yield should be expected to require higher levels of Lys than strains bred primarily for gain. Amino acid levels that optimize feed conversion appear to be similar to those needed to optimize breast meat yield.

In conclusion the results of this study indicate that when fed at time intervals more consistent with current industry practice that Met needs may be higher than suggested by NRC, especially in support of improved feed conversion and increased breast meat yields. When fed at time intervals consistent with current

Table 6: Effect of levels of methionine and lysine on processing characteristics of male broilers at 49 d of age (means of eight replicate pens of 5 males per treatment)

Methionine % of NRC	Lysine (% of NRC)				Average
	100	110	120	130	
Dressing percentage (%)					
100	67.87	68.57	68.06	69.41	68.48
115	68.84	69.43	69.34	68.84	69.11
130	68.92	69.66	69.05	68.44	69.02
Average	68.54	69.22	68.82	68.90	
Breast yield (% of dressed weight)					
100	20.97	21.70	21.65	20.46	21.19[y]
115	21.74	21.96	21.54	21.65	21.72[xy]
130	21.75	22.43	21.90	22.97	22.26[x]
Average	21.49	22.03	21.70	21.69	
Leg quarter yield (% of dressed weight)					
100	34.07	33.15	33.21	32.77	33.30
115	33.76	32.58	32.86	32.10	32.82
130	33.78	32.80	32.53	33.00	33.03
Average	33.87[a]	32.84[b]	32.87[b]	32.62[b]	
Wing yield (% of dressed weight)					
100	12.03	11.82	11.79	12.38	12.01
115	11.73	11.64	12.08	11.36	11.70
130	11.72	11.67	11.74	11.79	11.73
Average	11.83	11.71	11.87	11.84	
Abdominal fat (% of dressed weight)					
100	2.21	2.53	2.36	2.87	2.49
115	2.39	2.23	2.25	2.16	2.26
130	2.24	2.26	2.17	2.42	2.27
Average	2.28	2.34	2.26	2.48	
Probability > F	Met	Lys	Met x Lys	CV	
Dressing percentage	0.1633	0.4344	0.3304	2.06	
Breast yield	0.0023	0.4591	0.1691	5.40	
Leg quarter yield	0.2772	0.0019	0.8573	3.54	
Wing yield	0.1326	0.8409	0.2357	5.57	
Abdominal fat	0.1646	0.4888	0.4681	23.29	

abMeans with common superscript do not differ significantly (P<0.05).
xyMeans with common superscript do not differ significantly (P<0.05).

industry practice Lys needs to support body weight and feed conversion at early ages appear to be greater than suggested by NRC. Breast yield at 35 d was improved by increased Lys levels but not at 42 or 49 d of age. Other amino acid levels may be more critical when fed at typical commercial intervals than when fed at intervals on which NRC recommendations are based and should be examined.

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