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The Effects of Dietary Protein and Lysine Levels on Broiler Performance, Carcass Characteristics and N Excretion

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Abstract: In a 2×3 factorial arrangement, the effects of dietary protein and lysine levels on performance and carcass characteristics of Ross male broiler chickens from 1 to 3 weeks and 4 to 6 weeks of age were tested. Dietary treatments consisted of three levels of L-lysine.HCl in starter and grower period (0.0, 1.5 and 3.0 g/kg) and two levels of protein (208.4, 178.4 in starter and 181.2, 161.2 g/kg in grower period) with 12.12 MJ AME/kg diet. Reducing dietary protein decreased weight gain in starter, grower and total period up to 6.0, 4.6 and 5.6% respectively ($P<0.05$). It also decreased feed consumption in starter period ($P<0.05$). Decreasing dietary protein had no significant effect on gain to feed ratio and breast meat yield, but increased abdominal fat percentage significantly ($P<0.05$). Increasing dietary lysine increased feed consumption in starter and weight gain, feed to gain ratio in grower and total period of the experiment ($P<0.05$). It also increased breast meat yield and percentage ($P<0.05$). N excretion reduced significantly by decreasing dietary protein ($P<0.05$). Dietary treatments had no significant effect on mortality.

Key words: Protein, lysine, broiler, carcass, breast meat

Introduction

There has been great interest in reducing N concentration in poultry litter in recent year. Lowering crude protein is effective in decreasing N excretion in poultry production (Ferguson *et al*., 1998; Blair *et al*., 1999). Jacob *et al*. (1994) found that N excretion in litter could be lowered up to 210g/kg by reducing dietary CP by 25g/kg diet. Excess dietary protein also increases heat production and water consumption which increases moisture content of litter (Kleiber, 1961; Tasaka and Kushima, 1979; Alleman and Leclercq, 1997). In some previous studies feeding low protein diets to broilers decreased growth performance (Ferguson *et al*., 1998; Jacob *et al*., 1994; Jensen, 1991). It is showed that reducing CP diets by 2% in starter period did not affect Body Weight Gain (BWG) (Parr and Summer, 1991; Moran and Stilborn, 1996). It has been suggested that Amino acid requirements in broiler increases linearly with dietary CP (Garu, 1984; Boomgaardt and Baker, 1973; Morris *et al*., 1987; Morris and Abbeb, 1990; Morris *et al*., 1992). The mechanism of this action is unknown, but the Amino acid imbalance may be the most important factor for Amino acid needs (Morris *et al*., 1999).

Lysine (Lys) is accepted as the second limiting Amino acid based on corn and soybean meal, therefore it will be possible to supplement poultry diet with crystalline Lys to reduce CP content of the diet. The NRC (1994) recommended that broilers receive 11.0, 10.0 and 8.5 g Lys/kg of diet at 0 to 3, 3 to 6 and 6 to 8 weeks of age respectively. Lys needed for optimizing breast meat yield may be higher than the amount needed for optimal BWG and feed efficiency (Jackson *et al*., 1989; Hickling *et al*., 1990; Moran and Bilgili, 1990; Acar *et al*., 1991; Gorman and Balnave, 1995). Holsheimer and Ruesink (1998) showed that breast meat yield was increased in male broilers fed diet containing increasing Lys from 1-14 days of age, however the performance of broilers did not affected by dietary Lys from 15 to 49 days of age. It is well known that protein and Lys and its interaction is considered as an important factor which affects performance and carcass quality of growing chicks and so, dietary requirement of protein is actually a requirement for the Lys contained in the protein. Therefore the objective of this study was to evaluate the Lys and protein levels effects on performance and carcass characteristics with recommended level protein and another diet lower in protein than the recommended level, without changing the Methionine+Cystine and Threonine requirements recommended by NRC (1994).

Materials and Methods

An experiment with Ross 308 male broilers was conducted from 1 to 6 weeks of age. At day 1, 240 male chicks were placed in 24 floor pens (10 chicks per pen and 0.1m^2 floor space/chicks). Feed and water were provided *ad-libitum*. Treatment diets consisted of three levels of L- Lys.HCl in starter and grower period (0.0, 1.5 and 3.0 g/kg diet) and two levels of protein (208.4, 178.4 in starter and 181.2, 161.2 in grower period) with 4 replicates/treatment and 12.12 MJ AME/kg diet. The compositions of starter and grower diets are shown in Table 1. Calculated protein and Lys content of the experimental diets are shown in Table 2. Treatments

Table 1: Basal diets composition and analysis (g/kg diet)

Ingredient	Starter		Grower	
	Control	Low	Control	Low
Corn	580.2	655.2	663.2	713.7
Soybean meal	365.0	285.0	286.8	232.8
Sunflower oil	14.0	7.4	6.0	0.00
Di-calcium phosphate[1]	15.0	12.7	10.6	11.1
Limestone	13.8	14.4	7.8	14.5
DL-Methionine	1.5	2.1	0.4	0.9
L-Threonine	0.00	1.2	0.00	0.6
Premix[2]	5.0	5.0	5.0	5.0
Salt	3.0	3.0	3.0	3.0
Sand	+	+	+	+
Total	100	100	100	100
Nutrient analysis				
CP (calculated)	208.4	178.4	181.2	161.2
CP (analyzed))	210.8	184.0	183.1	164.5
AME MJ/kg	12.12	12.12	12.12	12.12
Ca	8.1	8.1	8.1	8.1
Available P	4.1	4.1	4.1	4.1
Lys (calculated)	10.0	8.4	8.2	7.2
Lys (analyzed)	9.6	8.0	8.1	6.9
Met+Cys (calculated)	8.1	8.1	6.5	6.5
Met+Cys (analyzed)	7.5	7.4	6.1	6.2
Thr (calculated)	7.2	7.2	6.7	6.7
Thr (analyzed)	7.1	7.0	6.9	6.6

[1]Dicalcium Phosphate 210 g Ca and 160 g P/kg. [2]Supplied per kilogram of diet: 6050 µg vitamin A (retinyl acetate + retinyl palmitate), 55 µg vitamin D_3, 22.05 µg vitamin E (dl-α-topheryl acetate), 2.0 mg K_3, 5 mg B_1, 6.0 mg vitamin B_2, 60 mg vitamin B_3, 4 mg vitamin B_6 , 0.02 mg vitamin B_{12}, 10.0 mg pantothenic acid, 6.0 mg folic acid, 0.15 mg biotin, 0.625 mg ethoxyquin, Supplied per kilogram of feed: 500 mg $CaCO_3$, 80 mg Fe, 80 mg Zn, 80 mg Mn, 10 mg Cu, 0.8 mg I, 0.3 mg Se

Table 2: Calculated crude protein (CP) and Lys content of experimental diets (g/kg diet)

Diet	CP	Lys	
		In diet	additionL- Lys.HCl
Starter			
1	208.4	10.0	0.0
2	208.4	11.2	1.5
3	208.4	12.4	3.0
4	178.4	8.4	0.0
5	178.4	9.6	1.5
6	178.4	10.8	3.0
Grower			
1	181.2	8.2	0.0
2	181.2	9.4	1.5
3	181.2	10.6	3.0
4	161.2	7.2	0.0
5	161.2	8.4	1.5
6	161.2	9.6	3.0

were derived by adding L-Lys.HCl (780 g L-Lys/kg) in basal diet. Prior to the experiment samples of ingredients (corn, soybean meal) were analyzed for protein and Amino acid. Crude protein was calculated by Kejeldal method. Amino acid concentration was determined following acid hydrolysis, Met and Cys following performic acid oxidation using a high performance cation exchange column (AOAC, 1980).

Weight gain, feed consumption and feed efficiency (adjusted for mortality) were measured on a pen basis from 1 to 42 day period weekly. Mortality was recorded throughout the experiment. At 42 days of age 4 birds in each treatment (Close to pen means BW with no visible abnormalities) were killed by cervical dislocation for carcass characteristics. Prior to killing the birds, feed and water were withdrawn for 10 and 4 hr, respectively. For N excretion a balance trial was done. At 7 days of age a total of 74 male broiler chickens with similar pen weight distributed among 24 wire battery cages (3 in each pen) and fed the experimental diets for 10 days. Feed consumption and feces excretion were recorded from 18-21 days of age. Excreta were collected on polyethylene sheets placed under wire battery floor for 3 days. Samples were collected and then stored at -3 ^{o}C until analyzing for nitrogen content. The factorial arrangement of 6 treatments consisting of two levels of

Table 3: Main effects of dietary crude protein (CP) and Lys levels on broiler performance

Diet	Weight Gain (g)			Feed consumption (g)			Gain: feed (kg/kg)		
	0-3 weeks	3-6 weeks	0-6 weeks	0-3 weeks	3-6 weeks	0-6 weeks	0-3 weeks	3-6 weeks	0-6 weeks
CP level									
Control	463[a]	1292[a]	1755[a]	792[a]	2730	3522	0.585	0.473	0.498
Low	435[b]	1232[b]	1657[b]	751[b]	2670	3421	0.579	0.462	0.484
Lys.HCl (g/kg)									
0.0	438	1203[b]	1631[b]	738[b]	2711	3449	0.594	0.444[b]	0.473[b]
1.5	450	1285[a]	1735[a]	781[ab]	2674	3455	0.578	0.481[a]	0.502[ab]
3.0	458	1299[a]	1757[a]	797[a]	2714	3511	0.574	0.479[a]	0.499[a]
Statistics									
Root MSE	225.71	0.0712	0.089	453.45	0.100	0.140	22.57	0.026	0.026
CP	0.0074*	0.056	0.038	0.044	0.163	0.105	0.007	0.327	0.420
Lys	0.245	0.0302	0.0274	0.048	0.68	0.677	0.245	0.021	0.067
CP*Lys	0.015	0.574	0.712	0.389	0.086	0.179	0.323	0.86	0.775

Means in columns with different superscripts are significantly different (P<0.05). *Probability of significance.

Table 4: Effects of dietary crude protein (CP) and Lys levels on male broiler carcass, breast meat yield, thigh meat, abdominal fat percentage and N excretion

Treatment	Carcass/ Body weight (g/kg)	Breast meat yield(g)	Breast meat/ Carcass (g/kg)	Thigh/ Carcass (g/kg)	Abdominal fat/carcass (g/kg)	N excretion (g/bird/day)
CP level						
Control	642.3[a]	382.92[a]	313.6	296.5	16.4[a]	0.868[a]
Low	626.6[b]	357.08[b]	320.1	291.2	22.2[b]	0.758[b]
Lys.HCl (g/kg)						
0.0	641.1	320.63[c]	298.5[b]	283.4[b]	22.0	0.861
1.5	636.8	410.00[a]	329.0[a]	293.8[ab]	20.3	0.768
3.0	625.6	379.83[b]	323.1[a]	304.5[a]	15.6	0.808
Statistics						
CP	0.025*	0.042	0.312	0.025	0.040	0.0002
Lys	0.154	0.001	0.002	0.004	0.095	0.059
CP*Lys	0.797	0.002	0.018	0.469	0.071	0.441

Means in columns with different superscripts are significantly different (P<0.05). *Probability of significance.

CP and three levels of Lys with CRD design were analyzed using the General Linear Models procedure of SAS (SAS Institute, 1999). When differences among means were found, means were separated using Duncan's new multiple range test (Steel and Torrie, 1980).

Results

The results of broiler performance and carcass characteristics are given in Table 3 and 4. Reducing dietary protein decreased weight gain in starter, grower and total period of the experiment up to 6.0, 4.6 and 4.6% respectively (P<0.05). Lowering dietary protein also decreased feed consumption in starter period (P<0.05), but it had no significant effect on gain to feed ratio in all phases of the experiment. Decreasing dietary protein increased abdominal fat significantly (P<0.05). Increasing Lys level in the diet increased weight gain and gain to feed ratio in grower and total period of the experiment (P<0.05). It also increased feed consumption in starter period of the experiment. A positive response in breast meat yield was achieved by increasing Lys level in the diet (P<0.05). The values of dietary Lys (11.2 and 12.4 in starter and 9.4, 10.6 g/kg in grower period) are higher than those of cited in the NRC (1994) based on 12.12MJ AME/kg diet. The results confirmed the previous studies which demonstrated that Lys requirement for growing chicks is higher than that of which NRC (1994) recommendation which is supplemented on the diet for maximal growth. It is also confirmed that increasing dietary Lys level increases breast meat yield.

It is concluded that reducing dietary protein with adding 1.5 g L-Lys.HCl/kg diet in starter and grower period (based on 12.12MJ AME/kg diet) could be suitable for improving body weight gain, feed efficiency, and breast meat yield for Ross broiler chickens under the conditions of this study.

Discussion

The results in Table 3 indicate that the NRC requirement for Lys is probably too low for the period of 3 to 6 week of age both in term of weight gain and gain to feed ratio. It is apparent from this data that protein and Lys levels and their interactions had no significant effect on feed consumption in grower and total period of the experiment, showing that dietary treatment had not adverse effect on this trait. It was shown that feed consumption tended to increase slightly, as the protein and Lys level increased. It was clear from the data that birds utilized feed more efficiently in grower period. Dietary protein did not significantly affect the yield of breast meat and thigh meat ($P>0.05$). There was a significant reduction in abdominal fat percentage for the higher protein diet (control). It might be a close relationship between fat percentage and the energy protein ratio. The smaller the ratio, the less fat will be deposited. Decreasing dietary protein increased the caloric protein ratio, resulting in excessive energy intake as relative to protein intake, thus resulted in higher carcass fat content, as similarly observed with other studies (Farrel, 1974; Bartov *et al*., 1974; Lesson *et al*., 1988; Yashamita *et al*., 1975). Although there was a trend for a reduction in fat pad percentage due to increase Lys level, the effect was not significant. Lowering the dietary protein level did not affect protein and fat content of breast meat. Increasing Lys level in diet increased breast meat percentage significantly, as shown in other researches (Bilgili *et al*.,1992; Gorman and Balnave, 1995; Han and Baker, 1994; Kidd *et al*., 1998). The concentration of dietary Lys can significantly influence breast meat yield for several reasons: it contains a high concentration of Lys (Table 4); Breast meat represents a large portion of carcass meat. Breast muscle development is also affected by sex, age, breed and genetics (Moran and Bilgili, 1990; Acar *et al*., 1991; Bilgili *et al*., 1992; Gorman and Balnave, 1995; Han and Baker, 1991). Their studies have also shown that an additional Lys increase breast meat accretion. Dietary Lys had not significant effect on mortality. The results are in agreement with pervious studies (Kerr *et al*., 1999; Kidd *et al*., 1998; Han and Baker, 1994). N excretion was reduced significantly by decreasing dietary protein level (0.868 versus 0.758 g/bird/day). This finding is in agreement with other studies (Jacob *et al*., 1994; Blair *et al*., 1999; Ferguson *et al*., 1998). An attempt to reduce the protein level of the diet would help to decrease diet cost (depend on grain and oilseed meal cost). The results of the present study showed that protein level could be reduced approximately 30 in starter and 20 g/kg diet in grower period based on 12.12MJ AME/kg diet without adverse effect on gain to feed ratio. In this case additional amino acids would be added to the diet. By decreasing protein level in broiler diet N excretion will be reduced significantly ($P<0.05$).

References

Association of Official Analytic Chemists, 1980. Official Methods of Analysis. 13th ed. Washington, DC.

Acar, N., E.T. Moran, Jr. and S.F. Bilgili, 1991. Live performance and carcass yield of male broiler from two commercial strain crosses receiving rations containing lysine below and above the established requirement between six to eight weeks of age. Poult. Sci., 70: 2315-2321.

Alleman, F. and B. Leclercq, 1997. Effect of dietary protein and environmental temperature on growth performance and water consumption of male broiler chickens. Br. Poult. Sci., 38: 607-610 .

Bartov, I., S. Bornstein and B. Lipstein, 1974. Effect of caloric to protein ratio on the degree of fatness in broiler fed on practical diets. Br. Poult. Sci., 15: 107-117.

Bilgili, S.F., E.T. Moran, Jr. and N. Acar, 1992. Strain cross response of heavy male broiler to dietary lysine in the finisher feed: Live performance and further processing yields. Poult. Sci., 71: 850-858.

Blair, R., J.P. Jacob, S. Ibrahim and P. Wang, 1999. A quantitative assessment of reduced protein diets and supplements to improve nitrogen utilization. Appl. Poult. Res., 8: 25-47.

Boomgaardt, J.O. and D.H. Baker, 1973. The lysine requirement of growing chicks fed sesame meal-gelatin diet at three protein level. Poult. Sci., 52: 586-591.

Farrel, D.J., 1974. Effect of dietary energy concentration on utilization of energy by broiler chickens on body determination by carcass analysis and predicted using tritium. Br. Poult. Sci., 15: 25-41.

Ferguson, N.S., R.S. Gates, J.I. Taraba, A.H. Cantor, A.J. Pescatore, M.J. Ford and D.J. Burnham, 1998. The effect of dietary crude protein on growth, ammonia concentration and litter composition in broiler. Poult. Sci., 71: 1481-1487.

Garu, C.R., 1984. Effect of protein level on the lysine requirement of the chicks. J. Nutr., 36: 99-108.

Gorman, I. and D. Balnave, 1995. The effect of dietary lysine and Methionine on the growth characteristics and breast meat yield of Australian broiler chickens. Aust. J. Agri. Res., 46: 1569-1577.

Han, Y. and H.D. Baker, 1991. Lysine requirements of fast-and slow-growing broiler chicks. Poult. Sci., 70: 2108-2114.

Han, Y. and H.D. Baker, 1994. Digestive lysine requirement of male and female broiler chicks during the period three to six weeks post hatching. Poult. Sci., 73: 1739-1745.

Hickling, D.R., W. Guenter and M.E. Jackson, 1990. The effect of dietary Methionine and lysine on broiler chicken performance and breast meat yield. Can. J. Anim. Sci., 70: 763-768.

Holsheimer, J.P. and E.W. Ruesink, 1998. Effect of performance, carcass composition, yield and financial return of dietary energy and lysine levels in starter and finisher diet fed to broiler. Poult. Sci., 77: 806-815.

Jackson, M.R., S. Li, E.J. Day and S. Omar, 1989. The effect of different lysine level fed in constant proportion to different crude protein level on the live performance and carcass characteristics of broiler chicken. Poult. Sci., 68 (supplement): 186 (Abstract).

Jacob, J.P., R. Blair, D.C. Bennett, T.R. Scott and R.C. Newberry, 1994. The effect of dietary protein and amino acid levels during the grower phase on nitrogen excretion of broiler chicken. Page in: Proceeding of Canadian Animal Science Meeting of Saskatchewan, Saskatoon, SK, Canada.

Jensen, L.S., 1991. Broiler performance as affected by intact protein versus synthetic amino acid. Page 83-89 in: Proceeding Georgia Nutrition Conference. Atlanta, GA.

Kerr, B.J., M.T. Kidd, K.M. Halpan, G.W. Mcward and C.L. Quarles, 1999. Lysine level increases live performance and breast yield in male broiler. J. Appl. Poult. Res., 8: 381-390.

Kidd, M.T., B.J. Kerr, K.M. Halpan, G.W. Mcward and C.L Quarles, 1998. Lysine levels in starter-finisher diets affect broiler performance and carcass traits. J. Appl. Poult. Res., 7: 351-358.

Kleiber, M., 1961. The fire of life. An Introduction to Animal Energetic (New York, John Wiley).

Lesson, S., L.T. Caston and J.D. Summer, 1988. Response of male and female broiler to diet protein. Can. J. Anim. Sci., 68: 882-889.

Moran, E.T., Jr. and B. Stilborn, 1996. Effect of glutamic acid on broiler given sub marginal crude protein with adequate essential amino acids using feeds high and low in potassium. Poult. Sci., 75: 120-129.

Moran, E.T., Jr. and S.F. Bilgili, 1990. Processing losses, carcass quality and meat yield of poultry chickens as influenced by dietary lysine. Poult. Sci., 69: 702-709.

Morris, T.R., K. Alazzawi, R.M. Gous and G.L. Simpson, 1987. Effect of protein concentration on response to dietary lysine by chicks. Br. Poult. Sci., 28: 185-195.

Morris, T.R. and S. Abbeb, 1990. Effect on arginine and protein on chicks response to dietary lysine. Br. Poult. Sci., 31: 261-266.

Morris, T.R., R.M. Gous and S. Abbeb, 1992. Effect of dietary protein concentration on the response of growing chicks to Methionine. Br. Poult. Sci., 33: 795-803.

Morris, T.R., R.M. Gous and C. Fisher, 1999. An analysis of the hypothesis that amino acid requirement for chicks should be stated as a proportion of dietary protein. World's Poult. Sci. J., 55: 7-22.

National Research Council, 1994. Nutrient requirements of Poultry. 9th edition (Revised). National Academy press Washington, DC.

Parr, J.F. and J.D. Summer, 1991. The effect of minimizing amino acid excess in broiler diets. Poult. Sci., 70: 1540-1549.

SAS Institute, 1999. SAS/STAT User's Guide. SAS Institute, Inc, NC.

Steel, R.G.D. and J.H. Torrie, 1980. Principle and procedures of statistics. 2nd ed. McGraw-Hill Book Co., Inc., New York.

Tasaka, I. and M. Kushima, 1979. Heat production when single nutrients given to fasted cockerels in: L.F. Mount (Ed) studies in the Agricultural and Food Sciences. Energy Metabolism, pp: 253-256. (London, Butterworth).

Yashamita, C., Y. Ishimoto T. Yamada, H.S. Medada and S. Ebisava, 1975. Effect of dietary protein and energy levels on abdominal fat content and meat taste. Japanese Poult. Sci., 12: 78-84.