

## Effects of Lysine-HCL Supplementation on Performance and Carcass Characteristics of Ross Broilers

A. Safamehr, A. Azgani and Y. Mehmannaavaz

Department of Animal Science, Islamic Azad University, Maragheh Branch, Maragheh, Iran

**Abstract:** The aim of the present study was to determine the effects of different levels of l-lysine HCL on performance and carcass characteristics of broiler chickens (Ross-308) from 1-42 days of old. A basal diet according to NRC was formulated. Four graded supplements of lysine as l-lysine HCL (110, 115, 120 and 125% of NRC) were added to the basal diet. Each experimental diet was fed to 80 chickens in a completely randomized design with 4 replicates for each treatment. Weight gain, feed intake and feed conversion ratio of each pen in starter and grower period were compared. Dietary lysine had a significant effect on body weight, feed intake, feed conversion ratio, breast and abdominal fat percentage ( $p < 0.05$ ). Supplementing of l-lysine HCL to starter and grower diets containing the NRC lysine level significantly improved body weight gain and feed intake ( $p < 0.05$ ). Body weight was maximized in birds fed 110% of the NRC recommendations. Feed conversion ratio were optimized by feeding 110% of the NRC Lysine recommendation. The results of this study indicate that increasing dietary lysine up to 110% of the NRC recommendation significantly increased breast yield in male chicks, with no improvement at higher levels and unsexed birds. Quadratic response curves were fitted to growth performance criteria of chicks. The requirement lysine level by segmented regression (plateau) method for body weight gain and feed conversion ratio in starter and grower period were 106.76, 106.8, 107.39 and 107.14, respectively.

**Key words:** Protein, lysine, performance, carcass characteristics, broilers

### INTRODUCTION

Lysine is accepted as the second limiting amino acid for poultry fed corn-soybean meal diets, therefore it will be possible to supplement poultry diet with l-lysine HCL to reduce crude protein content of the diet (Emmert and Baker, 1997; Han and Baker, 1994). The NRC (1994) recommended that broiler receive 1.1 and 1% lysine of diet at starter and grower period respectively. Lysine requirement for maximum breast meat yield may be higher than amount needed for optimal weight gain and feed conversion ratio (Bilgili *et al.*, 1990; Holsheimer and Ruesnik, 1993). Some research has shown that the lysine requirement is higher for males than females during the starter and grower periods (Han and Baker, 1994). Some research has shown that the lysine requirement was higher for improve feed consumption and feed conversion ratio than it was for weight gain (D'Mello, 1999). However, the performance of broiler effected by l-lysine HCL from 1-42 days of age. The diets limiting in lysine increase the abdominal fat in broilers. It is well known that lysine in considered as an important factor which effects on the

performance and carcass characteristics of growing chickens and so, dietary requirement of protein is actually a requirement for the lysine contained in the protein (Baker and Itan, 1994). Moreover, Most of the studies conducted to estimate the amino acid requirements during the starter and grower period have used battery brooders as rearing environment, which are different from the rearing systems used under commercial conditions and thus could make it more difficult to extrapolate experimental results to commercial production systems. Thus, the objective of our study was to evaluate impact of l-lysine HCL supplementation to providing 100, 110, 115, 120 and 125% of NRC recommendation on performance and carcass traits in broiler chickens.

### MATERIALS AND METHODS

A total of 400, 1 day old unsexed Ross 308 broiler chicks were obtained from a commercial hatchery and were individually weighed and randomly divided into 5 treatment groups (with 4 replications per treatment and 20 chicks per replications). According to the treatment

Table 1: Feed ingredients and compositions of experimental diets

Ingredients	Starter					Grower				
	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>	T <sub>5</sub>	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>	T <sub>5</sub>
Corn	58.11	58.11	58.11	58.11	58.11	64.42	64.42	64.42	64.42	64.42
Soybean meal	35.86	35.86	35.86	35.86	35.86	29.64	29.64	29.64	29.64	29.64
Fish meal	1.96	1.96	1.96	1.96	1.96	-	-	-	-	-
Soybean oil	0.5	0.5	0.5	0.5	0.5	2.03	2.03	2.03	2.03	2.03
Oyster shell meal	0.78	0.78	0.78	0.78	0.78	1.51	1.51	1.51	1.51	1.51
Dicalcium phosphate	1.27	1.27	1.27	1.27	1.27	1.25	1.25	1.25	1.25	1.25
Salt	0.39	0.39	0.39	0.39	0.39	0.34	0.34	0.34	0.34	0.34
Premix	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
DL-Methionine	0.13	0.13	0.13	0.13	0.13	0.7	0.7	0.7	0.7	0.7
l-lysine Hcl	-	0.103	0.154	0.206	0.257	-	0.094	0.141	0.188	0.235
Inert	0.5	0.397	0.346	0.294	0.243	0.25	0.156	0.109	0.062	0.015
<b>Calculated composition</b>										
AME <sub>n</sub> (kcal kg <sup>-1</sup> )	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
CP (%)	21.56	21.56	21.56	21.56	21.56	18.75	18.75	18.75	18.75	18.75
Calcium (%)	0.94	0.94	0.94	0.94	0.94	0.75	0.75	0.75	0.75	0.75
Available Phosphorus (%)	0.42	0.42	0.42	0.42	0.42	0.328	0.328	0.328	0.328	0.328
sodium (%)	0.18	0.18	0.18	0.18	0.18	0.14	0.14	0.14	0.14	0.14
Chloride (%)	0.187	0.187	0.187	0.187	0.187	0.14	0.14	0.14	0.14	0.14
Lysine (%)	1.03	1.133	1.184	1.236	1.287	0.94	1.034	1.081	1.128	1.175
Methionine (%)	0.47	0.47	0.47	0.47	0.47	0.36	0.36	0.36	0.36	0.36
Methionine+Cystein(%)	0.84	0.84	0.84	0.84	0.84	0.67	0.67	0.67	0.67	0.67

Supplied per kilogram of diet: vitamin A, 7000 UI; vitamin D<sub>3</sub>, 1400 UI; vitamin E, 20 mg; vitamin K<sub>3</sub>, 1.5 mg; vitamin B<sub>1</sub>, 0.6 mg; vitamin B<sub>2</sub> 5.0 mg; vitamin B<sub>6</sub>, 0.6 mg; vitamin B<sub>12</sub>, 10 mg; Pantothenic acid, 10 mg; niacin, 23 mg; Folic acid, 0.25 mg; biotin, 20 mg; choline, 300 mg; Fe, 25 mg; Zn, 40 mg; Mn, 60 mg; Cu, 6 mg; I, 0.38 mg; Se, 0.18 mg

groups, the chickens were arranged in completely randomized design (5 l-lysine HCL levels). The chickens were randomly allocated in wire pen (120.150 cm). Temperature, light and management were maintained according to Ross commercial catalog. The chicks were fed experimental diets from 1-42 days. The diets were isonitrogenous and isoenergetic. Adequate amounts of vitamins, minerals and essential amino acids were provided, in accordance with the recommendations of the national research council (NRC, 1994), in except to the levels of lysine. That provided 100, 110, 115, 120 and 125% of recommendations of NRC (1994). Water and feed were provided ad libitum. the composition and calculated Nutrient composition of the treatment diets is shown in Table 1. The body weight of the chickens in each replicate was recorded at 7, 14, 21, 28, 35 and 42 days of age. Feed consumption was determined by weighing residual feed. Processing measurements were collected on 42 day from 4 birds (2 male and 2 female) per pen. Birds were weighed and cooped 12 h before processing. The percentage of carcass, breast, legs and abdominal fat were obtained and recorded. The arrangements of 5 treatment consisting of 5 levels of l-lysine HCL with completely randomized design were analyzed using the General Linear Model (GLM) procedure. Data were tested for being normally distributed before analysis of variance. All statistical analyses were executed using the SAS software package (SAS Institute, 2002). When differences among means were found, means were separated using Duncan's new multiple range test and significance was based on a 0.05

probability level. The broken-line and the exponential model were fitted to treatment means of the experimental data by means of non-linear regression procedures. The optimum level of l-lysine HCL requirement was determined by segmented regression (plateau) method.

## RESULTS AND DISCUSSION

Level of lysine had a significant effect on weight gain at 21 and 42 day, at this times weight gain were significantly improved with increasing lysine level from 100 to 110% of NRC (1994) but the results of 115, 120 and 125% of NRC (1994) were lower than of 110% of NRC recommendations (Table 2). At 42 day of age, the weight gain of birds that had been fed 125% of NRC (1994) lysine recommendations did not differ significantly in comparison with control, suggesting an adverse effect from feeding this higher level (Table 2). It seems that in the present study, high levels of lysine HCL due to non ideal ratio of lysine resulted amino acid imbalance and catabolism of amino acids. D'Mello (1999) reported that supplementation of diet with excess lysine, in habited response of chicks to first limiting amino acid, namely methionine and decreased efficiency of protein utilization. At 21 and 42 day of age, increasing the level of lysine above that suggested by NRC (1994) improved feed conversion, with birds fed 110% of NRC (1994) having significantly higher feed conversion than those fed the diet with 100%, feed conversion of birds fed 115, 120 and 125% was intermediate between that of birds fed 100 and

Table 2: Effect of used l-lysine HCL levels on performance of broilers at 21 and 42 d of age

Treatment	Weight gain			Feed intake			Feed conversion ratio		
	0-21 days	22-42 days	0-42 days	0-21 days	22-42 days	0-42 days	2-21 days	22-42 days	0-42 days
Control	31.89 <sup>a</sup>	58.82 <sup>a</sup>	50.89 <sup>a</sup>	52.05 <sup>a</sup>	130.6 <sup>a</sup>	99.24 <sup>a</sup>	1.63 <sup>a</sup>	2.22 <sup>a</sup>	1.95 <sup>a</sup>
Control+10% lys	37.28 <sup>b</sup>	65.8 <sup>b</sup>	58.87 <sup>b</sup>	55.37 <sup>b</sup>	126.22 <sup>b</sup>	104.33 <sup>b</sup>	1.48 <sup>b</sup>	1.92 <sup>b</sup>	1.77 <sup>c</sup>
Control+15% lys	35.13 <sup>d</sup>	63.05 <sup>c</sup>	55.81 <sup>c</sup>	52.86 <sup>ac</sup>	127.67 <sup>c</sup>	101.83 <sup>c</sup>	1.50 <sup>c</sup>	2.02 <sup>c</sup>	1.82 <sup>b</sup>
Control+20% lys	32.95 <sup>ac</sup>	60.67 <sup>d</sup>	52.03 <sup>a</sup>	53.04 <sup>ac</sup>	130.66 <sup>a</sup>	100.24 <sup>a</sup>	1.61 <sup>ab</sup>	2.15 <sup>d</sup>	1.93 <sup>a</sup>
Control+25% lys	33.38 <sup>c</sup>	60.17 <sup>d</sup>	51.48 <sup>a</sup>	53.40 <sup>c</sup>	129.35 <sup>a</sup>	99.86 <sup>a</sup>	1.60 <sup>b</sup>	2.15 <sup>d</sup>	1.94 <sup>a</sup>
SEM	0.435	0.37	0.389	0.36	0.365	0.535	0.01	0.019	0.012

Values within comparisons with different superscripts differ (p<0.05)

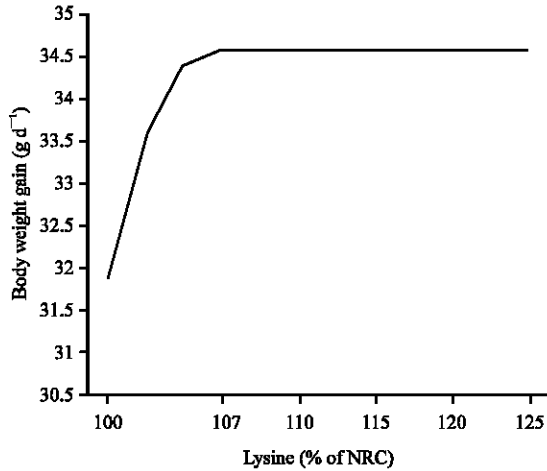


Fig. 1: Segmented regression between body weight gain and l-lysine HCL levels from 0-21 days old,  $GAIN_1 = 31/89 + 0/79(Lys_1 - 100) + 0/06(Lys_1 - 100)^2$   $Lys_1 \leq 106/76$ ,  $GAIN_1 = 34/57$   $Lys_1 > 106/76$

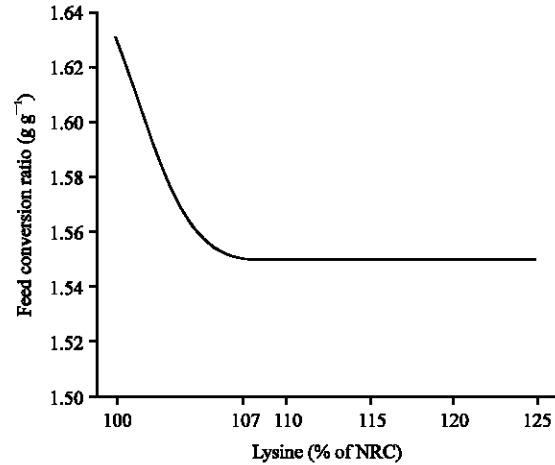


Fig. 3: Segmented regression between Feed conversion ratio and l-lysine HCL levels from 0-21 days old,  $GAIN_1 = 1/63 - 0/022(Lys_1 - 100) + 0/01(Lys_1 - 100)^2$   $Lys_1 \leq 107/39$ ,  $GAIN_1 = 1/55$   $Lys_1 > 107/39$

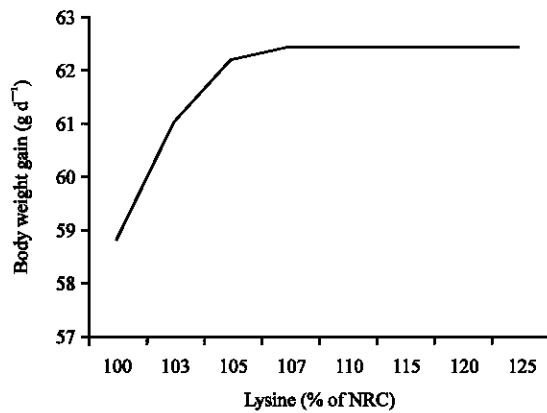


Fig. 2: Segmented regression between body weight gain and l-lysine HCL levels from 22-42 days old,  $GAIN_1 = 58/825 + 1/0579(Lys_1 - 100) + 0/0777(Lys_1 - 100)^2$  for  $Lys_1 \leq 106/805$ ,  $GAIN_1 = 62/425$  for  $Lys_1 > 106/805$

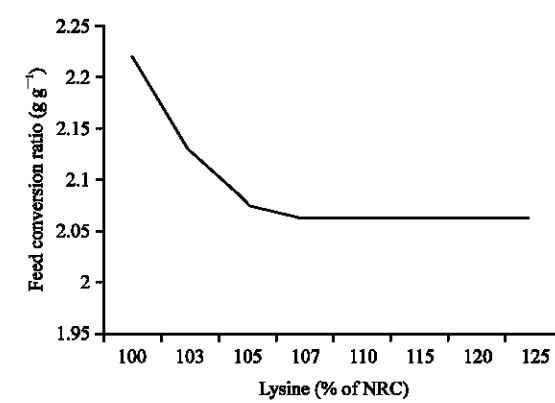


Fig. 4: Segmented regression between Feed conversion ratio and l-lysine HCL levels from 22-42 days old,  $FCR_1 = 2/22 - 0/0443(Lys_1 - 100) + 0/0031(Lys_1 - 100)^2$  for  $Lys_1 \leq 107/145$ ,  $FCR_1 = 2/0618$  for  $Lys_1 > 107/145$

110%. This results are in agreement with previous studies (Morris *et al.*, 1999; Baker *et al.*, 2002). The effects of the dietary treatments on dressing percentage are shown in Table 3. The effect of lysine level above that 115% of NRC (1994) were not significant on feed

conversion at 42 day. As shown in the study increasing the level of lysine in diets to 107% of NRC (1994) lysine recommendations actually resulted in improvement in feed conversion. The effects of lysine levels on body weight and feed conversion in the present study are in

Table 3: The effect of l-lysine HCL levels on carcass characteristics

Treatment	Dressing percentage			Legs yield (% of dressed weight)			Breast yield (% of dressed weight)			Abdominal fat (% of dressed yield)		
	Male	Female	Male and Female	Male	Female	Male and Female	Male	Female	Male and Female	Male	Female	Male and Female
Control	74.89 <sup>a</sup>	74.99 <sup>ab</sup>	74.94 <sup>ab</sup>	30.56 <sup>a</sup>	31.51 <sup>a</sup>	31.03 <sup>a</sup>	40.11 <sup>ac</sup>	33.89 <sup>a</sup>	37.00 <sup>a</sup>	3.98 <sup>a</sup>	4.69 <sup>a</sup>	4.33 <sup>a</sup>
Control+10% lys	74.98 <sup>ab</sup>	74.98 <sup>ab</sup>	74.98 <sup>a</sup>	28.95 <sup>b</sup>	28.49 <sup>a</sup>	28.72 <sup>a</sup>	45.37 <sup>b</sup>	33.74 <sup>a</sup>	39.96 <sup>a</sup>	3.83 <sup>a</sup>	4.43 <sup>a</sup>	4.14 <sup>ab</sup>
Control+15% lys	74.01 <sup>b</sup>	74.94 <sup>ab</sup>	74.97 <sup>ab</sup>	28.53 <sup>b</sup>	28.48 <sup>a</sup>	28.5 <sup>a</sup>	43.91 <sup>bc</sup>	36.88 <sup>b</sup>	39.99 <sup>a</sup>	3.99 <sup>a</sup>	4.11 <sup>b</sup>	4.06 <sup>b</sup>
Control+20% lys	74.91 <sup>ab</sup>	74.82 <sup>b</sup>	74.87 <sup>b</sup>	28.76 <sup>b</sup>	27.85 <sup>a</sup>	28.31 <sup>b</sup>	41.96 <sup>c</sup>	36.46 <sup>b</sup>	39.21 <sup>a</sup>	3.96 <sup>a</sup>	4.12 <sup>b</sup>	4.04 <sup>b</sup>
Control+25% lys	74.92 <sup>ab</sup>	75.03 <sup>a</sup>	74.97 <sup>ab</sup>	28.25 <sup>b</sup>	32.47 <sup>a</sup>	30.36 <sup>a</sup>	38.57 <sup>a</sup>	35.82 <sup>b</sup>	37.2 <sup>a</sup>	3.98 <sup>a</sup>	4.50 <sup>a</sup>	4.23 <sup>ab</sup>
SEM	0.03	0.06	0.04	0.49	1.62	0.85	1.01	0.38	1.09	0.07	0.84	0.08

Values within comparisons with different superscripts differ (p<0.05)

agreement with a several papers (Morris *et al.*, 1999; Baker, 2002). The effect of dietary lysine levels on weight gain and feed conversion 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. The results by segmented regression (plateau) method showed that the optimum levels of l-lysine HCL for body weight gain and feed conversion ratio in starter and grower period were 106.76, 106.8, 107.39 and 107.14, respectively (Fig. 1-4).

It is clear from Table 3 that the l-lysine HCL had not significant effect on carcass percent in this experiment. The results in agreement with previous studies (Kidd *et al.*, 1998; Mack *et al.*, 1999). The effects of dietary treatments on breast yield and leg percent are shown in Table 3. Increasing the dietary lysine level resulted in increased breast yield at 42 day of age in male broiler with except to 125% of NRC (1994), where as mean of both sex, numerical improvements in breast yield were observed when dietary lysine was increased over NRC (1994) but the differences were not statically significant. The results in agreement with previous studies (Garcia *et al.*, 2006). The increasing lysine supplement in the diets significantly (p<0.05) increased leg percent in male.

The effects of dietary treatments on abdominal fat content are shown in Table 3. Dietary treatments had not influence on abdominal fat content in male broiler, but mean of both sex, there was a reduction in abdominal fat as dietary lysine increased, with a significant reduction in birds fed 115 and 120% of NRC (1994) lysine as compared to those fed 100%, however, abdominal fat of birds fed 110 and 125% of NRC (1994) lysine did not differ significantly from that of birds fed diets with 100% of NRC (1994) lysine. Although, there was a trend for a reduction in abdominal fat due to increasing dietary lysine (in except to 25% above recommended levels) the effect was not significant. The lack of a reduction in percentage abdominal fat due to increasing dietary lysine is in contrast to data reported by Han and Baker (1994) and D'Mello (1999) but is supported by other research

(Bilgili *et al.*, 1999). These data support the concept that percentage abdominal fat is variable, being effected not only by dietary lysine, but possibly by genetic strain and processing age (Renden *et al.*, 1994). Previous data suggested the lysine requirement for maximum breast yield in female broilers was higher than the level considered adequate for male broilers. Lysine increases protein synthesis and decreases protein degradation in growing chickens. In addition, dietary lysine in one of the most limiting amino acids in broiler diets (Tesseraund *et al.*, 1992). Because breast meat yield is a primary concern for the poultry industry in order to meet consumer demand for white meat, primary poultry breeder companies have selected the modern broiler for increased breast meat yield. The concentration of dietary lysine can significantly influence breast meat yield for several reasons: Breast meat represent a large protein of carcass meat; it contains a high concentration of lysine (Table 3) and breast muscle development is effected by sex, age, breed and genetics (Moran and Bilgili, 1990; Bilgili *et al.*, 1992; Holvorson and Jacobsen, 1970; Han and Bker, 1994; Baker, 1991).

### CONCLUSION AND APPLICATIONS

The data suggests a response of performance to increasing l-lysine HCL, with a maximum response at approximately 110% of NRC (1994) recommendation.

For chicks during the 21-42 day, broken line lysine requirement estimates were lower than 110% of NRC (1994) estimate.

Formulation based on lysine amino acid promotes higher profitability for broiler production.

In conclusion results of this study indicate that when feed at time intervals more consistent with current industry practice that lys needs may be higher then suggested by NRC, especially in support of improved weight gain, food conversion and increased breast meat yields. When feed at time intervals consistent with current industry practice lysneeds to support body weight and food conversion appear to be greater than suggested by NRC.

## REFERENCES

- Baker, D.H., 1991. Partitioning of nutrients for growth and other metabolik fansion, efficiency and priority considerations. *Poult. Sci.*, 70: 1797- 1805.
- Baker, D.H. and Y. Han, 1994. Ideal amino acid profile for broiler chicks during the first three weeks post hatching. *Poult. Sci.*, 73: 1441-1447.
- Baker, D.H., A.B. Batal, T.M. Parr, N.R. Augspurger and Parsons, C.M. 2002. Ideal ratio (relative to lysine) of tryptophan, threonine, isoleucine and valine for chicks during the 2nd and 3rd weeks posthatch. *Poult. Sci.*, 81: 485-494.
- Bilgili, S.F. E.T. Moran and N. Aeber, 1992. Strain carcass response of heavy meal broilers to dietary lysine in the finisher feed: live performance and further processing yields. *Poult. Sci.*, 71: 850- 858.
- D'Mello, J.P.F., 1999. *Amino Acids in Farm Animal Nutrition*. 2nd Edn. Formerly of the Scottish Agricultural College, Edinburgh, UK., pp: 544.
- Emmert, J.L. and D.H. Baker, 1997. Use of the ideal protein concept for precision formulation of amino acid levels in broiler diets. *J. Application Poul. Res.*, 6: 426-470.
- Garcia, A.R., A. Batal and D.H. Baker, 2006. Variations in the digestible lysine requirement of broiler chicks Due to sex, performance parameters, Rearing environment and processing yield characteristics. *Poult. Sci.*, 85: 498- 504.
- Halvorson, D.B. and M. Jacobsen, 1970. Variations in development of muscles in chickens. *Poult. Sci.*, 49: 132-136.
- Han, Y.M. and D.H. Baker, 1994. Lysine requirement of male and female broiler chicks during the period three to 6 weeks post hatching. *Poult. Sci.*, 73: 1739-1745.
- Holsheimer, J.P. and E.W. Ruesnik, 1993. Relationship of dietary Lysine on carcass characteristics in broiler chickens. *Poult. Sci.*, 32: 789-798.
- Kidd, M.T., B.J. Kerr, K.M. Halpin, G.W. McWard and C.L. Quarles, 1998. Lysine levels in starter and grower-finisher diets affect broiler performance and carcass traits. *J. Applied Poult. Sci.*, 7: 351-358.
- Mack, S., D. Bercovici, G. Degroote, B. Leclercq, M. Lippens, M. Pack, J.B. Schutte and S. Van Cauwenberghe, 1999. Ideal amino acid profile and dietary lysine specification for broiler chickens of 20-40 days of age. *Br. Poult. Sci.*, pp: 257-265.
- Moran, E.T. and S.F. Bilgili, 1990. Processing losses, carcass quality and meat yield of broiler chickens as influenced by dietary lysine. *Poult. Sci.*, 69: 702-709.
- Morris, T.R., R.M. Gous and C. Fisher, 1999. An analysis of the hypothesis that amino acid requirements for chicks should be stated as a proportion of dietary protein. *World's Poult. Sci.*, 55: 7-22.
- National Research Council, 1994. *Nutrients Requirements of Poultry*. 9th Rev. Edn. National Academy Press. Washington, D.C.
- Renden, J.A., E.T. Moran and S.A. Uncaid, 1994. Lack of interactions between dietary lysine or strain cross and photoperiod for male broiler performance and carcass yield. *Poult. Sci.*, 73: 1651-1662.
- SAS, 2002. *SAS Users Guide: Statistics Version 5 Edition*. SAS Institute Inc. Cary, NC.
- Tesseraund, S., M. Larbier, A.M. Chagnau and P.A. Geraert, 1992. Effect of dietary lysine on muscle protein turnover in growing chickens. *Reprod. Nutr. Dev.*, 32: 103-171.