

Effect of Supplementation with Synthetic Lysine on the Performance of Finisher Broiler Chicks

Research Article

M. Melaku¹, M. Urge², G. Animut² and A. Getu^{3*}¹ Department of Animal Production and Technology, Faculty of Agriculture, Woldia University, Woldia, Ethiopia² Department of Animal Production and Technology, Faculty of Agriculture, Haramaya University, Ethiopia³ Department of Animal Production and Extension, Faculty of Veterinary Medicine, University of Gondar, Gondar, Ethiopia

Received on: 7 Jan 2014

Revised on: 12 May 2014

Accepted on: 31 May 2014

Online Published on: Mar 2015

*Correspondence E-mail: addisgetu2002@yahoo.com

© 2010 Copyright by Islamic Azad University, Rasht Branch, Rasht, Iran

Online version is available on: www.ijas.ir

ABSTRACT

The study was conducted to evaluate the effect of different levels of synthetic lysine (sLys) on dry matter intake (DMI), average daily weight gain (ADG), dry matter conversion ratio (DMCR), carcass characteristics and economics of production of finisher broiler chicks. As 240 day-old broiler chicks were randomly distributed to 12 pens of 20 chicks each and assigned to four treatment rations in a completely randomized design. Six broilers (3 males and 3 females) from each replication were starved for 16 hours and slaughtered to evaluate carcass characteristics. Control diet had a lysine content of 0.9 and 0.8% of the ration, which was 0.3 and 0.2% of the ration below the recommended level. The four rations were formulated by including sLys at levels of 0, 50, 100 and 150% of the deficient amount of lysine. No sLys in the ration (T₁) and rations to which 50% (T₂), 100% (T₃) and 150% (T₄) of the deficient amount of lysine being added as sLys. No significance difference (P>0.05) was observed among treatments in total and daily DMI, metabolic energy (ME) and crude protein (CP) intakes and DMCR at all phases of the experiment. Final body weight (1665, 1672, 1707 and 1786 g (standard error of the means (SEM)=18.04)) and ADG during the entire period (33.0, 33.1, 33.9 and 35.5 g/day (SEM=0.36) for T₁, T₂, T₃ and T₄, respectively) was significantly higher (P<0.05) for birds kept on T₄ diets. No significant difference (P>0.05) existed in mortality percentage among treatments. Dressed carcass weight (1407, 1426, 1461 and 1510 g (SEM=15.07)), breast weight (329, 334, 338 and 365 g (SEM=5.09)) and drumstick weight (134, 137, 135 and 150 g (SEM=2.3) for T₁, T₂, T₃ and T₄, respectively) were greater for T₄ than other treatments. In conclusion, 12.5% extra addition of sLys above the level recommended by NRC to the commercial diets, as in T₄, improved broiler performance and profitability.

KEY WORDS broiler chickens, commercial diet, lysine, supplementation.

INTRODUCTION

Poultry production is known by fast reproduction, short production cycle, high feed efficiency and high biomass per unit of land (Mekonnen, 2007). Scanes (2007) noted that eggs and poultry meat provide an excellent sources of nutrients. Cereal grains make up the bulk of poultry ration which are deficient in critical amino acids like lysine, methionine, threonine and tryptophan (Smith, 2001). Optimum

sulfur amino acid is important for broiler breast meat development whereas the protein and essential amino acids are important for whole carcass development in broilers chickens (Saima *et al.* 2010). Lysine is one of the most limiting amino acid in cereal grains and vegetable protein sources. In Ethiopia, animal protein and oil seed cakes are common to supply the requirement for essential amino acids. However, the composition of animal protein and oil seed cakes are too variable. Therefore, use of synthetic es-

sential amino acids in diet formulation for broilers may be essential and inevitable (Sibbald and Wolynetz, 1986). The requirement for amino acid also varies with environment. Therefore, this experiment was conducted to meet the following objectives. To evaluate growth rate, feed efficiency and carcass characteristics of broilers fed with different levels of synthetic lysine. To assess the profitability of broiler rations containing different levels of synthetic lysine (sLys).

MATERIALS AND METHODS

Study area

The experiment was conducted at Haramaya University Poultry Farm. The University is located at 42° 3' E longitudes, 9° 26' N latitude at an altitude of 1980 meters above sea level and 515 km east of Addis Ababa. The mean annual rainfall of the area amounts to 780 mm and the average minimum and maximum temperatures are 8 and 24 °C, respectively.

Feed ingredients and experimental rations

Four nearly isocaloric 3000 kcal/kg and 3200 kcal/kg ME and isonitrogenous 22 and 20% CP for broiler finisher rations (Tables 1 and 2) were formulated based on the laboratory analysis of the individual feed ingredients. Formulation of nouge seed cake (NSC), SBM, maize and wheat short (WS) was adjusted in order to keep the total energy and crude protein of the treatments to make them isocaloric and isonitrogenous. Vitamin premixes, limestone and salt were added equally in all treatment rations.

Experimental design and dietary treatments

A total of 240 day-old Hubbard Classic commercial broiler chickens of mixed sex were purchased from Debrezeit Agricultural Research Center (DZARC) and randomly divided into 12 experimental units (pens) of 20 chicks. The chicks weighed on average 46.6 ± 0.31 g at the start of the experiment. The experiment was arranged in a completely randomized Design with four dietary treatments containing different levels of sLys and three replications.

The lysine content of the major feed ingredients (Maize, SBM, NSC and WS) used in the experiment was taken from NRC (1994) and Brazilian tables for poultry and swine (Rostagno *et al.* 2005). Based on these values, the lysine content of the control diet used in the study without synthetic lysine addition was calculated. The lysine content was 0.8% of the ration. These values were subtracted from the recommended lysine requirement of 1.0% of the ration (NRC, 1994) for broilers during the finisher phases. Based on the above calculation, the deficiency in lysine was 0.2% of the ration for the finishers.

Therefore, the four rations were formulated by including sLys at levels of 0, 50, 100 and 150% of the deficient amount of lysine. So, the experimental treatments were T1= no sLys inclusion in the ration; T2= ration to which 50% of the deficient amount of lysine being added as sLys; T3= ration to which 100% of the deficient amount of lysine being added as sLys; and T4= ration to which 150% of the deficient amount of lysine being added as sLys.

Table 1 Percentage of ingredients in the experimental broiler finisher rations

Ingredients (%)	Treatments			
	T1	T2	T3	T4
Maize	48.0	47.6	48.6	48.2
Soybean meal	19.0	19.2	19.4	19.9
Wheat short	13.0	13.3	12.0	11.9
Nouge seed cake	17.5	17.3	17.3	17.2
Limestone	1	1	1	1
Broiler vitamin premix ¹	1	1	1	1
Salt (NaCl)	0.5	0.5	0.5	0.5
L-lysine HCl	-	0.1	0.2	0.3
Total	100	100	100	100

Broiler vitamin premix 1% per kg contains: vitamin A: 1000000 IU; vitamin D₃: 200000 IU; vitamin E: 1000 mg; vitamin K: 225 mg; vitamin B₁: 125 mg; vitamin B₂: 500 mg; vitamin B₃: 1375 mg; vitamin B₆: 125 mg; vitamin B₁₂: 1 mg; Folic acid: 100 mg; Choline chloride: 37500 mg and Biotin 15000 mg.

Trace elements: Iron: 0.45%; Copper: 0.05%; Manganese: 0.6%; Cobalt: 0.01%; Zinc: 0.7%; Iodine: 0.01% and Selenium: 0.04%.

Minerals: Calcium: 29.7%.

Other additives: Anti-oxidant (BHT): 0.05% and Synthetic lysine (sLys) added to the ration based on the deficiency level of 0.3 and 0.2% of the ration in the control diet for starter and finisher phases, respectively:

T1= no sLys inclusion in the ration.

T2= ration to which 50% of the deficient amount of lysine being added as sLys.

T3= ration to which 100% of the deficient amount of lysine being added as sLys.

T4= ration to which 150% of the deficient amount of lysine being added as sLys.

Chemical composition of feed ingredients and experimental diets

The chemical analysis of dietary ingredients and the experimental rations are presented in Table 2.

Experimental chicks and their management

The chicks were offered with feed twice a day at 8:00 a.m. and 4:00 p.m. *ad libitum* and clean water was available to the birds all the time throughout the experimental period with plastic fountains. The chicks were fed with the starter diet containing different levels of sLys for 28 days and switched to the finisher rations thereafter (day 29-49). Feed was weighed every morning using a sensitive balance and offered to the respective group during the entire experimental period. Refusals were also collected every morning and weighed for each replication. Light source was provided to each pen for 24 hrs during early age because of very low environmental temperature (sometimes below 0 °C) during the experiment and at night during late stage of the experiment. The chicks were vaccinated against Newcastle disease and infectious bursal disease (Gumboro) as shown in Table 3. Other health precautions and disease control measures were taken throughout the study period.

Table 2 Chemical composition of the ingredients used for ration formulation

Ingredients	DM (%)	Nutrients (% DM)				ME (kcal/kg DM)
		CP	EE	CF	Ash	
Maize	90.88	9.65	6.73	5.72	3.98	3647.36
Soybean meal	94.45	38.87	8.05	7.69	7.85	3386.54
Wheat short	90.74	15.4	5.08	8.09	4.84	3312.29
Noug seed cake	93.68	29.8	5.11	17.96	7.84	2316.06

DM: dry matter; CP: crude protein; CF: crude fiber; EE: ether extract and ME: metabolizable energy.

Oxytetracycline was given to the chicks at the start of the experiment for five consecutive days to keep the birds from other disease such as chronic respiratory diseases due to stress of transportation and early age adaptation problems.

Chemical analysis

The chemical analyses of feeds were done at Haromiya University Animal Nutrition and Soil laboratories. Representative samples were taken from each of the feed ingredients used in the experiment and analyzed before formulating the actual dietary treatments. The results of the analysis were used for formulation of the treatment rations. Samples from finisher rations of the four treatment diets were taken at each mixing for chemical analysis.

Table 3 Vaccination programs

Vaccine name	Type of vaccine	Vaccination day	Vaccination methods
NCD	HB1	1	Ocular routes
	Lasota	21	Drinking water
Gumboro	Gumboro	7	Drinking water
		19	Drinking water

The dry matter (DM), crude protein (CP), ether extract (EE), crude fiber (CF) and ash contents were determined following the proximate analysis method of the AOAC (1990). Nitrogen (N) content of the feed was determined by Kjeldahl procedure and crude protein (CP) were estimated as $N \times 6.25$. metabolizable energy (ME) content of the experimental diets was determined by indirect method according to the formula given by Wiseman (1987) as follows:

$$ME \text{ (kcal/kg DM)} = 3951 + 54.4 \text{ EE} - 88.7 \text{ CF} - 40.8 \text{ ash}$$

Dry matter and nutrient intake

A weighed amount of feed was offered to the chicks every day. The total feed consumption of the broiler was calculated as the difference between the amount of feed offered and that refused. The feed left over were collected and weighed every morning after removal of the external contaminants by hand. The DM intake was computed by multiplying feed offered with the dry matter (DM) of the offered feed. Dry matter of refusals was also computed as the amount of refusal collected multiplied by DM of the refusal.

Dry matter consumed was then calculated as DM of feed offered minus DM of the refusal. The daily ME intake was calculated by multiplying the daily DM intake with ME content of the diet. Similarly, the daily CP intake was calculated by multiplying the daily DM intake with CP content of the feed consumed. Mean daily DM intake was determined by employing the following formula (Knott *et al.* 2003):

$$\text{Mean daily DM intake (g)} = \frac{((\text{offered feed} \times \text{DM \%}) - (\text{collected ort} \times \text{DM \%}))}{(\text{number of days} \times \text{number of chicks})}$$

Body weight gain

The initial body weight was taken 30 h after hatching. Birds were weighed in group per pen on weekly basis with sensitive balance and average daily body weight gains (ADG) of the chicks were computed for each replication.

$$ADG = \frac{(\text{mean of final body weight} - \text{mean of initial body weight})}{(\text{number of days})}$$

Dry matter conversion ratio

The mean dry matter conversion ratio was calculated as the ratio of dry matter consumed to average daily gain by employing the following formula (Knott *et al.* 2003):

$$DM \text{ conversion ratio} = \frac{\text{mean daily DM intake (g)}}{\text{mean daily weight gain (g)}}$$

Carcass analysis

49 days old six broilers (3 male to 3 female ratios) from each replication were randomly selected and starved for 16 hours (Moran, 1995) and live weight was taken before slaughter. After slaughtering, the birds were defeathered, eviscerated and carcass characteristics were determined. Dressed carcass weight was measured after the removal of blood, head and feather and its percentage was calculated as the proportion of dressed carcass weight to slaughter weight multiplied by 100. Drumstick-thigh and breast meat were weighed separately and divided by slaughter weight to determine their percentage proportion. Fat around the proventriculus, gizzard, against the abdominal wall and the cloacae were removed and weighed and percentage slaughter

weight was calculated. The edible offal, of heart, liver and gizzard were weighed individually after separating from viscera. The total weight and length of small intestine and ceca were taken using sensitive balance and a centimeter plastic tape.

Morbidity and mortality

During the entire course of the experiment, the chicks were closely observed for any abnormalities. Mortality was recorded as occurred. Deaths after the start of the experiment were recorded as mortality and expressed as percent mortality at the end of the experiment.

Partial budget analysis

Partial budget analysis was conducted to determine the profitability of the inclusion of sLys in broiler ration. The analysis took into consideration the cost of feed (which is variable cost) consumed by the chicks, purchasing price of chicks and selling prices of the finished broilers and other costs were assumed to be similar for all the treatments. The analysis involved calculation of the variable cost and benefits. Net income (NI) or net return (NR) were calculated as the amount of money left when total variable costs (TVC) are subtracted from the total returns (TR) as follows (Knott *et al.* 2003):

$$NI (NR) = TR - TVC$$

The change in Net income (ΔNI) or Net return (ΔNR) were calculated by the difference between change in total return (ΔTR) and the change in total variable costs (ΔTVC) as follows (Knott *et al.* 2003):

$$\Delta NI (\Delta NR) = \Delta TR - \Delta TVC$$

The marginal rate of return (MRR) measures increases in net income (ΔNI) associated with each additional unit of expenditure (ΔTVC) and it was calculated as follows (Knott *et al.* 2003):

$$MRR = (\Delta NI / \Delta TVC) / 100$$

Where:

NR: net return.

TR: total return.

TVC: total variable cost.

Statistical analysis

The data collected during the study period was subjected to analysis of variance using the General Linear Model procedure of SAS (SAS, 2002). Data for the finisher period were analyzed for the effect of treatment rations. When the

treatment effect was significant, least significant difference (LSD) was employed to separate them. The first used model for analysis of the data was:

$$Y_{ij} = \mu + t_i + e_{ij}$$

Where:

Y_{ij} : individual observation.

μ : overall mean.

t_i : treatment effect.

e_{ij} : random error.

RESULTS AND DISCUSSION

It can be seen from the result that maize and SBM contained relatively high level of ME. The ME of maize was higher and SBM was lower than the value reported by Zewdu (2005); 3187.98 and 3670.35 kcal/kg DM, respectively. Zena (2011) reported higher values (3661.07 and 3970.39 kcal/kg DM for maize and SBM, respectively). The CP contents of SBM was comparable with that reported by Zewdu (2005); (38.49% CP) and lower than the amount reported by Zena (2011); (43.60% CP). The EE content of SBM was lower than the values reported by Zena (2011); (8.34% EE). CF content of NSC was higher and its ash was lower than the amount reported by Befikadu (2008); (17.2% CF and 10.6% ash, respectively). The calculated energy value of the treatment diets were not far from the recommended finisher (3200 kcal/kg DM) and contained similar amount of ME among treatments (Tables 4 and 5), since the inclusion levels of synthetic lysine amino acid could not bring substantially change the ME content of the treatment diets. Protein contents of the four dietary treatments were similar among treatments. CP content of the diets used in this study was also within the range of the recommended CP levels (20%). Although the total protein composition of a given feed is important, the quantity of the essential amino acids and their composition determines to a considerable extent its nutritive value in poultry ration (Fisher and Boorman, 1986).

Dry matter and nutrient intake

The mean DM and nutrient intake of the experimental diets are presented in Table 5. The total and daily DM intake showed no significant difference ($P > 0.05$) among treatments. Because of consistent increase of dry matter intake, experimental birds consumed similar amount of energy and protein. However, DM intake increased numerically with increasing level of sLys up to 100% (T_3) and reduced at 150% (T_4) inclusion levels in all periods. This indicates that the established level of lysine is adequate to promote optimum feed intake (Abudabos and Aljumaah, 2010).

Table 4 Chemical compositions of the finisher rations

Treatments ¹	DM (%)	Nutrients (% DM)				ME (kcal/kg DM)
		CP	EE	CF	Ash	
T1	92.46	19.54	6.52	7.83	9.60	3406.95
T2	92.29	19.62	6.48	7.91	9.43	3421.78
T3	92.09	19.80	6.25	7.65	9.23	3436.20
T4	92.32	20.97	5.89	7.36	8.90	3465.82

¹Synthetic lysine (sLys) added to the ration based on the deficiency level of 0.3 and 0.2 % of the ration DM in the control diet for starter and finisher phases, respectively:

T1= no sLys inclusion in the ration.

T2= ration to which 50% of the deficient amount of lysine being added as sLys.

T3= ration to which 100% of the deficient amount of lysine being added as sLys.

T4= ration to which 150% of the deficient amount of lysine being added as sLys.

DM: dry matter; CP: crude protein; CF: crude fiber; EE: ether extract and ME: metabolizable energy.

Table 5 Dry matter and nutrient intake of broilers fed diets containing different levels of synthetic lysine during the finisher and entire period

Intake	Treatments ¹				SEM	SL
	T1	T2	T3	T4		
Finisher phase						
Total DM (g/bird)	2867.5	2899.0	2944.1	2839.7	46.57	NS
Daily DM (g/bird)	136.54	138.04	140.19	135.22	2.21	NS
ME (kcal/kg DM)	465.20	472.37	481.73	468.66	7.64	NS
CP (g/bird/d)	26.68	27.08	27.75	28.35	0.48	NS

¹Synthetic lysine (sLys) added to the ration based on the deficiency level of 0.3 and 0.2 % of the ration DM in the control diet for starter and finisher phases, respectively:

T1= no sLys inclusion in the ration.

T2= ration to which 50% of the deficient amount of lysine being added as sLys.

T3= ration to which 100% of the deficient amount of lysine being added as sLys.

T4= ration to which 150% of the deficient amount of lysine being added as sLys.

SEM: standard error of mean; SL: significant level and NS: non significant.

The result was consistent with [Martinez and Laparra \(1998\)](#), who reported that increasing lysine levels from 1.1 to 1.2% did not result in improved DM intake for 1 to 35 days old birds. The body requires a continuous supply of amino acids to meet metabolic needs ([Matthews, 2000](#)), but greater intake than the required level reduces feed intake and impair proper nutrient balance. In agreement, [Mendes et al. \(1997\)](#) recorded lower feed consumption when the lysine level of the feed increased. Similarly, [Panda et al. \(2011\)](#) reported significant increase in feed intake when lysine content increased up to 1.2%, but dry matter intake reduced when the amount of synthetic lysine increased to 1.3%.

Birds in all treatments showed a similar increase in DM intake trough out the experimental period. DM intake of birds with age is obviously associated with increase in the size of birds and more feed consumption to satisfy the demand of nutrients.

Body weight gain

The final, total and daily body weight gains of chicks during the finisher period are shown in Table 6. The average initial weight of chicks in the present experiment was higher than the results reported by [Tadelle \(2003\)](#) and [Zena \(2011\)](#) for the same breed simply because the initial body weight of the chicks was taken 30 h after hatch and feeding. However, the final weight, total and daily body weight gain during the whole period of the experiment was similar to [Tadelle \(2003\)](#) and [Zena \(2011\)](#).

Total body weight and daily body weight gain for the entire period were significantly higher in T4 as compared to T1 and T2. There were no significant differences in these parameters between T1, T2 and T3, as well as between T3 and T4.

Thus, body weight response obtained when feeding sLys at 150% (T4) was not significantly improved compared to that supplemented with 100% (T3) sLys. This result suggests that 50 or 100% lysine inclusion will not allow the chicks to realize maximum gain. Similar finding was reported by [Coto et al. \(2009\)](#) and [Saima et al. \(2010\)](#). Supporting the trend observed in the current experiment, [Corzo and Kidd \(2004\)](#) noted that performance of broilers did not vary with increasing levels of supplemental sLys at early age, but those on high sLys supplement gained more at the end of the finisher.

The observed improvement in weight gain of birds fed T4 diet at the end of finishing period agreed with that reported by [Batal and Dale \(2006\)](#) who noted that the benefit of increased lysine levels may not be seen at early stage of growth.

In accordance with the present finding, [Panda et al. \(2011\)](#) reported that body weight gain increased and dry matter conversion ratio decreased linearly as dietary lysine increased up to 1.4%. This might be due to the increased dietary amino acid density, which is known to stimulate synthesis of insulin-like growth factor-I ([Tesseraud et al. 2003](#)). Moreover, lysine is known to increase nutrient digestibility and utilization ([Selle et al. 2007](#)).

At marginal level of lysine inclusion, growth and body weight was affected due to manifested de-pigmentation and reduced hemoglobin and hematocrit in chicken. Lysine is one of the most limiting essential amino acids for growth and its deficiency reduces weight gain (AAN, 2009). It is needed for proper collagen formation of bones, cartilage, ligaments, and tendons and production of antibodies, hormones and enzymes (NSHG, 2011).

Dry matter and nutrient utilization

No significant difference ($P>0.05$) was found among treatments (Table 7). However, T4 group contributed to the enhanced body weight gain of chicks. Mendes *et al.* (1997) found that increasing lysine levels up to 1.2% did not improve feed conversion ratio. Dozier *et al.* (2008) had showed that maximal feed efficiency requires a higher dietary level of lysine than that required for body weight gain. Safamehr *et al.* (2008) noted that 1.2% lysine recommendations of NRC (1994) is low and do not meet the needs of modern broilers. Coto *et al.* (2009) reported that birds fed diets supplemented with 1.1% lysine have a significantly lower dry matter conversion ratio (DMCR) than birds fed 1.3% and 1.5% lysine indicating that higher level of lysine supplementation is necessary to bring improvement in feed efficiency.

No significant difference in feed conversion ratio was found between the treatments, because of lysine level for optimum DMCR is typically reported to be higher than that required for maximum body weight gain (Labadan *et al.* 2001).

Morbidity and mortality

Mortality rate was associated with the weather condition and transportation stress. Rezaei *et al.* (2004) noted that NRC requirement for lysine is low for the period of 3 to 6 weeks of age and had no significant effect on mortality of chicks.

Mortality of chickens in this experiment did not seem to be related to the effect of the levels of sLys, rather than weather condition and most of the deaths during later ages were a sudden type that might have been related to rapid growth of broilers. Modern chickens have a small lung volume to body weight ratio causing inability of the respiratory system to respond to the broilers elevated oxygen needs, which can lead to hypoxia and respiratory acidosis (Baghbanzadeh and Decuyper, 2008).

Carcass characteristics

Significant differences ($P<0.05$) were found among treatments on slaughter, dressed carcass, breast meat and drumstick weights (Table 8). Slaughter and dressed carcass weights were greater for T4 than others.

Abdominal fat weight ($P<0.001$) and percent ($P<0.01$) were significantly lower in T3 and T4 indicating that high level of sLys supplementation reduces fat accumulation (Table 9).

Similar AAN (2009) who recorded reduced carcass fat content and increased protein accretion in broilers fed with high sLys in the ration. There were no significant differences ($P>0.05$) in edible and non edible offal among dietary treatments.

Table 6 Body weight gain and mortality percentage of broilers fed diets containing different levels of synthetic lysine

Body weight gain	Treatments ¹				SEM	SL
	T1	T2	T3	T4		
Initial BW (g/b)	794.17	799.28	807.05	842.88	9.7	NS
Final BW (g/b)	1665.33 ^b	1671.58 ^b	1706.83 ^{ab}	1785.75 ^a	18.04	*
Total BWG (g/b)	871.16	872.30	899.78	942.87	13.17	NS
ADG (g/b)	41.48	41.53	42.84	44.89	0.62	NS
Mortality %	1.60	1.49	1.43	1.38	0.05	NS

The means within the same row with at least one common letter, do not have significant difference ($P>0.01$).

¹ Synthetic lysine (sLys) added to the ration based on the deficiency level of 0.3 and 0.2 % of the ration DM in the control diet for starter and finisher phases, respectively:

T1= no sLys inclusion in the ration.

T2= ration to which 50% of the deficient amount of lysine being added as sLys.

T3= ration to which 100% of the deficient amount of lysine being added as sLys.

T4= ration to which 150% of the deficient amount of lysine being added as sLys.

BWG: body weight gain and ADG: average daily gain.

SEM: standard error of mean; SL: significant level and NS: non significant.

Table 7 Dry matter conversion ratio of broilers fed diets containing different levels of synthetic lysine during finisher period

Experimental period	Treatments ¹				SEM	SL
	T1	T2	T3	T4		
Finisher	3.29	3.32	3.27	3.01	0.07	NS

¹ Synthetic lysine (sLys) added to the ration based on the deficiency level of 0.3 and 0.2 % of the ration DM in the control diet for starter and finisher phases, respectively:

T1= no sLys inclusion in the ration.

T2= ration to which 50% of the deficient amount of lysine being added as sLys.

T3= ration to which 100% of the deficient amount of lysine being added as sLys.

T4= ration to which 150% of the deficient amount of lysine being added as sLys.

SEM: standard error of mean; SL: significant level and NS: non significant.

However, Nasr and Kheiri (2011) noted that diets formulated by high lysine level promoted a better conversion of amino acid and significant increase in weight of liver, heart and gizzard.

Generally, this study showed that the higher efficiency of T3 and T4 allowed a better transformation of amino acid intake into tissue synthesis.

Partial budget analysis

The partial budget analyses of broilers supplemented with different levels of sLys is given Table 10. Net return per chick, was obtained by subtracting feed costs from that obtained from the sale of broilers. The highest net return of 41.39 birr / chick was obtained from the sale of birds reared under the feeding regime of highest sLys.

Table 8 Carcass characteristics of broilers fed different levels of synthetic lysine

Parameters	Treatments ¹				SEM	SL
	T1	T2	T3	T4		
Slaughter wt (g)	1582.89 ^b	1598.31 ^b	1639.94 ^{ab}	1682.91 ^a	15.49	*
Dressed carcass wt (g)	1406.52 ^b	1425.88 ^b	1461.36 ^{ab}	1510.41 ^a	15.07	*
Dressing (% SW)	88.8	89.2	89.1	89.8	0.25	NS
Breast wt (g)	329.02 ^b	333.66 ^b	338.00 ^b	364.57 ^a	5.09	*
Breast (% SW)	21.07	20.58	20.61	21.66	0.20	NS
Drumstick wt (g)	134.08 ^b	137.05 ^b	135.24 ^b	150.08 ^a	2.30	*
Thigh wt (g)	165.70	172.36	177.61	176.71	2.49	NS

¹ Synthetic lysine (sLys) added to the ration based on the deficiency level of 0.3 and 0.2 % of the ration DM in the control diet for starter and finisher phases, respectively: T1= no sLys inclusion in the ration.

T2= ration to which 50% of the deficient amount of lysine being added as sLys.

T3= ration to which 100% of the deficient amount of lysine being added as sLys.

T4= ration to which 150% of the deficient amount of lysine being added as sLys.

SEM: standard error of mean; SL: significant level and NS: non significant.

Table 9 Edible and non-edible offal of broiler fed ration with different levels of synthetic lysine

Parameters	Treatments ¹				SEM	SL
	T1	T2	T3	T4		
Heart wt (g)	8.22	9.63	8.79	7.19	0.28	NS
Liver wt (g)	40.03	40.89	44.16	43.60	1.14	NS
Lung wt (g)	7.54	7.64	7.21	7.52	0.14	NS
Giblet wt (g/b)	85.12	88.48	90.20	88.68	1.13	NS
Giblet percent (% SW)	5.38	5.53	5.50	5.27	0.08	NS
Abdominal fat wt (g)	34.38 ^a	33.49 ^a	28.06 ^b	26.83 ^b	1.08	***
Abdominal fat (% SW)	2.14 ^a	2.11 ^a	1.71 ^b	1.59 ^b	0.07	**
Spleen (g)	2.11 ^b	2.09 ^b	2.39 ^{ab}	2.63 ^a	0.08	*
Pancreas (g)	4.82	5.66	5.20	5.43	0.14	NS
SI empty wt (g)	46.57	45.27	51.59	50.57	1.17	NS
Length of SI (cm)	174.71	172.55	179.45	178.22	2.17	NS
Crop and esoph wt (g)	10.38	11.33	10.61	10.50	0.22	NS
Ceaca empty wt (g)	7.89	7.77	7.45	7.70	0.16	NS
Length of ceaca (cm)	16.86	16.81	17.43	17.52	0.18	NS
Proventriculus wt (g)	8.45	9.42	9.81	8.08	0.27	NS
Gizzard empty wt (g)	36.89	37.96	37.24	37.88	0.36	NS

*** (represents strongly significant) ** (represents highly significant different) and * (represents significant different).

¹ Synthetic lysine (sLys) added to the ration based on the deficiency level of 0.3 and 0.2 % of the ration DM in the control diet for starter and finisher phases, respectively:

T1= no sLys inclusion in the ration.

T2= ration to which 50% of the deficient amount of lysine being added as sLys.

T3= ration to which 100% of the deficient amount of lysine being added as sLys.

T4= ration to which 150% of the deficient amount of lysine being added as sLys.

SEM: standard error of mean; SL: significant level and NS: non significant.

The reason might be due to higher growth rate and heavier final body weight, as a result of better feed conversion efficiency of the chicks that were supplemented with higher sLys amino acid than the NRC (1994) recommendation.

The highest price of feed was recorded in T4 and T3 diets since the price per kg of lysine was higher. A similar result was reported as positive responses of adding sLys to diets (Onu *et al.* 2010).

Table 10 Economic efficiency of broiler chicks fed diets containing different levels of synthetic lysine amino acid

Parameters	Treatments ¹			
	T1	T2	T3	T4
Purchase price / chick (ETB)	6	6	6	6
Total feed cost (birr/kg)	6.99	7.19	7.40	7.61
Sell price of chick (birr/bird)	51.29	51.48	52.56	55
Change in total variable cost (ΔTVC)	-	0.20	0.41	0.62
Total return	45.29	45.48	45.56	49
Net return	38.30	38.29	39.16	41.39
Change in net return	-	-0.01	0.86	3.09
Marginal rate of return	-	-0.05	2.09	4.98

¹ Synthetic lysine (sLys) added to the ration based on the deficiency level of 0.3 and 0.2 % of the ration DM in the control diet for starter and finisher phases, respectively:

T1= no sLys inclusion in the ration.

T2= ration to which 50% of the deficient amount of lysine being added as sLys.

T3= ration to which 100% of the deficient amount of lysine being added as sLys.

T4= ration to which 150% of the deficient amount of lysine being added as sLys.

SEM: standard error of mean; SL: significant level and NS: non significant.

ETB: Ethiopian birr.

This is because of the higher weight gain and better feed efficiency that resulted in increased profitability of the chicks fed synthetic amino acid supplementation.

CONCLUSION

No significance difference was observed among treatments in total and daily DMI, metabolic energy and crude protein (CP) intakes and DMCR in response to sLys supplementation. Final body weight and ADG (g/d) during the experimental period were significantly higher for birds kept on T4 diets. No significant difference existed in mortality percentage among treatments. Dressed carcass weight (g), breast weight and (g) and drumstick weight were greater for T4 than other treatments. In conclusion, 12.5% extra addition of sLys above the level recommended by NRC to the commercial diets, as in T4, improved broiler performance and profitability.

REFERENCES

- AAN. (2009). Ajinomoto Animal Nutrition. Feeding broilers different lysine to apparent metabolizable energy ratios during 40 to 2000 gram live weight period. Poultry research report. Available at: http://www.lysine.com/new/Technical%20Reports/Poultry/PR_R12.pdf.
- Abudabos A. and Aljumaah R. (2010). Evaluation of digestible lysine needs for male broiler. *Int. J. Poult. Sci.* **9(12)**, 1146-1151.
- AOAC. (1990). Official Methods of Analysis. Vol. I. 15th Ed. Association of Official Analytical Chemists, Arlington, VA, USA.
- Baghbanzadeh A. and Decuyper E. (2008). Ascites syndrome in broilers: physiological and nutritional perspectives. *Avian Pathol.* **37(2)**, 117-126.
- Batal A.B. and Dale N.M. (2006). Lysine: sources, bioavailability and factors affecting requirements. MS Thesis. Univ. Georgia Athens, GA, USA.
- Befikadu Z. (2008). The effect of feeding azolla (*Azolla filiculoides*) as a partial protein supplementation on the performance and carcass characteristics of broiler chicks. MS Thesis. Alemaya Univ., Ethiopia.
- Corzo A. and Kidd M.T. (2004). Starter synthetic lysine level and strain cross effects on performance and carcass traits of broiler females. *Br. J. Poult. Sci.* **6**, 93-97.
- Coto C., Wang Z., Cerrate S., Perazzo F., Abdel-Maksoud A., Yan F. and Waldroup P.W. (2009). Effect of protein and amino acid levels on bone formation in diets varying in calcium Content. *Int. J. Poult. Sci.* **8(4)**, 307-316.
- Dozier I.W.A., Corzo A., Kidd M.T. and Schilling M.W. (2008). Dietary digestible lysine requirements of male and female broilers from forty-nine to sixty-three days of age. *Poult. Sci.* **87**, 1385-1391.
- Fisher C. and Boorman K.N. (1986). Nutrient requirements of poultry and nutritional research. Pp. 47-51 in 19th Poult. Sci. Symp., London, UK.
- Knott S.A., Leury B.J., Cummins L.J., Brien F.D. and Dunshea F.R. (2003). Relationship between body composition, net feed intake and gross feed conversion efficiency in composite sire line sheep. Pp. 525-528 in Progress in Research on Energy and Protein Metabolism. W.B. Souffrant and C.C. Metges Eds. EAAP publication. Wageningen, Germany.
- Labadan M.C.J., Hsu K.N. and Austic R.E. (2001). Lysine and arginine requirements of broiler chickens at two to three week intervals to eight weeks of age. *Poult. Sci.* **80**, 599-606.
- Martinez A. and Laparra-Vega J.L. (1998). Synthetic lysine and electrolyte balance do not interact to affect broiler performance. *J. Appl. Poult. Res.* **7**, 313-319.
- Matthews J.C. (2000). Amino acid and peptide transport systems. MS Thesis. Univ. Kentucky, Lexington, Kentucky, USA.
- Mekonnen G.E. (2007). Characterization of smallholder poultry production and marketing system of dale, wonsho and loka abaya woredas of southern Ethiopia. MS Thesis. Hawassa

- Univ., Ethiopia.
- Mendes A.A., Watkins S.E., England J.A., Saleh E.A., Waldroup A.L. and Waldroup P.W. (1997). Influence of synthetic lysine levels and arginine: lysine ratios on performance of broilers exposed to heat or cold stress during period of three to six weeks of age. *Poult. Sci.* **76**, 472-481.
- Moran J.E.T. (1995). Body composition. Pp. 139-148 in *Poultry Production: World Animal Science Series: C9*. P. Hunton Ed., Elsevier.
- Nasr J. and Khein F. (2011). Increasing amino acids density improves broiler live weight. *Int. J. Poult. Sci.* **10(7)**, 523-526.
- NRC. (1994). *Nutrient Requirements of Poultry*, 9th Rev. Ed. National Academy Press, Washington, DC., USA.
- NSHG. (2011). *Nutritional Supplements Health Guide*. Lysine benefits and improving your health (how lysine benefits the body). Available at: www.nutritional-supplements-health-guide.com.
- Onu P.N., Ayo-Enwerm M.C. and Ahaotu E.O. (2010). Evaluation of carcass characteristics and cost effectiveness of broiler chicks fed synthetic lysine and methionine supplemented soybean-based diets. *Int. J. Sci. Natur.* **1(1)**, 22-26.
- Panda A.K., Rama Rao S.V., Raju M.V.L.N., Lavanya G., Pradeep Kumar Reddy E. and Shyam Sunder G. (2011). Early growth response of broilers to dietary lysine at fixed ratio to crude protein and essential amino acids. *Asian-australas J. Anim. Sci.* **24(11)**, 1623-1628.
- Rezaei M., Moghaddam H.N., Reza J.P. and Kermanshahi H. (2004). The effects of dietary protein and lysine levels on broiler performance, carcass characteristics and nitrogen excretion. *Int. J. Poult. Sci.* **3(2)**, 148-152.
- Rostagno S.H., Albino L.F.T., Donzele J.L. and Gomes P.C. (2005). *Brazilian Tables for Poultry and Swine. Composition of Feedstuffs and Nutritional Requirements*. Universidade Federal de Viçosa-Departamento de Zootecnia.
- Safamehr A., Azgani A. and Mehmannaavaz Y. (2008). Effects of lysine-HCl supplementation on performance and carcass characteristics of Ross broilers. *Res. J. Biol. Sci.* **1(1)**, 1197-1201.
- Saima M.K., Jabbar M.A., Mehmud A., Abbas M.M. and Mahmood A. (2010). Effect of lysine supplementation in low protein diets on the performance of growing broilers. *Pakistan Vet. J.* **30(1)**, 17-20.
- Scanes C.G. (2007). Contribution of poultry to quality of life and economic development in the developing world. *Poult. Sci.* **86(11)**, 23-28.
- Selle P.H., Ravindran V., Ravindran G. and Bryden W.L. (2007). Effects of dietary lysine and microbial phytase on growth performance and nutrient utilisation of broiler chickens. *Asian-australas J. Anim. Sci.* **20(7)**, 1100-1107.
- Sibbald I.R. and Wolynetz M.S. (1986). Effects of synthetic lysine and feed intake on energy utilization and tissue synthesis by broiler chicks. *Poult. Sci.* **65**, 98-105.
- Smith A.J. (2001). *Poultry: The Tropical Agriculturalist series (CTA)*. Rev. Ed. Macmillan Education LTD, Oxford. London.
- SAS Institute. (2002). *SAS[®]/STAT Software, Release 9.0*. SAS Institute, Inc., Cary, NC. USA.
- Tadelle D., Alemu Y., Moges H.M. and Fasil K. (2003). Effect of level of rapeseed (*Brassica carinata*) cake in rations on broiler performance. *Livest. Res. Rural Develop.* **15(4)**. <http://www.lrrd.org/lrrd15/4/tade154.htm>.
- Tesseraud S., Pym R.A., Bihan-Duval E.L. and Duclos M.J. (2003). Response of broilers selected on carcass quality to dietary protein supply, live performance, muscle development, and circulating insulin-like growth factors (IGF-I and -II). *Poult. Sci.* **82**, 1011-1016.
- Wiseman J. (1987). Feeding of non-ruminant animals. Pp. 9-15 in *Meet. Nutr. Requir. Avail. Res.*, London, UK.
- Zena K. (2011). Comparative performance evaluation of Hubbard classic and Cobb-500 commercial hybrid broilers fed ration containing imported or local protein balancer. MS Thesis. Haramaya Univ., Dire Dawa, Ethiopia.
- Zewdu W. (2005). Evaluation of the feeding and replacement value of brewer's dried grain yeast mixture for noug (*Guizotia abyssinica*) cake in chick's starter diet as protein supplement. MS Thesis. Alemaya Univ., Dire Dawa, Ethiopia.