PROTEIN SPARING EFFECT AND AMINO ACID UTILIZATION IN BROILERS FED TWO TYPES OF LYSINE

K. N. Heo, I. K. Han[1] and H. Lee[2]

Department of Animal Science and Technology, College of Agriculture and Life Sciences
Seoul National University, Suweon, 441-744 Korea

Summary

A growth experiment was conducted to evaluate the nutritivie values of supplemental lysine and methionine in broiler chicks. Two types of L-lysine, liquid and powder type, and DL-methionine were added to the diets at different levels of dietary protein with two growth phases, 0-3 weeks and 4-6 weeks named starter and grower, respectively. Six hundred seventy two chicks were allotted in 14 treatments; 3 controls by dietary CP level (starter-grower) with CP 23-21%, CP 21-19% and CP 20-18, 8 groups of liquid and powder lysine supplementation of 0.1, 0.2, 0.3 and 0.4%, and 3 groups of lysine and methionine supplementation. Body weight, feed intake, and excreta were measured and analyzed to determine growth performance, amino acid digestibilities, and the quantity of excreted nitrogen in feces. Chicks fed CP 23-20 with 3,200 ME kcal showed significantly better growth performance than those fed CP 21-18 for 6 weeks. The supplementation of 0.2% of either type of lysine to CP 21-19 diet improved weight gain and feed efficiecy to the extent that CP 23-21 diet was fed. Physical type of lysine did not affect chick's growth and amino acid digestibilities of the diets. The level of CP in the diet significantly affected nitrogen excretion in feces. Supplementation of lysine and methionine to CP 21-18 diet reduced fecal nitrogen by 10% compared to CP 23-21 diet. It was confirmed that 0.2% of supplemental lysine to the broiler diet spared the dietary protein by 3%, and also reduced nitrogen excretion in feces by 10%.

(Key Words : Animo Acid Digestibility, L-lysine, DL-methionine, Nitrogen Excretion, Broiler Chicks)

Introduction

Supplementation of synthetic amino acid to low-protein diets is common practice to provide adequate amino acids to the animal. Lysine and methionine are being used mostly as supplements for poultry diets. Lysine is the second limiting amino acid after the first limiting amino acid, methionine, in broiler diets based on corn-soybean meal. Growth performance of broiler chicks fed a low-protein diet is improved by supplementation of lysine (Waldroup et al., 1976; Daghir, 1983; Sibbald and Wolynetz, 1986; Han et al., 1991).

Nitrogen pollution from animal wastes could be a limit of the animal production. The nutritional manupulation of reducing dietary protein is one of solutions to the environmental problem facing today animal husbandry.

The manufacturing of L-lysine includes the process that liquid type of lysine is condensed, crystallized, and dried to produce powder lysine. This intermediate is used by feed mills as a substitute of powder lysine. Due to advatage of low price and easy handling, the use of liquid lysine could be cost saving for feed manufacturers. The nutritive values of liquid lysine have not been evaluated.

The objectives of this experiment are; 1) to investigate protein sparing effect by addition of lysine and methionine to low-protein diets, 2) to evaluate the nutritive value of liquid lysine, and 3) to measure the reduction of nitrogen excretion by decresing dietary proteins in broiler chicks.

Materials and Methods

Six hundred seventy two male chicks (Arbor Acres × Arbor Acres) were housed in battery brooders with raised wire floors. Chicks were allotted to 14 dietary treatments with 6 replicates per treatment and eight chicks per replicate. Treatments consist of 3 controls by crude protein

[1]Address reprint requests to Dr. I. K. Han, Department of Animal Sciences and Technology, College of Agriculture and Life Sciences, Seoul National University, Suweon 441-744, Korea

[2]Sewon Campany, Ltd. Seoul 157-200, Korea

Received November 28, 1994
Accepted April 20, 1995

level, 2 types of lysine with 4 levels of supplementation, and the supplementation of lysine and methionine with 3 levels. Experimental diets were prepared with corn, wheat; hard, soybean meal, fish meal, corn gluten meal, wheat bran, rapeseed meal, tallow, limestone, tricalcium phosphate, salt, commercial vitamin-mineral premixture, and sand to meet NRC nutrient requirements of poultry (1984). Energy and CP levels of the diets were maintained as experimental design (table 1) by adjusting ingredient contents when L-lysine and DL-methionine were supplemented. The growth trial was conducted for the period of 6 weeks. Feed and water were provided ad libitum. Group body weight and feed consumption, and mortality were recorded weekly.

TABLE 1. EXPERIMENTAL DESIGN

Treatment	C1	C2	C3	L1	L2	L3	L4	P1	P2	P3	P4	M1	M2	M3
CP(0-3 wk)	23	21	20	21	21	21	21	21	21	21	21	20	20	20
(4-6 wk)	21	19	18	19	19	19	19	19	19	19	19	18	18	18
Amino acids added (%):														
Lysine	0	0	0	0.1	0.2	0.3	0.4	0.1	0.2	0.3	0.4	0.05	0.1	0.2
Methionine	0	0	0	0	0	0	0	0	0	0	0	0.025	0.05	0.1

For amino acid digestibilty and nitrogen excretion, excreta were collected each 12 hours on the 3 successive days during the 3rd and 6th week of the experimental period. The total collection method was employed. Collected excreta were placed in plastic bags and frozen immmediately after each collection. Successive collections were added to the respective bags to provide a single frozen composite for each pen. Samples were dried in a air-forced drying oven at 60℃ for 24 hours and stored for the further analysis.

Proximate analysis of feed and excreta were conducted by AOAC methods (1990). Samples for amino acid analysis were hydrolysed in 6N HCl for 16 hours at 110℃ (Mason, 1984), and then conducted by automatic amino acid analyzer (LKB model 4150, alpha).

Statistical data were analyzed by Analysis of Variance (SAS, 1985). Three seperate data analyses were conducted by using GLM procedure; 1) 3 controls, 2) 2 controls, plus lysine types and levels added to the diets, and 3) 1 control, plus lysine and methionine levels added in the diets. Differences of mean values among treatments were seperated by Dnucan's multiple range test (Duncan, 1955) when P values have significance ($p < 0.05$).

Results and Discussion

Mortality was recorded in order to monitor the possible inclusion of toxic substance from liquid lysine. The result showed no significant difference among liquid lysine added group and other groups.

The growth performance of broilers fed diets at differnt CP levels is shown in table 2. A typical dose-response to the levels of CP in the diets has been observed. Weight gain and feed intake increased, and feed efficiency improved as CP levels of diets increased. table 3 showed the effect of physical type and level of lysine added on the growth performance of the chicks. Any significant difference was observed either on interaction or on main effect. The supplementation of both types of lysine had better weight gain and feed efficiency than C2 control, but not significantly.

TABLE 2. EFFECTS OF LEVEL OF DIETARY PROTEIN ON THE GROWING PERFORMANCES OF BROILER CHICKS FOR 0-6 WEEKS

Treat-ments	Initial body weight (g)	Final body weight (g)	Body weight gain (g)	Feed intake (g)	Feed effi-ciency (feed / gain)
C1	66.5	1,631.4^{a}	1,564.9^{a}	2,988.3^{a}	1.91^{a}
C2	66.1	1,551.9^{b}	1,485.8^{b}	2,913.5^{ab}	1.96^{b}
C3	66.4	1,461.3^{c}	1,394.9^{c}	2,802.4^{b}	2.01^{c}

^{abc}; Mean values with different superscripts within the same column are significantly different ($p < 0.05$).

The effect of lysine and methionine addition to a low protein diet (C3) is presented in table 4. More than 0.1% of lysine and 0.05% of methionine to C3 diet improved the animal performance to the extent of that of C1. Feed efficiencies of chicks fed M2 and M3 diets improved comparing to C3 control, but did not reach the level of chicks fed C1 control.

Kang and Kwack (1983) reported that the supplementation of lysine 0.15% and methionine 0.1% spared dietary protein by 2% in broiler chicks. Han et al.

TABLE 3. EFFECTS OF PHYSICAL TYPE AND SUPPLEMENTAL LEVEL OF LYSINE ON THE GROWING PERFORMANCES OF BROILER CHICKS FOR 0-6 WEEKS

Treatments	Initial body weight (g)	Final body weight (g)	Body weight gain (g)	Feed intake (g)	Feed efficiency (feed / gain)
C1	66.5	1,631.4^{ab}	1,564.9^{ab}	2,988.3	1.91^{b}
C2	66.1	1,551.9^{b}	1,485.8^{b}	2,913.5	1.96^{a}
L1	66.5	1,578.2^{ab}	1,511.8^{ab}	2,924.8	1.93^{ab}
L2	66.1	1,662.1^{a}	1,595.9^{a}	3,043.0	1.91^{b}
L3	65.9	1,609.7^{ab}	1,543.8^{ab}	2,943.5	1.91^{b}
L4	66.3	1,566.2^{ab}	1,499.9^{ab}	2,875.3	1.92^{b}
P1	66.1	1,562.1^{b}	1,495.9^{b}	2,881.7	1.93^{ab}
P2	66.3	1,602.0^{ab}	1,535.7^{ab}	2,914.6	1.90^{b}
P3	66.3	1,625.4^{ab}	1,559.1^{ab}	2,972.9	1.91^{b}
P4	66.5	1,626.2^{ab}	1,559.7^{ab}	3,017.4	1.93^{ab}
Physical type					
Liquid	66.2	1,604.1	1,537.9	2,946.7	1.92
Power	66.3	1,603.9	1,537.6	2,946.6	1.92
Lysine level					
0.1	66.3	1,570.2	1,503.9	2,903.3	1.93^{a}
0.2	66.2	1,632.1	1,565.9	2,978.8	1.90^{b}
0.3	66.1	1,617.6	1,551.4	2,958.2	1.91^{ab}
0.4	66.4	1,596.2	1,529.8	2,946.3	1.92^{ab}
Significance					
Pysi. type	0.49	0.99	0.99	0.99	0.96
Lys. level	0.75	0.22	0.22	0.62	0.07
Type × level	0.49	0.27	0.27	0.14	0.61

^{ab} Mean values with different superscripts within the same column in each factor are significantly different ($p < 0.05$).

(1978) observed the same growth performance with supplementation of lysine 0.1% and methionine 0.1% as the control which contatined 2% more of CP content. Meanwhile, the authors failed in obtaining protein sparing effect by lowering the CP level by 3% at the optimal energy level. In this experiment, lowering 3% of CP with supplementation of lysine 0.1% and methionine 0.05% was feasible with no detrimental effect on chick growth.

Amino acid digestibilities were reported by 2 growth phases; 0-3 and 4-6 weeks named stater and grower, respectively. Treatment of C1 and C3 showed significantly ($p < 0.05$) greater digestibilities in isoleucine, leucine, threonine and valine than treatment C2 during grower period (table 5).

TABLE 4. EFFECTS OF SUPPLEMENTAL LEVEL OF METHIONINE AND LYSINE ON GROWTH PERFORMANCE OF BROILER CHICKS FOR 0-6 WEEKS

Treatments	Initial body weight (g)	Final body weight (g)	Body weight gain (g)	Feed intake (g)	Feed efficiency (feed / gain)
C1	66.5	1,631.4^{a}	1,564.9^{a}	2,988.3^{a}	1.91^{c}
C2	66.4	1,461.3^{b}	1,394.9^{b}	2,802.4^{b}	2.01^{a}
M1	66.1	1,501.3^{b}	1,435.2^{b}	2,863.0^{ab}	1.99^{a}
M2	65.9	1,602.9^{a}	1,536.9^{a}	2,989.9^{a}	1.95^{b}
M3	66.0	1,602.5^{a}	1,536.5^{a}	2,993.2^{a}	1.95^{b}

^{abc} Mean values with different superscripts within the same column are significantly different ($p < 0.05$).

At stater period, uncertainty was observed in effect of physical type and level of added lysine (table 6). Histidine showed the difference in digestibilty between powder and liquid types of lysine, but no explanation was abstracted. All digestibilities of histidine were very low at 40-60%. At grower period in table 7, no difference was shown on the effect of supplemental lysine level while powder type had better digestibilities than liquid type in arginine, isoleucine, methionine, threonine and the mean value of total amino acids, but for lysine. The effect of supplemental lysine and methionine on digestibility is presented in table 8. Supplementation of lysine and methionine to C3 control showed better digestibilities than C1 control at starter period. However, since C3 group showed better digestibility of overall amino acids than C1 group it was hardly concluded that the supplementation of lysine and methionine improved amino acid digestibilities.

Dry matter excretion did not differ among control groups during 2 phase of gorwth period of 6 weeks (table 9). Chicks fed low protein diets (C2 and C3) excreted less nitrogen in feces than those fed C1 diet by about 10%. It is well known that manupulation of diets with low-protein level reduces nitrogen pollution in animal husbandry. The results from this experiment showed a numerically low nitrogen excretion by 10% at both feeding phases.

Neither physical type nor level of lysine added affected dry matter excretion, but nitrogen excretion was significantly affected by these two factors. The groups fed liquid lysine excreted more nitrogen than the groups fed powder type. The diets with 0.3% of lysine supplementation resulted in signifcantly ($p < 0.05$) more nitrogen excretion than those with 0.1% addition at starter

TABLE 5. EFFECTS OF DIFFERENT LEVELS OF DIETARY CP ON AMINO ACID DIGESTIBILITY (%)

Treatment	Essential amino acids										
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	VAL	Submean*	Mean**
					(0-3 weeks)						
C1	92.8^{a}	41.4	89.7	87.2	86.8	86.3	86.3	83.6	84.2	82.0	81.4
C2	97.0^{a}	42.7	92.8	91.2	88.7	89.1	85.5	86.5	86.6	84.4	84.4
C3	97.0^{a}	53.3	93.6	91.9	83.5	87.7	91.5	87.5	87.5	85.9	85.6
					(4-6 weeks)						
C1	94.8	38.9	96.3^{a}	92.3^{a}	86.5	84.6	94.1	91.4^{a}	91.0^{a}	85.6^{a}	86.4^{a}
C2	94.1	38.4	93.1^{b}	88.5^{b}	83.1	82.6	90.3	84.7^{b}	88.2^{b}	82.5^{b}	81.2^{b}
C3	95.5	33.6	95.8^{a}	93.2^{a}	84.7	83.5	88.4	90.0^{a}	91.4^{a}	84.0^{ab}	83.1^{ab}

* Mean digestibility of essential amino acids except for tryptophan.
** Mean digestibility of all amino acids except for tryptophan.
^{ab} Mean values with different superscripts within the same column in each period are significantly different ($p < 0.05$).

TABLE 6. EFFECTS OF DIFFERENT LEVELS OF SUPPLEMENTAL LYSINE ON AMINO ACID DIGESTIBILITY (0-3 WEEKS, %)

Treatment	Essential amino aicds										
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	VAL	Submean*	Mean**
C1	92.8^{b}	41.4^{abc}	89.7^{b}	97.2^{b}	86.8^{b}	86.3	86.3^{ab}	83.6^{ab}	84.2^{c}	82.0^{c}	81.4^{bc}
C2	97.0^{a}	42.7^{abc}	92.8^{ab}	91.2^{ab}	88.7^{ab}	89.1	85.5^{ab}	86.5^{ab}	86.6^{abc}	84.4^{abc}	84.4^{abc}
L1	92.6^{b}	41.0^{abc}	92.6^{ab}	91.1^{ab}	89.9^{ab}	86.0	90.9^{ab}	85.7^{ab}	89.3^{abc}	84.4^{abc}	84.1^{abc}
L2	94.5^{ab}	41.0^{abc}	93.0^{ab}	89.2^{ab}	89.8^{ab}	85.1	89.0^{ab}	83.0^{b}	86.4^{abc}	83.4^{abc}	81.0^{c}
L3	96.4^{a}	43.5^{ab}	95.1^{a}	92.2^{a}	91.2^{a}	88.8	88.7^{ab}	87.3^{ab}	91.8^{a}	86.1^{a}	85.3^{abc}
L4	96.9^{a}	36.2^{c}	94.4^{a}	91.0^{ab}	92.1^{a}	88.9	89.6^{ab}	87.5^{ab}	90.1^{ab}	85.2^{ab}	84.4^{abc}
P1	95.5^{ab}	39.7^{bc}	91.3^{ab}	89.3^{ab}	89.0^{ab}	88.3	83.8^{b}	85.2^{ab}	84.5^{bc}	82.9^{bc}	82.4^{abc}
P2	96.9^{a}	61.1^{ab}	94.3^{a}	92.3^{a}	92.5^{a}	89.2	90.0^{ab}	89.8^{a}	91.1^{a}	88.6^{a}	88.6^{a}
P3	96.5^{a}	62.4^{a}	94.2^{a}	92.0^{a}	92.4^{a}	89.6	90.7^{ab}	88.6^{ab}	88.8^{abc}	88.3^{abc}	87.6^{ab}
P4	94.7^{ab}	40.9^{abc}	93.7^{ab}	91.2^{ab}	91.7^{a}	86.5	92.2^{a}	86.6^{ab}	87.6^{abc}	85.0^{abc}	85.7^{abc}
Physical type											
Liguid	95.1	40.4^{b}	93.8	90.9	90.8	87.2	89.5	85.9	89.4	84.8	83.7
Powder	95.9	51.0^{a}	93.4	91.2	91.4	88.4	89.2	87.5	88.0	86.2	86.1
Lysine level											
0.1	94.1^{b}	40.3	92.0^{b}	90.2	89.4	87.2	87.3^{b}	85.5	86.9	83.6	83.2
0.2	95.7^{ab}	51.1	93.6^{ab}	90.7	91.2	87.1	89.5^{ab}	86.4	88.8	86.0	84.8
0.3	96.4^{a}	52.9	94.6^{a}	92.1	91.8	89.2	89.7^{ab}	87.9	90.3	87.2	86.5
0.4	95.8^{ab}	38.6	94.1^{ab}	91.1	91.9	87.7	90.9^{b}	87.0	88.8	85.1	85.0
Probability (P):											
Physi. type	0.21	0.04	0.59	0.66	0.28	0.38	0.68	0.14	0.21	0.21	0.05
Lysine level	0.06	0.11	0.11	0.38	0.02	0.65	0.08	0.43	0.21	0.18	0.28
Type × level	0.03	0.33	0.61	0.16	0.13	0.37	0.00	0.07	0.03	0.21	0.06

* Mean digestibility of essential amino acids except for tryptophan.
** Mean digestibility of all amino acids except for tryptophan.
^{abc} Mean values with different superscripts within the same column in each factor are significantly different ($p < 0.05$).

TABLE 7. EFFECTS OF DIFFERENT LEVLES OF SUPPLEMENTAL LYSINE ON AMINO ACID DIGESTIBILITY (4-6 WEEKS, %)

Treatment	Essential amino acids										
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	VAL	Submean*	Mean**
C1	94.8^{ab}	38.9^{ab}	96.3^{ab}	92.3	86.5^{ab}	84.6^{def}	94.1^{a}	91.4^{abc}	91.0^{abcd}	85.6	86.4^{ab}
C2	94.1^{bc}	38.4^{ab}	93.1^{abc}	88.5	83.1^{b}	82.6^{f}	90.3^{a}	84.7^{d}	88.2^{cd}	82.5	81.2^{d}
L1	91.2^{c}	36.1^{b}	96.0^{ab}	92.0	90.4^{a}	86.3^{cde}	92.2^{a}	90.1^{abc}	91.9^{abc}	85.1	84.7^{bc}
L2	96.9^{ab}	46.1^{ab}	91.7^{c}	92.6	91.2^{a}	86.2^{cde}	77.8^{b}	88.7^{c}	92.0^{abc}	84.8	84.2
L3	97.4^{ab}	61.3^{a}	96.0^{ab}	91.8	92.7^{a}	88.0^{bcd}	89.8^{a}	89.7^{bc}	92.0^{abc}	88.7	86.1^{ab}
L4	95.0^{ab}	48.0^{ab}	92.9^{bc}	88.2	89.9^{a}	83.3^{ef}	88.4^{a}	84.2^{d}	87.9^{d}	84.2	82.2^{cd}
P1	98.0^{a}	41.0^{ab}	96.8^{ab}	93.6	88.1^{ab}	89.6^{abc}	93.0^{a}	92.4^{ab}	93.1^{ab}	87.3	87.1^{ab}
P2	97.6^{ab}	34.3^{b}	96.6^{ab}	93.1	90.6^{a}	91.6^{a}	91.2^{a}	92.9^{a}	93.9^{a}	86.9	87.2^{ab}
P3	95.7^{ab}	42.1^{ab}	97.0^{a}	94.5	91.3^{a}	84.0^{ef}	92.8^{a}	91.5^{abc}	89.4^{bcd}	86.5	86.7^{ab}
P4	97.5^{ab}	48.0^{ab}	96.9^{ab}	93.8	92.0^{a}	90.6^{ab}	92.4^{a}	92.2^{ab}	92.3^{ab}	88.4	88.6^{a}
Physical type											
Liquid	95.1^{b}	47.9	94.1^{b}	91.1	91.0	85.9^{b}	87.1	88.2^{b}	90.9	85.7	84.3^{b}
Powder	97.2^{a}	41.3	96.8^{a}	93.8	90.5	88.9^{a}	92.3	92.2^{a}	92.2	87.3	87.3^{a}
Lysine level											
0.1	94.6^{b}	38.5	96.4	92.8^{ab}	89.2	87.9^{ab}	92.6	91.2^{a}	92.5	86.2	85.9
0.2	97.2^{a}	40.2	94.1	92.9^{ab}	90.9	88.9^{a}	84.5	90.8^{a}	92.9	85.8	85.7
0.3	96.6^{ab}	81.7	96.5	93.1^{a}	92.0	86.0^{b}	91.3	90.6^{a}	90.7	87.6	86.4
0.4	96.2^{ab}	48.0	94.9	91.0^{b}	91.0	86.9^{ab}	90.4	88.2^{b}	90.1	86.3	85.4
Probability (p):											
Physi. type	0.02	0.22	0.01	0.00	0.69	0.00	0.06	0.00	0.20	0.08	0.00
Lysine level	0.15	0.26	0.22	0.11	0.54	0.09	0.18	0.02	0.12	0.46	0.86
Type × level	0.01	0.37	0.32	0.07	0.68	0.00	0.37	0.02	0.10	0.07	0.15

* Mean digestibility of essential amino acids except for tryptophan.
** Mean digestibility of all amino acids except for tryptophan.
^{abcdef} Mean values with different superscripts within the same column in each factor are significantly different ($p < 0.05$).

TABLE 8. EFFECTS OF DIFFERENT LEVELS OF LYSINE AND METHIONINE ON AMINO ACID DIGESTIBILITY (%)

Treatment	Essential amino acids										
	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	VAL	Submean*	Mean**
(0-3 weeks)											
C1	92.8^{b}	41.4	89.7^{b}	87.2	86.8^{ab}	86.3^{b}	86.3	83.6	84.2^{b}	82.0	81.4
C3	97.0^{a}	53.3	93.6^{a}	91.9	83.5^{b}	87.7^{ab}	91.5	87.5	87.5^{ab}	85.9	85.6
M1	97.0^{a}	42.2	95.0^{a}	93.0	84.3^{b}	89.8^{ab}	91.4	89.2	90.8^{a}	85.8	86.7
M2	96.7^{a}	48.6	94.1^{a}	91.7	86.7^{ab}	91.6^{a}	91.0	86.3	89.2^{ab}	86.2	85.3
M3	95.7^{a}	45.3	94.7^{a}	91.6	88.4^{a}	91.7^{a}	90.9	87.5	88.8^{ab}	86.1	85.0
(4-6 weeks)											
C1	94.8	38.9	96.3	92.3^{ab}	86.5^{ab}	84.6^{ab}	94.1	91.4^{a}	91.0^{a}	85.6^{a}	86.4^{a}
C3	95.5	33.6	95.8	93.2^{ab}	84.7^{b}	83.5^{b}	88.4	90.0^{ab}	91.4^{a}	84.0^{ab}	83.1^{ab}
M1	96.4	26.1	94.9	91.4^{b}	87.4^{ab}	85.5^{ab}	88.1	87.4^{ab}	92.9^{a}	83.3^{ab}	82.3^{b}
M2	91.4	23.9	94.6	91.6^{b}	88.5^{ab}	85.6^{ab}	91.6	86.7^{b}	86.4^{b}	82.3^{b}	81.1^{b}
M3	94.7	34.9	96.4	93.7^{a}	90.8^{a}	88.5^{a}	96.0	91.1^{ab}	91.7^{a}	86.4^{a}	86.4^{a}

* Mean digestibility of essential amino acids except for tryptophan.
** Mean digestibility of all amino acids except for tryptophan.
^{ab} Mean values with different superscripts within the same column in each period are significantly different ($p < 0.05$).

TABLE 9. EFFECTS OF DIFFERENT LEVELS OF DIETARY CP ON DRY MATTER AND NITROGEN EXCRETION PER KG DIET OF BOILER CHICKS (%)

Treatment	Dry matter		Nitrogen	
	(g)	(%)	(g)	(%)
	(0-3 weeks)			
C1	166.6	100.0	8.57	100.0
C2	176.6	106.0	7.79	90.9
C3	171.2	102.8	7.41	86.4
	(4-6 weeks)			
C1	211.8	100.0	8.44	100.0
C2	210.3	99.3	7.42	87.9
C3	203.1	95.9	7.51	88.9

TABLE 10. EFFECTS OF DIFFERENT LEVELS OF SUPPLEMENTAL LYSINE ON DRY MATTER AND NITROGEN EXCRETION PER KG DIET OF BROILER CHICKS (0-3 WEEKS, %)

Treatment	Dry matter		Nitrogen	
	(g)	(%)	(g)	(%)
C1	166.6	100.0	8.57[ab]	100.0
C2	176.6	106.0	7.79[ab]	90.9
L1	157.8	94.8	7.57[ab]	88.3
L2	154.7	92.9	7.79[ab]	90.9
L3	171.7	103.1	9.13[a]	106.5
L4	166.8	100.1	8.72[a]	101.7
P1	160.7	96.5	6.98[b]	81.4
P2	152.0	91.3	7.69[ab]	89.7
P3	146.1	87.7	8.16[ab]	95.2
P4	167.1	100.3	7.59[ab]	88.5
Physical type				
Liquid	163.0		8.333[a]	
Powder	156.5		7.579[b]	
lysine level				
0.1	159.4		7.25[b]	
0.2	153.4		7.74[ab]	
0.3	160.1		8.69[a]	
0.4	167.0		8.20[ab]	
Probability (p);				
Physi. type	0.37		0.04	
Lysine level	0.58		0.03	
Type × level	0.46		0.68	

[ab] Mean values with different superscripts within the same column in each factor are significantly different ($p < 0.05$).

period of 3 weeks (table 10). This phenomenon continued at grower period with significance ($p < 0.05$). The addition of 0.3 and 0.4% lysine showed 22 and 17% increases, respectively, of nitrogen excretion comparing to 0.1 or 0.2% lysine supplementation (table 11).

TABLE 11. EFFECTS OF DIFFERENT LEVELS OF SUPPLEMENTAL LYSINE ON DRY MATTER AND NITROGEN EXCRETION PER KG DIET OF BROILER CHICKS (4-6 WEEKS, %)

Treatment	Dry matter		Nitrogen	
	(g)	(%)	(g)	(%)
C1	211.8	100.0	8.44	100.0
C2	210.3	99.3	7.42	87.9
L1	202.1	95.4	6.74	79.8
L2	195.1	92.1	6.60	78.1
L3	193.4	91.3	8.61	102.0
L4	197.1	93.0	8.17	96.7
P1	205.1	96.9	7.02	83.2
P2	205.4	97.0	7.06	83.6
P3	206.2	97.4	8.15	96.5
P4	196.0	92.6	8.03	95.1
Physical type				
Liquid	197.3		7.53	
Powder	203.2		7.56	
Lysine level				
0.1	203.6		6.88[a]	
0.2	201.3		6.88[a]	
0.3	200.4		8.36[b]	
0.4	196.5		8.09[b]	
Probability (p);				
Physi. type	0.49		0.93	
Lysine level	0.94		0.05	
Type × level	0.93		0.90	

[ab] Mean values with different superscripts within the same column in each factor are significantly different ($p < 0.05$).

In case of both lysine and methionine supplementation, dry matter and nitrogen excretion from the groups fed low-protein diets (C2, M1, M2 and M3) compared to C1 control in two growth phases (table 12). At starter period M3 diet feeding showed significant ($p < 0.05$) reduction in nitrogen excretion than C1 diet.

In conclusion, Chicks fed CP 23-21% diet with 3,200 ME kcal showed better growth performance than chicks fed CP 22-19% or CP 21-18% for 6 weeks. The supplementation of more than 0.2% of lysine to CP 22-

19% improved weight gain and feed efficiency of broilers to the extent that CP 23-21% was fed. This experiment confirmed the protein sparing effect by lowering the dietary protein by 3%. Physical type or level of lysine added to the diets did not affect on growth performance and amino acid digestibilities of the diets. The level of CP in the diet affect nitrogen excretion in feces. Reduction of dietary protein by 3% decreased more than 10% of fecal nitrogen.

TABLE 12. EFFECTS OF DIFFERENT LEVELS OF SUPPLEMENTAL LYSINE AND METHIONINE ON DRY MATTER AND NITROGEN EXCRETION PER KG DIET OF BROILER CHICKS (%)

Treatment	Dry matter		Nitrogen	
	(g)	(%)	(g)	(%)
	(0-3 weeks)			
C1	166.6[a]	100.0	8.57[a]	100.0
C3	171.2[a]	102.8	7.41[ab]	86.4
M1	169.3[a]	101.7	8.03[ab]	93.7
M2	159.9[ab]	96.0	7.18[ab]	83.8
M3	145.2[b]	87.2	6.83[b]	79.7
	(4-6 weeks)			
C1	211.8	100.0	8.44	100.0
C3	203.1	95.9	7.51	88.9
M1	202.9	95.8	7.32	86.7
M2	203.0	95.8	7.49	88.7
M3	190.4	89.9	7.22	85.5

[ab] Mean values with different superscripts within the same column in each peried are significantly different ($p < 0.05$).

Literature Cited

AOAC. 1990. Official method of analysis (15th ed.). Association of official analytical chemists, Washington, D.C.

Daghir, N. J. 1983. Effect of lysine and methionine supplementation of low protein roaster diets fed after six weeks of age. Poult. Sci. 62:1572.

Duncan, D. B. 1955. Multiple range and multiple F tests. Biometrics. 11:1.

Han, I. K., H. D. Kim, B. C. Park, I. B. Kim and Y. J. Choi. 1991. Protein sparing effect by addition of synthetic amino acid on different energy-protein levels in broiler chicks. Korean J. Anim. Nutr. Feed 15 (2):58.

Han, I. K., S. J. Ohh, H. R. Cho and J. I. Yoon. 1978. Protein sparing effect of DL-methionine and L-lysine in the broiler rations. Korean J. Anim. Sci. 20(6):613.

Kang, H. S. and C. H. Kwack. 1983. Protein sparing effect of synthetic amino acid for broiler diet. Korean J. Anim. Sci. 25(2):76.

Mason, V. C. 1984. Metabolism of nitrogenous compounds in the large gut. Proc. Nutr. Soc. 43:45.

NRC. 1984. Nutrient Requirements of Poultry (8th ed.). National Academic Press. Washington D.C., U.S.A.

SAS. 1985. SAS User's Guide : Statistics, SAS Inst, Inc., Cary, NC.

Sibald, I. T. and M. S. Wolynetz. 1986. Effects of dietary lysine and feed intake on energy utilization and tissue synthesis by broiler chicks. Poultry Sci. 65:98.

Waldroup P. W., T. J. Mitchell, J. P. Payne and K. R. Hazen. 1976. performance for chicks fed diets forumulated to minimize excess levels of essential amino acid. Poultry Sci. 55:243.