EFFECTS OF METABOLIZABLE ENERGY AND LYSINE ON GROWTH AND FEED CONVERSION RATIO OF H'MONG BROILERS AT 0 TO 4 WEEK - AGE

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Abstract – *An experiment was conducted to evaluate the interactive influences of dietary ME and lysine on growth of H'mong broilers from 0 to 28 days of age. The study was in a 3x3 two-factorial design, with the first factor being 3 levels of ME (3,000; 3,100 and 3,200 kcal/kg of feed) and the second one being 3 levels of lysine (1.1%; 1.0% and 0.9%), and 4 replicates with 6 broilers for each. Two hundreds and sixteen broilers were placed into 36 bamboo floor pens (6 birds/pen). The diets were formatted from corn yellow, soybean meal, soybean oil, DCP, shell, mineral and vitamin premixes, salt, and some of synthetic essential amino acids. Chicks were fed ad libitum and provided water all of time. The feeding trial was lasted for 4 weeks. The result indicated that the ME 3,000 kcal/kg of feed and lysine 1.1% diet resulted in the most efficient feed conversion ratio.*

Keywords: metabolizable energy, lysine, H'mong broiler, growth, feed conversion ratio.

I. INTRODUCTION

Local H'mong chickens with black skin, bone and meat [1] and their meat contains high lysine and methionine giving it good taste when consumed [2].

Like other variety of chicken breeds, growth and development of H'mong broilers depend on several factors, especially metabolizable energy (ME) and protein of diets, which play a very important role. D'Mello [3] indicated that when CP content increases from 140 to 280 g/kg of diet, there is a marked and progressive reduction in the efficiency in use of the first-limiting amino acid (AA), lysine. Supplementation of protein for feed using efficiency on birds' growth belongs to better balanced essential AAs in the diets [4]. Moreover, the animal body only synthesizes proteins from patterns of balanced AAs and if unlimited AAs are provided, the diets will have unbalanced AAs. Birds' growth performance has maintained when essential AAs were supplied in the low-protein diets [5]. Besides, other studies have indicated that low-protein diets but adequate AAs still supported best for broilers' feed intake and growth ability [6]–[9].

Lysine is used as a reference AA for calculating ideal ratios, because it is a limited essential AA. Therefore, ideal AA ratios, with lysine as the reference AA, are being increasingly used throughout the world for diet formulation of poultry today [10]–[15]. Mack et al. [14] also found that the lysine requirement for maximal feed efficiency was substantially higher than that required for maximal weight gain. Hence, the lysine content of the diets was calculated according to high levels to investigate the growth performance of H'mong broiler breed in this study.

Supplementation of synthetic essential AAs in the low-protein diets has also restricted enviromental pollution by nitrogen [16]. Thus, the purpose of this study is to determine the effects of ME and lysine on growth of H'mong broilers from 0 to 4 weeks of age.

II. MATERIALS AND METHODS

Animals and experimental design: two hundreds and sixteen 0-day-old H'mong chicks were allocated into nine treatments in 3*3 factorials, 4 replicates, and 6 birds for each experimental unit. The first factor consisted of 3 levels of ME (3,000; 3,100; 3,200 kcal/kg of feed) and the second factor was of 3 levels of lysine (0.9%;

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1.0%; 1.1%). Methionine + cystine, threonine, and tryptophan followed the AA ideal profile of Baker [12]. All birds were raised in bamboo floor cages, continuous lighting, natural ventilation, and 27 - 30^{o}C of ambient temperature. The diets were offered ad libitum and water was freely available throughout the four-week trial.

Feed analyses and calculations: The feedstuffs were analyzed for dry matter (DM), crude protein (CP), crude fibre (CF), ether extract (EE), ash, calcium, and phosphorus by standard Weende methods [17] at the College of Agriculture and Applied Biology - Can Tho University. ME of soybean oil (SBO) was calculated by formulation of Ketels and DeGroote [18] $ME = 8.227 - 10.318^{[-1,168(\text{ratio unsaturated fatty acid : saturated fatty acid})]}$. AA contents were analyzed in Laboratory department of Animal nutrition - Institute of Agricultural Science for Southern Viet Nam. ME content of the feedstuffs was calculated from chemical analysis data using the equation of Kinh [19]. Yellow corn (YC): ME (kcal/kg of feed) = 19.0 +37.5CP + 78.5EE + 11.2CF + 37.7 NFE.

Soybean meal (SBM): ME (kcal/kg of feed) = -2.7 + 35.1CP + 96.7EE - 4.2CF + 28.6NFE.

Data collection: Birds were weighed to evaluate bodyweight gain (BWG) and feed was weighed to calculate their feed consumption every week. Weight, feed intake (FI), and feed conversion ratio (FCR) (g of feed/g of BWG) were measured for each week.

Data analysis: Analysis of variance was calculated with the General Linear Model procedure (GLM) in Minitab 13.2 [20].

III. RESULTS AND DISCUSSION

Effects of dietary ME on BWG, FI, and FCR of broilers: Table 3 shows that daily feed, ME, CP, and lysine intake; daily BWG; and FCR were significantly different among broilers in diets of three different dietary ME levels. The results of ME intake daily of birds decreased when the dietary ME was over 3,000 kcal/kg of feed. This finding is similar to the report by Lung and Man [21] that birds‘ FI was a negative correlation with the ME level of diets.

Summers [22] demonstrated that dietary energy concentration strongly influenced in FI, or the daily FI of birds negatively correlated with ME in the diets. Birds also decreased FI after obtaining adequate energy for their requirement [23]. Moreover, FI of broilers will decrease when the ME-containing diets increased from 2,600 to 3,200 kcal/kg of feed [24]. The amount of FI of H’mong broilers was equivalent to that of FI of 0-4 week-old broilers imported from Egypt at 10-34 g/bird/day in the researching result of Dat et al. [25]; at 10-34 g/bird/day in the study of Tam [26].

H’mong broilers consumed higher feed in treatments containing 3,000 kcal/kg of feed but lower ME compared to others. Previously, it was found that broilers still have good ability to control its FI based on desire requirement to normalize FI and to regulate its FI to supply for the lacks of dietary ME changes [27],. Moreover, Loi [28] found that ME consumed by local Ac broilers in high-ME-diets was higher than that of low ME diets because of the difference between ME of diets. However, ME consumed by H’mong broilers was 45.04-46.88 kcal/bird/day, which was lower than that consumed by broilers imported from Egypt at 53.7-55.5 kcal/bird/day [26].

Dozier et al. [29] pointed that caloric intake did not differ as dietary available ME increased because the broilers were able to adjust feed consumption abilities to achieve the similarity of caloric intake when provided diets varying in available ME. Therefore, caloric consumption per unit of BWG decreased as available dietary ME increased, but caloric intake per unit of total white meat was not affected by the dietary ME. In the current research, H’mong broilers adjusted the amount of FI in the diets varying ME to balance energy consumption, but broilers’ feed consumption was only regulated relatively.

In addition, CP consumption reduced when progressively increasing ME of diets. This was because CP concentrations of diets were similar, the broilers decreasingly ingested resulting in reduced CP consumption. H’mong’s daily CP intake was lower than that of broilers imported from Egypt at 3.9-4.02 g/bird/day [26]. Moreover, because there was difference of feed consumption among treatments, the amount of lysine was differently consumed by H’mong broilers.

Therefore, the birds’ BWG tended to reduce as they were provided with diets above 3,000 kcal/kg of feed. The BWG of H’mong was closely positive correlated to its consumed lysine (r =

Table 1: Chemical compositions of feedstuffs

Feedstuffs	DM (%)	Chemical compositions of feedstuffs (% of feed)									
		CP	ME (kcal/kg)	EE	CF	Lys	Met+cys	Thr	Trp	Ca	P
YC	86.90	7.59	3,236	3.31	4.84	0.21	0.28	0.25	0.05	0.63	0.29
SBM	87.50	42.74	2,512	2.35	7.35	2.23	1.14	1.51	0.52	0.63	0.67
SBO	-	-	8,227	-	-	-	-	-	-	-	-
DCP	-	-	-	-	-	-	-	-	-	24.11	19.29
Sell	-	-	-	-	-	-	-	-	-	29.22	-

Table 2: Diets and their nutrient values

Feedstuffs (kg)	ME 3,000 kcal			ME 3,100 kcal			ME 3,200 kcal		
	Lysine 0.9%	Lysine 1%	Lysine 1.1%	Lysine 0.9%	Lysine 1%	Lysine 1.1%	Lysine 0.9%	Lysine 1%	Lysine 1.1%
YC	56.18	55.81	56.06	54.49	53.25	53.52	54.17	53.40	52.99
SBM	38.45	38.6	38.03	37.97	38.9	38.36	36.56	36.99	37.00
SBO	2.48	2.58	2.65	4.5	4.71	4.77	6.24	6.42	6.57
L-Lysine-HCl	-	0.03	0.14	-	0.03	0.14	-	0.10	0.17
DL-Methionine	0.06	0.13	0.20	0.06	0.13	0.20	0.09	0.15	0.22
L-Threonine	-	-	0.03	-	-	0.03	-	-	0.05
DCP	2.00	2.02	2.02	2.15	2.15	2.15	2.11	2.11	2.17
Sell	0.10	0.10	0.14	0.10	0.10	0.10	0.10	0.10	0.10
Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
Total	100	100	100	100	100	100	100	100	100
Nutrient value (%)									
ME (kcal/kg of feed)	2,987	2,987	2,987	3,087	3,087	3,087	3,185	3,185	3,185
CP	20.76	20.89	20.88	20.42	20.82	20.83	19.83	20.11	20.77
EE	5.24	5.33	5.40	7.20	7.38	7.44	8.89	9.05	9.19
CF	5.55	5.54	5.51	5.43	5.44	5.41	5.31	5.30	5.28
Ca	1.10	1.11	1.12	1.13	1.12	1.12	1.11	1.10	1.11
P	0.81	0.81	0.81	0.83	0.83	0.83	0.81	0.81	0.82
Lysine	0.90	1.00	1.10	0.90	1.00	1.10	0.90	1.00	1.10
Met+cys	0.65	0.72	0.79	0.65	0.72	0.79	0.65	0.72	0.79
Threonine	0.72	0.72	0.74	0.71	0.72	0.74	0.68	0.69	0.74
Tryptophan	0.22	0.23	0.20	0.22	0.23	0.22	0.22	0.22	0.22

0.842) meaning that when decreasing lysine consumption, broilers obtained lower BWG. As the dietary ME also contained over 3,000 kcal/kg of feed, FI of broilers was limited. This resulted in decreasing some of the consumed nutrients in the diet, especially lysine contents.

H'mong broilers had higher ratio of dietary lysine to ME of the diet containing 3,000 kcal/kg of feed attained, as compared to that in the diets containing 3,100 and 3,200 kcal/kg of feed. Similarly, the findings of Kerr et al. [30]; Labadan et al. [31]; and Mbajiorgu et al. [32] found that the ratio of dietary lysine to energy did not have significant effects on feed intake, nitrogen digestiblity, and ME intake, but the high-ratio diets supported for optimum of growth rate and FCR.

Birds' greater FI in the higher-CP diets was found by Sengar [33] but that was opposite to the report of Waldroup et al. [24] in which low-CP diets significantly depressed appetite. Broilers increasingly fed at about ME levels (from 2,600 to 3,200 kcal ME/kg) showed no significant effects on performance parameters, although there was a decrease in FI and an improvement in feed conversion with increasingly dietary ME levels [24].

On the other hand, Holsheimer and Veerkamp [34] reported that BWG was 4.2% higher and feed conversion was 12.1% higher with increasing levels of ME. Performance parameters showed a linear increasing response when levels of 3,200; 3,400 and 3,600 kcal ME/kg were used for broiler chickens during the finishing phase

Table 3: Effects of ME on BWG, FI, and FCR of birds

Terms	Levels of ME (kcal/kg of feed)			SEM	P
	3,000	3,100	3,200		
FI daily (g/bird)	15.08^{a}	15.19^{a}	14.64^{b}	0.09	0.001
ME intake D (kcal/bird)	45.04^{b}	46.88^{a}	46.63^{a}	0.27	0.001
CP intake D (g/bird)	3.14^{a}	3.14^{a}	2.94^{b}	0.02	0.001
Lysine intake D (g/bird)	0.152^{a}	0.153^{a}	0.147^{b}	0.001	0.001
L/ME ratio intake (g/Mcal)	3.370	3.261	3.161	-	-
Initial BW (g/bird)	28.37	28.40	28.37	0.14	0.98
Final BW (g/bird)	193^{a}	190^{b}	182^{c}	0.67	0.001
BWG daily (g/bird)	5.90^{a}	5.77^{b}	5.48^{c}	0.03	0.001
FCR	2.44^{b}	2.50^{a}	2.49^{a}	0.01	0.001

a, b, and c: Means within each row with the same superscript letter are not significantly different ($P > 0.05$); D: daily, BW: bodyweight, L: lysine

[35]. These findings were collected on broilers with high growth and good feed conversion ability, the broilers gained better with increasing dietary ME exceeding 3,200 kcal/kg of feed. Conversely, as H'mong chicken breed is of low growth, they were raised by the diets over 3,000 kcal ME/kg of feed that resulted in decreasing FI and BWG.

The current BWG of H'mong at 4 weeks was equivalent to the investigating results of Van et al. [36]. However, it was lower than the findings of Van [37] and Hong et al. [2]. FCR of broilers differed signicantly and FCR increased when ME of diets was above 3,000 kcal/kg of feed. Birds' FCR of this research was lower than that of Van [37]; Quyen and Son [38]. This implied that if diets are balanced well, especially lysine, feed using efficency will be better.

Effects of dietary lysine on BWG, FI, and FCR of broilers: In Table 4, it is shown that feed, ME, and CP intake were not significantly different among trials. This indicated that increasing of dietary lysine from 0.9% to 1.1% did not change feed, ME, and CP intake. Lysine is a basal unit of protein and adding lysine to balance diets will also supply dietary CP. Hence, when supplying lysine into the dietary with fixed CP, FI was not influenced. The result also showed a low correlation ratio between lysine intake and feed consumption (r = 0.258). The study was likely in line with the report of Araújo et al. [39] that when supplying 0.95%; 1.05%; and 1.15% lysine into the diets, the feed consumption of broilers did not change.

However, lysine intake, BWG, and FCR of H'mong were significantly different and the amount of lysine intake also correlated closely with H'mong's BWG (r = 0.842). Moreover, increasing the amount of dietary lysine resulted in higher lysine/ME ratio and hence improving BWG.

Besides, as lysine is an AA to calculate other essential AAs following an ideal AA pattern, a little change of lysine content only influenced broilers' BWG. This was similar to the results of Baker et al. [15] that the broilers' diet containing 1.27% lysine had more BWG than that of 0.84% lysine. Also, Kidd et al. [40] supplied lysine to the broilers' diet at 105% compared with the requested level of Skinner et al. [41], recieved better BWG. Han and Baker [42] demonstrated that the more dietary lysine content supplied the better broilers' yield and carcass. Conversely, if broilers were raised by diets being lack of lysine, the birds' BWG reduced 45% compared with birds which were raised by diets with normal lysine levels [43]. Parr and Summers [6] also indicated that adding 10% lysine to the diets containing normal lysine requirement did not change growth performance of broilers.

Moreover, the correlation ratio between consumed lysine and FCR was -0.81 and this indicated that the ratio had closely negative correlation. This finding confirmed the results of Araújo et al. [39]; Han and Baker [42]; and Kidd et al. [40], which pointed out that the increased dietary lysine resulted in improved feed consumption efficiency of broilers. FCR of 14 old-day broilers was also better in excessive AA diets [41], [44], [45] and supplement of AAs in high levels will

Table 4: Effects of dietary lysine on BWG, nutrient intake, and FCR of birds

Terms	Levels of lysine (%)			SEM	P
	0.9	1.0	1.1		
FI daily (g/bird)	15.03	14.86	15.01	0.09	0.32
ME intake D (kcal/bird)	46.39	45.83	46.33	0.27	0.30
CP intake D (g/bird)	3.06	3.06	3.10	0.02	0.18
Lysine intake D (g/bird)	0.135[c]	0.150[b]	0.167[a]	0.001	0.001
L/ME ratio intake (g/Mcal)	2.918	3.275	3.599	-	-
Initial BW (g/bird)	28.31	28.46	28.37	0.14	0.75
Final BW (g/bird)	181[c]	186[b]	198[a]	0.67	0.001
BWG daily (g/bird)	5.45[c]	5.64[b]	6.05[a]	0.03	0.001
FCR	2.60[a]	2.50[b]	2.34[c]	0.01	0.001

a, b, and c: Means within each row with the same superscript letter are not significantly different ($P > 0.05$); D: daily, BW: bodyweight, L: lysine

ensure to provide AAs adequately. In addition, when the lysine content of diets increased, the FI of broilers consumed was lower, but bird's bodyweight did not change due to higher feed using efficiency [42]. As the level of dietary lysine increased 0.1% compared with the basal diet, BWG of birds was added more 0.19 g/bird/day, but FCR decreased 0.1 kg of feed over kg of BWG.

Effects of dietary ME and lysine on BWG, FI, and FCR of broilers: In Table 5, it is shown that feed, ME, CP, and lysine intake did not differ significantly. In contrast, the final bodyweight of birds was significantly different. This pointed out that there was an interaction between dietary ME and lysine. The present data supported the report of Boomgaardt and Baker [46], where broilers consumed lower lysine in high ME diets resulting in reducing BWG that did not influence lysine using efficiency. Leeson and Summers [47] pointed out that if diets contain adequately essential AAs, growth and development of birds would be good in the most sensible ME consumption. H'mong's BWG of the current study was higher than that of Noi birds of Quyen [48], similar to that observed by Van et al. [36], and lower than that result of Van [37].

The study also showed that diets containing three levels of ME interacting with 3 levels of lysine made significant difference of birds' FCR. With value of $P<0.01$ and delimitated analyzing results of treatment pairs, it was demonstrated that the main impact factor was the interaction between ME and lysine. FCR of H'mong of this study was lower than the research findings of Quyen and Son [38] that FCR of Noi broilers was 2.96-4.42 when birds were raised by the diets mainly based on ME and crude protein.

IV. CONCLUSION

0-4 week-age H'mong broilers should be raised by the diet containing ME 3,000 kcal/kg of feed and lysine 1.1% for better obtaining BWG and FCR.

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Table 5: Effects of ME and lysine of diets on BWG, nutrient intake, and FCR of birds

Factors	ME 3,000 kcal/kg of feed interacting with 3 levels of lysine			ME 3,100 kcal/kg of feed interacting with 3 levels of lysine			ME 3,200 kcal/kg of feed interacting with 3 levels of lysine				
Terms	0.9%	1.0%	1.1%	0.9%	1.0%	1.1%	0.9%	1.0%	1.1%	SEM	P
FI daily (g/bird)	15.05	15.11	15.07	15.25	15.00	15.31	14.79	14.46	14.66	0.15	0.67
ME intake daily (kcal/bird)	44.97	45.13	45.02	47.08	46.31	47.27	47.12	46.07	46.69	0.47	0.66
CP intake daily (g/bird)	3.13	3.16	3.15	3.11	3.13	3.19	2.93	2.91	2.97	0.03	0.69
Lysine intake daily (g/bird)	0.136	0.153	0.167	0.137	0.152	0.170	0.133	0.146	0.163	0.002	0.56
Lysine/ME ratio intake (g/Mcal)	3.013	3.381	3.716	2.915	3.272	3.596	2.826	3.171	3.485	-	-
Initial bodyweight (g/bird)	28.33	28.35	28.43	28.33	28.55	28.33	28.28	28.48	28.35	0.24	0.98
Final bodyweight (g/bird)	182^{ef}	190^{c}	208^{a}	183^{de}	189^{cd}	198^{b}	177^{f}	180^{ef}	188^{cd}	1.16	0.001
BWG daily (g/bird)	5.50^{ef}	5.77^{c}	6.41^{a}	5.54^{de}	5.73^{cd}	6.04^{b}	5.32^{f}	5.42^{ef}	5.70^{cd}	0.04	0.001
FCR	2.61^{a}	2.51^{b}	2.21^{d}	2.61^{a}	2.49^{b}	2.40^{c}	2.59^{a}	2.49^{b}	2.41^{c}	0.02	0.001

a, b, and c: Means within each row with the same superscript letter are not significantly different (P > 0.05)

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