EFFECTS OF METABILIZABLE ENERGY TO PROTEIN RATIOS IN DIET AT 1 TO 21 DAYS OF AGE ON PRODUCTION PERFORMANCE AND CARCASS CHARACTERISTICS OF F1 MIA × LUONG PHUONG CHICKEN

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ABSTRACT

An experiment was conducted to determine the optimal ME and CP ratios for F1 (Mia × Luong Phuong) chicken based on growth performance from 1 to 21 days of age and second, further investigate the influence of body weigh at day 21 on growth performance and carcass traits of F1 (Mia × Luong Phuong) chicken from 22 to 84 days of age. Two hundred dayold F1 Mia × Luong Phuong chicks were randomly allotted to treatments following a Randomized Complete Block Design. There were 4 replicates per treatment with 10 birds in each cage. The treatments used were four ratios of metabilizable energy (ME) to crude protein (CP) in diet of 150, 142.5, 135.7, 129.5 and 123.9. Result showed that there were significant differences in body weight (BW), body weight gain (BWG), average daily gain (ADG), Feed conversion ratio (FCR) among chicken groups fed diets containing different ME to CP ratios. There were no significant differences observed for average daily feed intake (ADFI) and acceptability across treatment. Crude protein efficiency of chicks fed diets containing ME to CP ratios of 142.5 or 135.7 were better ($P<0.05$) as compared to those fed diets containing 150, 129.5 and 123.9 of ME to CP ratios. While ratio of ME to CP in booster diets did not effect on the growth performance of grower, finisher phases and carcass yield.

Keywords: *booster diets, chicken, colorchicken, protein in diet, metabolizable energy.*

INTRODUCTION

Poultry production of Vietnam has been continued significantly growing at an average of 10.10% per annum in the last 4 year with about 481.080 million heads in 2019. The meat of poultry was obtained as the second largest meat sector with 1,302 thousand metric tons (GSO, 2019). Significant developments in genetics, management, health and nutrition are largely responsible for the rapid growth experienced today (Tran Thanh Van et al., 2015). Predilection for using native chicken, hybrid/color chicken of Vietnamese consumer has induced the amount of these that always accounts for high percentage in population (Tran Thanh Van et al., 2015a). Native chicken such as Ri, Mia, Ho, Dong Tao etc; and colored chickens like Luong Phuong, Tam Hoang, Kabir, SASO chicken and their hybrid comprise the most popular chicken under semi-intensive system in smallholders of Vietnam. These groups of chicken account for about 76.6% of poultry population (GSO, 2019) but nutrient research for them was unsystematic. Therefore, no nutrient specification apply for these groups. Nutrition requirement for native chicken, color chicken and their hybrid were applied from other group chicken which are found to be incorrect. Previous researches have been conducted to estimate ME to CP ratio of color chicken from 1 to 70 day of age (Tran Thanh Van et al., 2016) but information is limited for ME to CP ratio of native, color chicken and their cross during the starter period (1 to 21 days). Whereas Holsheimer and Ruesink (1993) and Kidd et al. (1998) suggested that the quality of diet in earlier feeding phases may have carryover effects on growth performance and carcass composition. Leeson and Summers (2009) indicated that a 1 g difference in day 7 body weight will be multiplied to 3 g at day 18 and 5 g at day 49. Therefore, the objective of this study was first to determine the optimal ME and CP ratios for F1 (Mia × Luong Phuong) chicken based on growth performance from 1 to 21 days of age and second, further investigate the influence of body weigh at day 21 on growth performance and carcass traits of F1 (Mia × Luong Phuong) chicken from 22 to 84 days of age.

MATERIALS AND METHODS

Location and time

The experiment was conducted in the Minh Chau farm of Thai Nguyen city of Thai Nguyen Province, while the feed samples were chemically analyzed by the Laboratory of Animal Science and Veterinary Medicine, Thai Nguyen University of Agriculture and Forestry. It was implemented from September 2018 to January 2019.

Experimental design

A total of 200 straight - run day old chicks of F1 Mia × Luong Phuong were randomly allotted to treatments following a Randomized Complete Block Design. There were 4 replicates per treatment with 10 birds in each cage. The treatments used were five ratios of ME to CP in diet of 150 (2850 kcal ME/19% CP), 142.5 (2850 kcal ME/20% CP) 135.7 (2850 kcal ME/21% CP), 129.5 (2850 kcal ME/22% CP) and 123.9 (2850 kcal ME/23% CP). All diets were formulated to meet or exceed the nutrient recommendations for colour feather broiler (TCVN 2265:2007)

Feeds and Feeding

The experimental diets were formulated based on Brill feed formulation program. The experimental birds were fed with self-formulated feeds booster rations. The birds were fed *ad-libitum*. The amount of feeds given and left over were measured and recorded experimental chickens were fed with different energy to protein ratios in the rations from 1 to 21 days of age. Chickens were fed with commercial feed from 22 to 84 days of age.

Table 1. Ingredients of nutritional value for chicken experiments period 1 to 21 days of age

Item / Ingredient, %	ME:CP ratios				
	150.0	***142.5***	***135.7***	***129.5***	***123.9***
Corn, yellow	62.41	62.34	62.24	62.00	61.79
Soybean meal	22.68	23.11	23.38	23.77	24.10
Soybean protein concentrate	6.00	6.00	6.00	6.00	6.00
Coconut oil	2.10	2.13	2.17	2.26	2.34
Monodicacil Phosphat 21	1.63	1.62	1.62	1.62	1.61
Blood cells dried	1.50	1.50	1.50	1.50	1.50
Limestone	1.40	1.40	1.40	1.40	1.40
Salt	0.47	0.47	0.47	0.47	0.47
Choline chloride 60%	0.25	0.25	0.25	0.25	0.25
DL – Methionine	0.51	0.40	0.38	0.30	0.24
L – Lysine HCl	0.40	0.30	0.21	0.11	0.02
L – Threonine	0.21	0.16	0.09	0.04	0.00
L – Valine	0.16	0.04	0.01	0.00	0.00
Vitamin premix[1/]	0.13	0.13	0.13	0.13	0.13
Mineral premix[2/]	0.10	0.10	0.10	0.10	0.10
Coccidiostat	0.05	0.05	0.05	0.05	0.05
Total	100.00	100.00	100.00	100.00	100.00

Item / Ingredient, %	ME:CP ratios				
	150.0	***142.5***	***135.7***	***129.5***	***123.9***
Calculated composition:					
ME, kcal/kg	2850	2850	2850	2850	2850
CP (N × 6.25), %	19.00	20.00	21.00	22.00	23.00
Crude fat, %	4.78	4.81	4.85	4.94	5.02
Ash, %	2.17	2.19	2.21	2.23	2.25
NDF, %	10.57	10.61	10.65	10.67	10.69
ADF, %	4.30	4.33	4.35	4.38	4.39
Ca, %	0.90	0.90	0.90	0.90	0.90
Available P, %	0.45	0.45	0.45	0.45	0.45
Linoleic acid, %	1.43	1.43	1.43	1.43	1.43
Standardized ileal digestible (SID, %) SID Lys	1.27	1.27	1.27	1.27	1.27
SID Met	0.69	0.67	0.66	0.65	0.64
SID Met + Cys	0.94	0.94	0.94	0.94	0.94
SID Thr	0.83	0.83	0.83	0.83	0.83
SID Val	0.95	0.95	0.95	0.98	1.03
SID Trp	0.20	0.21	0.23	0.24	0.26

[1/]The vitamins- premix contained the following quantities of vitamins per kilogram of premix: Vitamin A, 11,000,000 IU/kg; Vitamin D, 5,000,000 IU/kg, Vitamin E, 50,000 mg/kg; Vitamin K, 3,000 mg/kg; thiamine, 2,000 mg/kg; riboflavin, 7,000 mg/kg; pyridoxine, 3,000 mg/kg; niacin, 40,000 mg/kg; pantothenic acid, 15,000 mg/kg; vitamin B12, 15 mg/kg; folic acid, 1,5000 mg/kg;

[2/]The micro minerals- premix contained the following quantities of micro minerals per kilogram of premix:

Fe, 92,000 mg/kg; Cu, 7,500 mg/kg; Zn, 60,000 mg/kg; Mn, 50,000 mg/kg; I, 700 mg/kg; Se, 150 mg

The measurements taken

Feed, nutrient and ME intakes: dry matter (DM), organic matter (OM), ash, neutral detergent fiber (NDF). Chemical analyses of DM, OM, CP, EE, CF, NFE, NDF and ash followed the procedure of AOAC (1990) while ME was calculated according to (Rostagno et al., 2011).

Body weight. The initial weight, weight at day 21, day 49 and final (84 days old) weight of the experimental birds was gathered using an appropriate weighing scale.

Carcass characteristics. At 84 days of age, one male and one female bird from each replication were randomly selected for carcass data collection. Birds were fasted for 8 h, then weighed and dressed. Birds were killed by cutting the jugular vein, scalded, plucked and eviscerated. The abdominal fat was removed from the abdomen and gizzard and weighed immediately after evisceration using a precision scale. From the eviscerated carcass, skinless and boneless wing, thigh and drumstick were obtained and all cuts was weighed on a precision scale. Carcass yield, commercial cuts, and the relative weight of the abdominal fat was calculated relative to the bird body weigh at slaughter and expressed as a percentage.

Feed Consumption. The daily feed consumption of the experimental birds was monitored. This was done by weighing the leftover feeds in the trough at the end of the day and subtracting it from the total amount of feeds given for the day. This was done from beginning up to the end of the experiment.

Daily weight gain was measured by weighing the initial live weight and final live weight.

Feed conversion ratio was calculated by the daily feed intake and daily gain.

Statistical analysis

Data was analyzed using the MIXED procedure of SAS with cage as the experimental unit. The model included the diet as the fixed effect and block as the random effect. Least square means was calculated for each independent variable. When diet is a significant source of variation, least square means will be separated using the PDIFF option of SAS adjusted using a Tukey-Kramer test. The α-level that was used to determine significance and tendencies between means were 0.05 and 0.01, respectively.

RESULTS AND DISCUSSION

Growth performance

The growth performances of the experimental birds are shown in Table 2.

Table 2. Effect of varying ME to CP ratios on growth performance from d 1 to 21 days of age[1/]

Item	ME to CP ratios					SEM	*P-Value*
	150	*142.5*	*135.7*	*129.5*	*123.9*		
Bird weight, g							
Day 1	39.72	39.86	40.64	39.71	39.66	0.60	0.329
Day 21	199.92[b]	241.53[ab]	254.50[a]	246.06[a]	258.08[a]	11.26	0.010
Day 1 to 21							
BW gain, g	160.20[b]	201.67[ab]	213.86[a]	206.34[a]	218.42[a]	11.09	0.010
ADG, g	7.60[b]	9.55[ab]	10.18[a]	9.61[ab]	10.32[a]	0.50	0.007
ADFI, g	19.31	19.37	19.51	19.97	20.28	1.03	0.954
FCR	2.55[a]	2.03[b]	1.92[b]	2.09[b]	1.97[b]	0.10	0.004
Livability,%	95.00	97.50	100.00	95.00	97.50	2.42	0.526

[1/]Data are least square means of 4 replicate per treatment with 10 birds per replicate.

[a-b] Least square means with different superscripts in arrow differ (P<0.05)

Significant differences (P<0.05) were noted in BW, BW gain, ADG, FCR among chicks fed diets with different ME to CP ratios. Feeding 150 ratio of ME to CP diet resulted to be significantly (P<0.05) lowest BW, BW gain, ADG, FCR than other dietary groups. No (P>0.05) significant differences were observed for ADFI across the treatments. Ratios ME to CP in diets did not affect (P>0.05) livability.

Elmutaz et al. (2014) compared the effect of ME to CP ratios on growth performance of broiler chicks (Cobb × Cobb) from 1 to 21 d of age and showed that BW, BW gain, ADG and FCR of chicks fed ratio of ME to CP of 136 to 157 in diets were not significantly different. Progressive increase of the ratio from 157 to 186 adversely effected the performance. Their results indicate that BW and BWG of birds fed the diet containing ME to CP of 157 were greater than those fed with diets containing a ratio of 170 and 186.

Table 3. Overall growth performance of broilers fed with varying ME to CP ratios from d 1 to 21 of age[1/]

Item	ME to CP ratios					SEM	*P-value*
	150	***142.5***	***135.7***	***129.5***	***123.9***		
Bird weight, g							
Day 21	199.92[b]	241.53[ab]	254.50[a]	246.06[a]	258.08[a]	11.26	0.010
Day 49	807.83	784.03	815.14	801.70	791.30	27.32	0.917
Day 84	1697.03	1636.55	1742.40	1709.30	1693.3	70.45	0.808
Day 22 to 49							
BW gain, g	607.92	542.5	560.64	555.64	533.22	22.11	0.202
ADG, g	21.83	19.37	19.83	19.76	19.04	0.76	0.128
ADFI, g	59.37	57.39	55.53	60.155	56.35	3.04	0.659
FCR	2.72	2.96	2.81	3.04	2.96	0.13	0.448
Livability,%	100.00	100.00	97.50	97.50	100.00	1.58	0.573
Day 50 to 84							
BW gain, g	889.20	852.53	927.28	907.61	902.00	61.97	0.920
ADG, g	25.41	24.36	26.37	25.94	25.77	1.75	0.920
ADFI, g	101.72	98.86	97.99	104.50	98.50	5.37	0.880
FCR	3.99	4.10	3.76	4.14	3.84	0.28	0.880
Livability,%	100.00	100.00	97.50	100.00	100.00	1.12	0.444
Day 1 to 49							
BW gain, g	768.11	744.17	774.50	761.99	751.65	27.13	0.920
ADG, g	15.68	15.19	15.81	15.55	15.34	0.55	0.920
ADFI, g	42.06	41.01	40.09	42.39	40.83	1.85	0.826
FCR	2.69	2.70	2.55	2.73	2.67	0.11	0.699
Livability,%	95.00	97.50	97.50	92.50	97.50	2.58	0.573
Day 1 to 84							
BW gain, g	1657.30	1596.70	1701.80	1669.59	1653.64	70.17	0.810
ADG, g	19.73	19.01	20.26	19.88	19.69	0.83	0.812
ADFI, g	66.92	65.07	63.88	67.88	64.79	2.80	0.740
FCR	3.28	3.44	3.18	3.49	3.29	0.14	0.213
Livability,%	95.00	97.50	95.00	92.50	97.50	2.66	0.570

[1]*Data are least square means of 4 replicate per treatment with 10 birds per replicate.*

[a-b]*Least square means with different superscripts in a row differ ($P < 0.05$)*

Similarly, Hernández et al. (2012) studied the effect of ME to CP on growth performance of female Ross 308 and showed that ME to CP can be increased from 135 to 155 with suitable EAA supplementation without any adverse effect on performance of broiler chickens in the starter phase (day 8 to 21). In contrast Zaman et al. (2008) studied the effect of ME to CP on Starbro from 1 to 28 days of age raising under hot summer condition fed with 126, 138 and 152 ME to CP ratios showed that ME to CP ratio had quadratic effects on BW gain and FCR. The result also showed that the ratio of ME to CP in diets did not effect on feed intake. Their result indicated that BW and BW gain of birds fed the diet containing ME to CP of 138 was the best. The lower ME to CP ratios requirement in current research compared with estimates from Elmutaz et al. (2014) may be due to strain, time and location of experimentation, environmental conditions. The present study showed that higher ME to CP ratio requirement compared with estimates from Zaman et al. (2008) may be due to strain, time and location of experimentation and age of chicken. In addition, the present study findings suggested that similar levels of essential amino acid (EAA), diet with ME to CP of 150 failed to support the growth performance which were the same to that of 142.5, 135.7, 129.5 and 123.9 ME to CP groups. Poorer performance with high ME to CP ratios could be associated with lack of sufficient nitrogen for none essential amino acid (NEAA) synthesis. Therefore, when high ME to CP diet is fed, this excess is reduced, leaving less EAA available for conversion to the NEAA (Elmutaz et al., 2014)

From day 22 to 49, day 50 to 84, day 1 to 49 and day 1 to 84 no significant differences (P>0.05) in BW, BWG, ADG, ADFI, FCR and livability were observed among all the treatments (Table 3). This was expected as all chickens were fed a common grower and finisher diet. These results indicate that growth performance in the early chick phase may influence overall production performance; however, the magnitude of the difference decreases with age.

Efficiency of Protein Utilization

From 1 to 21 day of age, CP intake of chickens increased (P<0.05) with decreasing ME to CP ratio (Table 4) from 150 to 123.9. There were (P<0.05) significant differences in CP:BW gain when birds were fed from 123.9 to 150 ratios of ME to CP; however, CP:BW gain best (P<0.01) when birds were fed ratios ME to CP of 135.7. This suggests that this level is optimal requirement for ME to CP. No significant (P<0.05) different were observed between diets containing ME to CP ratios of 135.5 and 129.5. Protein efficiency with reduced protein content of the diet in our study was in agreement with the findings of Aletor et al. (2000) and Kamran et al. (2008). These results support the suggestion that formulating diets in ideal protein and amino acids pattern would lead to the best efficiency of protein utilization.

Caloric efficiency

From day 1 to 21, daily ME intake was unchanged regardless of the ME to CP ratio (Table 5). Caloric efficiency was improved (P<0.01) when chicks were fed diets containing ME to CP of 142.5, 135.7, 129.5 and 123.9. Caloric efficiencies were calculated using the total ME consumed and dividing it by the growth rate; therefore, a lower value equates to improved caloric efficiency. As a result, improving dietary caloric efficiency is an important tool to effectively reduce cost of production. This indicates that the ME to CP ratio for poorest caloric conversion is 150 ratio ME to CP.

Dressing percentage and carcass yield

Carcass yield (Table 6) did not (P>0.05) differ among the treatments regardless of the ME to CP ratio in the diet. Likewise, Kidd and Fancher (2001) evaluated the growth performance of male (Ross × Ross 508) broilers fed with varying levels of ME to CP ratios from d 1 to 19 of age, and reported that ME to CP level in booster phase did not affect carcass composition of broilers at day 42. Halima et al. (2016) also indicated that ME to CP ration in the booster diet is independent of the breast muscle weight of broilers at d 50.

Table 4. Effect of different energy to crude protein ratios on daily protein intake and efficiency of protein utilization of chicken (Day 1 – 21)[1/]

Item	ME to CP ratios					SEM	P-Value
	150	*142.5*	*135.7*	*129.5*	*123.9*		
CP intake, gr/d	3.67^{b}	3.88^{ab}	4.10^{ab}	4.39^{a}	4.66^{a}	0.22	0.037
CP efficiency, gr/kg BW gain	484.06^{a}	406.78^{b}	403.87^{b}	459.22^{a}	453.42^{a}	20.61	0.047

[1/]Data are least square means of 4 replicate per treatment with 10 birds per replicate.

[a-b] Least square means with different superscripts in arrow differ (P<0.05)

Table 5. Effect of different energy to crude protein ratios on daily ME intake and efficiency of ME utilization of chicken (Day 1 – 21)[1/]

Item	ME to CP ratios					SEM	P-Value
	150	*142.5*	*135.7*	*129.5*	*123.9*		
ME intake, kcal/d	55.05	55.21	55.61	56.90	57.80	2.95	0.954
Caloric efficiency, kcal/kg BW gain	7260.83^{a}	5796.59^{b}	5481.16^{b}	5948.99^{b}	5618.50^{b}	290.47	0.004

[1/]Data are least square means of 4 replicate per treatment with 10 birds per replicate.

[a-b] Least square means with different superscripts in arrow differ (P<0.05)

Table 6. Effect of different energy to crude protein ratios on carcass yield, %

Item	ME to CP ratios					SEM	P-Value
	150	*142.5*	*135.7*	*129.5*	*123.9*		
Dressing percentage, %	76.01	76.27	76.28	75.62	75.68	0.67	0.928
Breast yield, %	31.31	31.08	30.00	30.08	31.88	1.21	0.621
Breast muscle yield, %	21.09	20.98	21.01	20.98	20.43	0.51	0.647
Leg quarters yield, %	29.71	29.88	30.42	29.71	29.03	0.99	0.905
Leg quarter muscle yield, %	21.73	21.69	22.46	21.69	21.79	0.68	0.844
Wing yield, %	12.91	12.45	11.99	12.12	12.99	0.60	0.679
Abdominal fat yield, %	0.93	0.88	0.78	0.85	0.72	0.09	0.498

CONCLUSIONS

The result indicated that the optimum performance for F1 (Mia × Luong Phuong) chicken in the present experiment was obtained bybroiler fed diets formulated to contain ME and CP ratios of 142.5 or 135.7 from 1 to 21 days of age. Ratio of ME to CP in booster diets did not affect on growth performance of grower and finisher phases of F1 Mia × Luong Phuong chickens. No significant differences (P>0.05) in carcass characteristics were observed across all the treatments.

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