

RESPONSE OF DIFFERENT GENOTYPES OF BROILERS TO LYSINE SUPPLEMENTATION RAISED UNDER PRACTICAL CONDITION

B. Indarsih and M. H. Tamsil

*Faculty of Animal Science, Mataram University,
Jalan Majapahit No 62 Mataram, NTB Indonesia
Corresponding E-mail: budiindarsih@gmail.com*

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ABSTRAK

Penelitian ini dilakukan untuk mengevaluasi suplementasi lisine pada broiler komersial umur 4 sampai 42 hari. Percobaan faktorial dengan 2 strain (Arbor Acres dan Lohmann) yang dibedakan jantan dan betina sebanyak 450 ekor, kemudian ditimbang dan secara acak ditempatkan pada 60 kandang bambu ukuran 2 m² dalam bangunan kandang terbuka. Starter komersial diberi lisin mono-HCL dengan level 0,0; 0,5; 1,0; 1,5; dan 2,0 g/kg dari umur 4-21 hari, kemudian diberi pakan finisher komersial dari umur 22-42 hari. Konsumsi pakan dan pertambahan bobot badan diukur setiap minggu. Pada umur 43 hari, 4 ekor untuk setiap ulangan diambil sebagai sampel dan dipotong untuk mengukur parameter karkas. Hasil penelitian menunjukkan bahwa penambahan lisin pada ransum komersial meningkatkan berat karkas secara signifikan ($P < 0,05$), dan cenderung meningkatkan daging dada serta menurunkan lemak abdominal. Strain Arbor Acres merespon dengan baik pada pakan dengan lisin yang rendah sedangkan strain Lohmann merespon lebih baik pada pakan dengan lisin tinggi.

Katakunci: lisin, broiler, strain, daging dada, lemak abdominal

ABSTRACT

This study evaluated lysine supplementation of 4 to 42 day of age of two commercial broiler genotypes (Arbor Acres and Lohmann). Four hundred and fifty day-old chicks were sexed and randomly distributed into 60 bamboo pens each 2 m². A starter commercial diet as a basal diet was supplemented with lysine mono-HCL in a 2x2x5 factorial arrangement with lysine levels of 0.0, 0.5, 1.0, 1.5 and 2.0 g/kg fed from 4-21 days of age, and then followed by a finisher diet fed from 22-42 days of age. Feed consumption, body weight gain and FCR were determined on weekly basis. On d 43 of experiment, 4 birds per each replicate were processed for carcass parameters. Results of the study revealed that lysine supplementation in a starter commercial diet increased significantly carcass weight ($P < 0.05$). Improved breast meat and lower abdominal fat were found in lysine supplementation. Arbor Acres broilers response more efficient in low lysine whilst Lohmann broilers were better in a higher level of lysine.

Keywords: Lysine, broiler, genotype, breast meat, abdominal fat

INTRODUCTION

Responses between and even within a single genotype to different nutrition vary widely. However, differences in nutritional needs were the main factor influencing differences in the carcass, resulting in differences in body composition (Moran, 1994). This leads to differences in nutritional needs for growth, where one genotype was different from others, especially its response to protein and amino acids (Leclercq *et al.*, 1993; Sterling *et al.*, 2006). Praharaj *et al.* (2002) studied the interaction

between genotypes and dietary lysine content in commercial broiler chicks during the period post-hatching to 42 d of age. There was a significant genotype by dietary lysine interaction for body weights at 14 and 28 d of age.

Labadan *et al.* (2001) found the estimated lysine requirement for breast muscle growth of the 0- to 2-wk-old broiler ($1.32 \pm 0.01\%$) is substantially higher than the NRC (1984) or NRC (1994) estimates. For fast-growing chickens, age and sex affected the genetic potential for protein deposition (Samadi and Liebert, 2006; Dozier *et al.*, 2009) and there was a variation of energy and

protein requirements at different broilers (Cherry *et al.*, 1978).

Referring to Bartov and Plavnik (1998) that the amino acid levels recommended by NRC (1971, 1987, 1994) were less appropriate in some experimental circumstances. Therefore, some studies revealed the need to correct the proportion levels of crude protein to lysine (Harm and Russell, 1995; Labadan *et al.*, 2001). This is due to the fact that the lysine requirement is higher than the NRC (1994) requirement measured with the experimental situation (Lehmann *et al.*, 1996; Kerr *et al.*, 1999; Rezaei *et al.*, 2004; Aftab *et al.*, 2007; Indarsih and Pym, 2010). Breast meat deposition can be optimized on feeding at a higher level of lysine in the starter and finisher diets than those recommended by NRC (1994) as studied by Rezaei *et al.* (2004).

Lysine is one of the limiting amino acids in modern broiler diets and its inclusion in the diet of the several studies is intended to achieve optimal performance (Hosseini *et al.*, 2009; Viola *et al.*, 2009; Nasr and Kheiri, 2011) particularly for breast muscle growth (Moran and Bilgili, 1990; Labadan *et al.*, 2001; Queentin *et al.*, 2005). However, under the practical condition, efforts to maximize performance are impeded by insufficient supply of amino acids when the nutritional need for each genotype is not completely identified. In addition, most studies examined responses of broilers to lysine or amino acid requirements used the formulated diets based on the experimental condition (Labadan *et al.*, 2001; Praharaj *et al.*, 2002; Sterling *et al.*, 2006). Therefore, the following study was conducted to determine the response of different commercial broilers to lysine supplementation. And the specific objective of this work is to examine a standard commercial ration in terms of its applicability for broiler industry under practical condition.

MATERIALS AND METHODS

Birds and housing

Four hundred and fifty day-old chicks of commercial broilers obtained from two national commercial breeding companies were used in this study. These two commercial genotypes (strain 1 = Arbor Acres = AA; strain 2 = Lohmann = LN) were obtained on the same day (n=225 per genotype) and they were then wing banded and sexed by feather sexing. The birds were randomly

distributed into 60 bamboo cages of 1 m² each and were equipped with one hanging feeder and one rounded plastic drinker. A standard commercial diet was offered for the first 3-days of age, and then they were fed an experimental diet supplemented by lysine until 42 day of age. Birds were provided 24 hours of light was throughout the experimental period. Chicks were vaccinated at the hatchery for Marek's disease while Newcastle Disease vaccination was carried out during the study. Experimental diets were provided in crumble form for starter phase and pellet form for finisher phase. The birds were kept in an open-sided house with uncontrolled temperature or varied. Feed and water were available *ad libitum*. Environmental temperature was recorded daily.

Diets and Treatments

The experiment was in a completely randomized design (CRD) in a factorial arrangement. Two genotypes, five dietary treatments and two sexes were imposed in this study. The birds were divided into five groups with three replicates each 12 birds (180 birds/genotype), and fed a commercial starter diet containing 213 g CP/kg diet from d-old-chicks to 3 weeks of age, and then a commercial finisher diet containing 171 g CP/kg diet as a control group. Prior to study, feed were analyzed for crude protein, crude fat, and crude fiber (Table 1) according to the methods of the Association of Analytical Chemists (AOAC, 1990). The experimental diets were a commercial starter diet and supplemented with of 0.00, 0.5, 1.0, 1.5, and 2.0 g/kg lysine mono-HCL. Rice hulls were finely grounded to provide 1.0% of the amount of a finisher diet that serves as a dilution.

Measurement

Individual body weight of broilers was recorded at the beginning of the experiment and at 9, 16, 23, 30, 37 and 42 days of age thereafter. Feed conversion ratio (FCR) was calculated as the ratio between feed intake (FI) and body weight gain (BWG) taking into account in the calculation of dead chickens. Breast meat was measured by taking the breast meat to the left and right with the skinless and boneless. Abdominal fat was defined as fat around the abdomen, around vent and covering the gizzard.

At the end of the experiment on day 42, 4 broilers whose body weights were similar to the

Table 1. Chemical Composition of Commercial Diets Used (%)

	Starter Diet	Grower Diets
Crude Protein*	21.3	17.1
Crude Fiber	3.4	3.7
Crude Fat	3.5	5.5
Water	12.2	11.7
Ash	10.7	10.9
Calcium**	0.9	0.8
Phosphor	0.7	0.6

* Analyzed according to AOAC (1976)

** Information of manufacture

group average were selected from each of the replicate groups in each treatment. After a 12-h fast, birds were stunned with a knife, bled by severing the jugular vein, scalded in water for 1-1.5 min, and defeathered manually to determine percentage breast meat (BM) and abdominal fat (AF).

Data Analysis

Data were analyzed by ANOVA based on the General Linear Model (GLM) procedure using SAS version 6:21 (SAS Institute Inc., 1985). Genotype, sex and lysine were as main effects. When differences among means were found, means were compared using Duncan's new multiple range test (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Performance

Body weight gain, feed intake, feed conversion and final body weight of two different genotypes from hatching until the age of 42 days were presented in Table 2. Figure 1 and 2 are graphs of body weight gain (g/d) of each commercial broiler chicken in response to lysine supplied diet which were measured weekly.

This study demonstrated that increasing dietary lysine have no significant effects on all growth performance parameters measured. However, significant differences in FI, FCR and BW but not BWG due to genotypes were observed (Table 2). Genotype by dietary lysine interaction was not significant at 42 d of age for

BWG, FI, FCR and BW. In terms of BWG, male broilers have a greater response than female broilers to dietary lysine (Table 2 and 4) as expected. However, FCR for both sexes was not significant ($P>0.05$). This indicates that males required a higher level of dietary lysine than females for maximal BWG and dietary digestible lysine for FCR was higher than for BWG (Greenwood *et al.*, 2005; Dozier *et al.*, 2009; Dozier *et al.*, 2010; Indarsih and Pym, 2010; Mehri *et al.*, 2010). Male growing chickens gained faster than females due to higher daily feed intake in males (Samadi and Libiert, 2006) were also observed in this study.

In general, broilers fed with a standard commercial diet showed lower BW, providing evidence that lysine supplementation is essential to improve performance. This study found that the 2.0 g/kg lysine added diet resulted in the highest body weight at 42 d of age (2253 g) and with no lysine supplementation performed the lowest body weight in the control birds (2163 g). A better performance in a height lysine is related to a higher amino acid availability to muscle growth and the better efficiency rate of protein and energy in transforming into tissue synthesis and accumulation (Nasr *et al.*, 2011).

Responses of AA birds to an increment of lysine supplementation for BWG varied (Figure 1) whilst LN birds responded in a similar manner from hatching to 30 d of age (Figure 2). The average growth rate was 50.6 g/d and 47.5 g/d and the highest responses were in 0.5 g/kg lysine HCL (52.4 g/d) for AA birds and 1.0 g/kg lysine HCL (48.0 g/d) for LN birds respectively. The AA broilers were significantly more efficient than did LN broilers with FCR was 1.871 and 1.923 respectively. These are probably related to the differences in the ratio of synthesis and degradation of body proteins (Fatufe *et al.*, 2004). The present findings are consistent with Praharaj *et al.* (2002), Sterling *et al.* (2006), and Rack *et al.* (2009) who observed differences in response to CP and limiting amino acids in different genotypes.

Feed intake increased linearly in response to the incremental dietary lysine (Table 2). This is similar to previous studies reported by some workers (Sterling *et al.*, 2006; Aftab *et al.*, 2007; Viola *et al.*, 2009). However, this study also obtained at the highest feed intake did not increase the abdominal fat. These results corresponded with those of Hosseini *et al.* (2009) who observed an increase in feed intake of excess

Table 2. Effect of Sex, Strain and Dietary Treatment on Body Weight Gain (g), Feed Intake (g), FCR and Live Body Weight (g) of Commercial Broilers from Hatching until 42 Days of Age

Treatment		Gain (g)	Feed Intake (g)	FCR (g:g)	Live weight (g)
Lysine HCL (g/kg)	0.0	2028	3774	1.862	2163
	0.5	2046	3845	1.886	2196
	1.0	2066	3977	1.928	2199
	1.5	2069	3993	1.929	2210
	2.0	2083	4005	1.938	2253
Sex	Male	2140 ^a	4045 ^a	1.895	2245 ^a
	Female	1974 ^b	3791 ^b	1.923	2155 ^b
Genotype	AA	2083	3840 ^b	1.871 ^b	2214 ^a
	LN	2032	3996 ^a	1.947 ^a	2176 ^b
ANOVA	DF	Probabilities			
Lysine	4	0.9176	0.1091	0.4179	0.6390
Sex	1	0.0002	0.0003	0.3414	0.0186
Genotype	1	0.2170	0.0206	0.0001	0.3637
Lysine x Sex	4	0.7472	0.7325	0.4958	0.2040
Lysine x Genotype	4	0.2076	0.2156	0.5610	0.5788
Sex x Genotype	1	0.3305	0.1804	0.9937	0.2359
Lysine x Sex x Genotype	4	0.9958	0.5331	0.6853	0.0105
Error	59				

a-b Values within comparison with different superscripts indicate significantly different (P<0.05)

lysine diet was related to higher requirements for energy to support better metabolism of additional lysine.

Considerable research have reported that broilers fed low CP diet supplemented with essential amino acids, to some extent, could accurate growth depression (Hussein and Al-Batshan, 1999; Sterling *et al.*, 2006; Abdel-Maksoud *et al.*, 2010; Khan *et al.*, 2011). Lysine was one of the essential amino acids that are very critical primarily in the commercial feed in the tropical regions where the ambient temperature have a contributable effect on feed intake. The

low performance of the high temperature was because of the limited ability of chickens to release body heat (Gous, 1998; Ojano-Dirain and Waldroup, 2002). In warmer conditions (32°C) compared to 22°C, lysine would affect the metabolism of proteins (Tabiri *et al.*, 1998; Temim *et al.*, 2000), resulting to increasing the requirements of energy. In addition, at hot climate, high protein does not change the protein turnover (Temim *et al.*, 2000). Low performance in high temperature was due to reduced feed intake (Hussein and Al-Batshan, 1999; Faria Filho *et al.*, 2007) with a consequent effect was

Table 3. The Influence of Lysine Level on Breast Meat, Abdominal Fat and Carcass (g) of Broiler Genotypes from Hatching to 42 Days of Age

Treatments		Breast Meat (g)	Abdominal Fat (g)	Carcass (g)
Lysine HCL (g/kg)	0.0	337.5	46.7	1563 ^a
	0.5	337.9	45.3	1524 ^a
	1.0	351.1	49.0	1570 ^a
	1.5	332.0	48.6	1516 ^b
	2.0	354.7	45.7	1643 ^a
Sex	Male	358.1 ^a	46.9 ^b	1619 ^a
	Female	327.7 ^b	47.9 ^a	1485 ^b
Genotype	AA	339.2	46.1	1565
	LN	346.2	48.8	1538
Lysine	4	0.5595	0.7417	0.8848
Sex	1	0.0015	0.0112	0.0008
Genotype	1	0.5217	0.1131	0.5442
Lysine x Sex	4	0.4748	0.6319	0.9170
Lysine x Genotype	4	0.1169	0.2666	0.0430
Sex x Genotype	1	0.0867	0.0502	0.0085
Lysine x Sex x Genotype	4	0.3080	0.4959	0.5383
Error	99			
Total	118			

a-b Values within comparison with different superscripts indicate significantly different (P<0.05)

deficiency in other nutrient requirements particularly lysine intake.

Razuki *et al.* (2011) reported the differences between genotypes in BW to be genotype dependent. The differences between genotypes in their growth at high ambient temperature were related to their genetic potential for growth rate. For instance, BWG of Rose, Hubbard, Cobb and Lohmann from 29-49 d of age were 1032±15.89, 1017±16.90, and 1113±16.30 and 1051±15.89 g at environmental temperature 35-36°C. At the time of the study, the experiment was conducted in an open-sided house with ambient temperature can be categorized quite high with a range between 32-35°C. This condition mainly affects in the control group with no lysine supplementation which showed the lowest total

body weight gain than other groups. This is also supported by the data of lower total feed intake compared with the group receiving lysine supplementation (Table 2). When refer to the study of Temim *et al.* (2000), it was clear that at heat exposure changes specifically the requirements of some amino acids rather than protein requirements. Increasing utilization of the protein fraction of the diet may have caused an increase in the total heat increment metabolized (Rack *et al.*, 2009). Therefore, improvement in weight gain with the use of low CP diet supplemented with lysine was more likely due to a reduction in heat increment produced by the metabolism of excess proteins (Saima *et al.*, 2010). The low protein diet with ideal protein concept improved performance in heat exposure

Table 4. Live Weight, Breast Meat and Abdominal Fat of Two Different Genotypes Fed Supplemented Lysine from 4 to 42 Days of Age with SEM*

Geno- types	Lysine Supple- mentation (g/kg)	N	Male			Female		
			Live weight (kg)	Breast (% of live weight)	Fat (% of live weight)	Live weight (kg)	Breast (% of live weight)	Fat (% of live weight)
AA	0.0	12*	2.23±0.07	14.86±1.53	1.86±0.55	1.98±0.16	15.04±0.49	2.47±0.60
AA	0.5	12	2.46±0.16	15.27±0.79	1.89±0.52	1.99±0.07	15.03±2.15	2.04±0.46
AA	1.0	12	2.33±0.32	16.45±1.97	1.79±0.15	2.18±0.25	15.33±1.84	2.24±0.60
AA	1.5	11	2.53±0.34	14.58±1.08	1.88±0.36	1.99±0.16	15.33±1.21	2.61±0.74
AA	2.0	12	2.36±0.39	15.52±1.59	1.89±0.55	2.27±0.42	15.09±1.68	2.22±0.70
LN	0.0	12	2.35±0.25	15.64±1.02	2.02±0.39	2.28±0.29	15.95±1.92	2.18±0.41
LN	0.5	12	2.28±0.40	15.49±1.80	2.26±0.72	2.06±0.29	15.37±1.43	2.02±0.22
LN	1.0	11	2.23±0.86	15.56±0.77	2.36±0.83	2.05±0.18	16.58±1.69	2.62±0.57
LN	1.5	12	2.09±0.23	15.06±1.03	2.18±0.46	2.12±0.12	16.31±1.04	2.04±0.36
LN	2.0	13	2.26±0.29	16.90±0.01	2.16±0.74	2.04±0.08	16.20±0.70	2.55±0.48

*SEM = Standard Error Mean

broilers (Faria Filho *et al.*, 2007). Thus, it is possible that low performance broilers reared under practical condition which is mostly raised in different environment, lysine supplementation could eliminate the detrimental effects of high ambient temperature. This suggests that environmental temperature should be taken into account in formulating a diet when broilers are raised in an open –sided house.

In regard to the effect of sex for all variables measured, this study showed significant differences ($P<0.05$) except for feed conversion (Table 2). Males have demonstrated a better ability to use the feed to be converted into body weight. Males genetically have slow feathering growth than females which influence the different needs and use of dietary protein. Samadi and Liebert (2006) estimated the genetic potential for daily N deposition in fast growing chickens. They reported that daily protein deposition is depending on age and sex. Males gain faster from post-hatching to 45 d of age than females. Daily protein deposition increase from 11 to 21 g/d for males and 10 to 19 g/d for females respectively. In addition, it was shown by the study of Li and Nolan (2002) that the daily protein synthesis and

degradation rate for male broilers were higher than female broilers, suggesting that protein accretion rate in males was also higher than females. It is much clear that the need for lysine in males was higher than females.

Genotypes and Carcass Parameters

The results in Table 3 indicate that the 2.0 g/kg lysine supplemented in a commercial standard diet improved the carcass weight with no significant effect in breast meat and abdominal fat. Genotypes by dietary lysine interaction were not significant for the carcass composition measured, but the response of chicks to increasing dietary lysine level improved breast meat yield and reduced abdominal fat for both genotypes. AA broilers were heavier for dietary lysine supplementation; however, LN broilers had higher breast yields. In addition, AA broilers were more efficient in lower lysine supplementation (1.0 g lysine/kg diet) with the highest percentage of breast meat (16.45±1.97 g/kg) and the lowest abdominal fat (1.79±0.15 g/kg) (Table 4) or 383.36±70.72 and 41.65±5.92 g respectively (data not shown). Whilst, LN broilers showed better response in 2.0 g/kg lysine with the highest

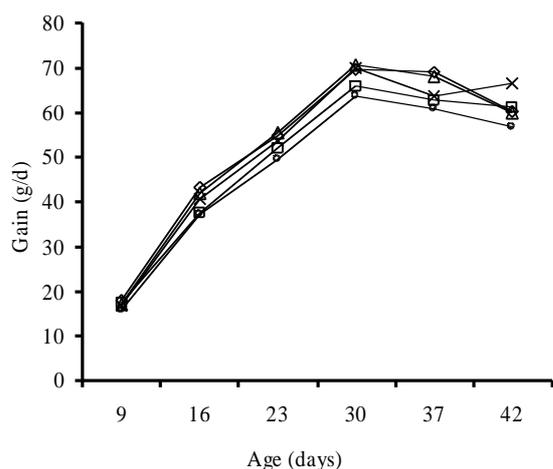


Figure 1. Gain (g/d) of Arbor Acres from 9 to 42 Day of Age at Different Lysine Supplementation (□:control; ◇:0.5; Δ:1.5; x :1.5 and ○:2.0 g/kg lysine mono-HCL)

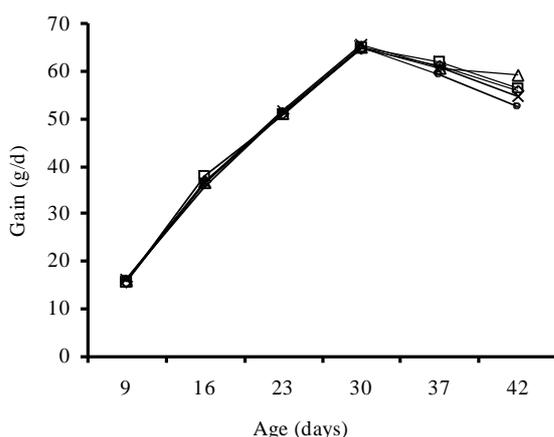


Figure 2. Gain (g/d) of Lohmann from 9 to 42 Day of Age at Different Lysine Supplementation (□:control; ◇:0.5; Δ:1.5; x :1.5 and ○:2.0 g/kg lysine mono-HCL)

percentage of breast meat (16.90 ± 0.01 or 380.3 ± 42.45 g) and lower fat (2.16 ± 0.74 or 48.76 ± 18.62 g) (data not shown). The present findings are consistent with Sterling *et al.* (2006) and Alawumi and Fagbuaro (2011) who showed the differences between genotypes in BW and carcass traits to be genotype dependent.

It is interesting to note that the reduction in breast meat in males fed with a standard diet with no lysine was larger than females (Table 4). This

indicates that males are more susceptible to low levels of dietary lysine in both genotypes and AA broilers require low level of dietary lysine. Hussein and Al-Batshan (1999) found that there is interaction between temperature, sex, dietary protein and lysine breast meat. Ojano-Dirain and Waldroup (2002) also observed that increasing dietary lysine (from 1.03 to 1.16%) of moderate heat-stressed (26.7°C) from 3 to 6 week-old male broilers significantly increased breast meat (from 22.99 to 23.55%) and reduced abdominal fat (0.832 to 0.663%).

In regard to effect of sex on carcass parameters, this present experiment showed that male broilers had higher value in carcass weight, breast weight and abdominal fat weight ($P < 0.05$) than females. Although digestible lysine of the basal diet was not determined, this study was supported by the observations of Garcia *et al.* (2006), who reported differences in digestible lysine requirement for males and females for breast meat deposition. The highest breast meat (379.4 ± 15.5 g) and body weight gain (1591.0 ± 27 g) of male broilers from 21 to 42 days of age due to lysine supplementation have been reported by Ghahri *et al.* (2010). These authors found the lysine requirement averaged $1.097 \pm 0.073\%$ and $0.907 \pm 0.0046\%$ with linear-broken line estimation at 22% and 18% crude protein for BM and BWG respectively. Thus, breast meat yield again was better in diet supplemented lysine, and the implication of this study is that lysine addition in a conventional standard diet is necessary and separated feeding system should also be considered to achieve the optimal performance.

CONCLUSION

The results of the present study demonstrated that different genotype broilers grown under conventional management practice in uncontrolled environment required different nutritional need. Lysine supplementation is more desirable to support the actual growth potential and breast meat yield of fast growing broilers particularly in which a conventional standard commercial diet was used. Low performance of particular genotypes was due to their nutritional requirement was not completely fulfilled.

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