

Effect of High-Protein Diet on Body Weight and *Pectoralis thoracicus* Muscle Performance on Pelung and Broiler Chicken (*Gallus gallus domesticus*)

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Abstract. The present study was conducted to determine the effect of high-protein diet on body weight and *Pectoralis thoracicus* muscle performance of Pelung and broiler chicken (*Gallus gallus domesticus*) from 1 to 14 days of age. Sixty broilers and Pelung day old chickens (DOC) were fed with high-protein diet containing 25% crude protein (CP) and low-protein diet containing 10% crude protein. The birds were divided into 4 groups, each contained 15 birds. As the control groups, group 1 and group 2 (broilers) were given high protein diet and low protein diet, respectively for 14 days, while group 3 and group 4 (Pelung chickens) were fed on high protein diet and low protein diet, respectively for 14 days. All birds were grown up to 14 days. Variables measured were body weight, *Pectoralis thoracicus* weight and area, and myofiber diameter. At 1; 7 and 14 days, pectoralis muscles were dissected and measurements were conducted. Data were statistically analyzed using the ANOVA of One Way Classification, followed by Tukey test. The results showed that Pelung chicken have lower body weight, *Pectoralis thoracicus* weight and area, and myofiber diameter compared to broiler chicken. Pelung chicken fed on high-protein diet showed higher body weight, *Pectoralis thoracicus* weight and area, and myofiber diameter at 7 and 14 days compared to the Pelung fed on low-protein diet. In conclusion, high-protein diet succeeded to support body weight and *Pectoralis thoracicus* muscle performance in broiler and pelung chickens.

Keywords: High-protein diet, Pelung chickens, *Pectoralis thoracicus* muscle

Abstrak. Penelitian bertujuan untuk mengetahui pengaruh pakan berprotein tinggi terhadap bobot badan dan performans otot *Pectoralis thoracicus* ayam pedaging dan ayam Pelung. Enam puluh ekor anak ayam umur sehari (DOC) yang terdiri atas 30 ekor ayam pedaging (galur Cobb 500) dan 30 ekor ayam Pelung dengan bobot antara 30-40 gram digunakan pada penelitian ini. Ayam dibagi dalam 4 kelompok dan masing-masing kelompok terdiri dari 15 ekor DOC. Kelompok pertama sebagai kontrol adalah DOC ayam pedaging yang diberi pakan yang mengandung protein tinggi yaitu 25%. Kelompok kedua, DOC ayam pedaging yang diberi pakan protein rendah yaitu 10%. Kelompok ketiga, DOC ayam Pelung yang diberi pakan berprotein tinggi dan kelompok keempat, DOC ayam Pelung yang diberi pakan rendah protein. Ayam dipelihara selama 14 hari. Variable yang diukur meliputi bobot badan, bobot dan area otot *Pectoralis thoracicus*, dan diameter miofibril. Data dianalisis dengan analisis variansi, dilanjutkan dengan Uji Tukey. Hasil menunjukkan bahwa ayam Pelung memiliki bobot badan, bobot dan luas area otot, dan diameter miofibril yang lebih rendah dibanding ayam pedaging. Ayam Pelung yang diberi pakan berprotein tinggi menghasilkan bobot badan, bobot dan luas area otot *Pectoralis thoracicus* dan diameter miofibril pada hari ke 7 dan 14 yang lebih tinggi dibanding ayam Pelung yang diberi pakan rendah protein. Berdasarkan hasil penelitian dapat disimpulkan bahwa pemberian pakan protein tinggi pada ayam broiler dan Pelung dapat meningkatkan bobot badan dan penampilan otot *Pectoralis thoracicus* pada bagian otot dada.

Kata kunci: Pakan protein tinggi, ayam pelung, otot *Pectoralis thoracicus*

Introduction

Consumers in Indonesia are very concerned with local chickens because of the unique meat quality. The problem is that local chicken meat supply is lower than demand (Balai Penelitian dan Pengembangan Pertanian, 1999). According to Department of Agriculture Indonesia (2008), population of local chickens in 2007 was 317.400 and broiler was 920.851. Product capacity of local chickens in 2007 was 349 tons while broiler was 918 tons.

Many problems make the product capacity of chickens low, for example the weight growth of local chicken is lower than that of broilers. To reach 1 kg body weight, local chickens need 3-4 months while broilers only need 1 month (Iskandar, 2004; Scheuermann, et al., 2004). Indonesian local chicken potential for the meat is Pelung chicken. The size of Pelung chicken body is more likely to increase than local chickens which have small body size (Iskandar, 2006).

Potential broilers usually have good performance and muscle development. Muscles are constructed by many myofibers which are the main component of muscle. The number of myofiber in chicken muscles has a good correlation with acceleration of weight growth and chest muscles (Scheuermann et al., 2004).

Increasing growth in broilers is also influenced by nutrition. Starter weft containing crude protein 23%, lysine 1.21%, metionin+cystein 0.91% and thyrosin 0.84% can increase weight body after hatching (Wang et al., 2006). Weft with high protein has a good digest character, can increase the number of myofiber and satellite cells in chicken chest muscle (*Pectoralis thoracicus*) 3 days after hatching (Mozdziak et al., 2002).

Research about the effect of high protein weft into performance of *Pectoralis thoracicus* muscles at Pelung chicken was not reported. In this research, the experiment was designed to

observe the effect of high protein weft on acceleration of weight body and performance of *pectoralis thoracicus* muscles. This research is applicable to increase the potency of Indonesian local chicken meat and chicken poultry with high economy value to increase prosperity.

Materials and Methods

Birds and Housing

Sixty day old chicks (DOC), separated by strain Cobb 500, consisted of 30 broilers as control group and 30 Pelung chickens as treatment group. All birds were housed in semi intensive system and kept under standard management conditions. Water was provided ad libitum throughout the experimental period. Percentage of crude proteins in high-protein diet was 25% with metabolism energy (ME) about 2950-3050 Kcal/kg, and level crude protein in low-protein diet was 10% with metabolism energy (ME) about 2640 Kcal/kg.

Methods

Chickens were divided into 4 groups, each consisted of 15 DOCs. Group 1 (control) had DOC from the offspring of two parental strain Cobb 500 fed on high- protein diet (HP). Group 2 had DOC from the offspring of two parental strains Cobb 500 fed on low-protein diet (LP). Group 3 had DOC from the offspring of two parental Pelung chickens fed on HP for 14 days. Group 4 had DOC from the offspring of two parental Pelung chickens fed on LP for 14 days. Feed was provided ad libitum during the experimental period. Five DOCs from each group were counterweighed at 7 and 14 day, and then slaughtered to observe the weight of pectoralis superficialis (PS). The muscle weight of left PS was weighed then the right PS was used to count the width of Pectoralis thoracicus area with ott planimeter (Figure 1). The diameter of myofiber was measured with software micrometer from histological

preparation. Histological preparation started by cutting the Pectoralis thoracicus in smaller piece about 3x3 mm, and then fixating with Bouin's, followed by dehydration with alcohol from 70% to absolute alcohol. Clearing process or dealcoholization used toluol compound. Furthermore, infiltration process was done using paraffin then embedded with paraffin wax. Paraffin blocks were cut by rotary microtome in 5 μ m and then affixed to preparation glass. The next step is deparaffination and rehydration with xylene and alcohol (McManus dan Mowry, 1960).

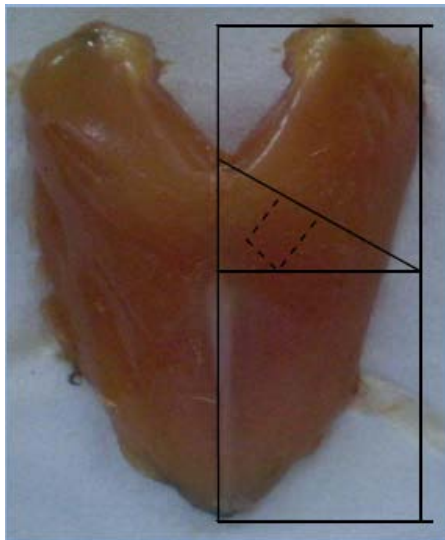


Figure 1. Schematic of *Pectoralis superficialis* muscle which are still attached to the bone. Taking sample of muscle used by lateral cutting with orientation (.....) then histological process to count myofiber diameter. Sign (-----) used to perform size of muscle area and tissues cutting for counting myofiber diameter

Statistics

Data of chicken weight, weight of Pectoralis superficialis, area of Pectoralis thoracicus and myofiber diameter were analyzed using a 1-way ANOVA, with LSD-test and Tukey-test at significance level 5%. All statistical analyses used SPSS 13.0 software (SPSS Science, 2006).

Results and Discussion

Weekly body weight measurement for 2 weeks showed that feeding high protein (crude protein 25%) in broiler chickens showed significant difference compared to groups of broiler and Pelung fed on low protein and Pelung fed on high protein (Table 1). Longo et al., 2007 reported that the adequate protein availability in the prestarter phase seemed to be essential to increase muscle development in later phases. Prestarter diets that contained highly available carbohydrates and proteins could be used to avoid gluconeogenesis, contributing to maintain the body reserves. Early diet manipulation in chickens can modify their growth and fat accumulation. Weight gain in group 2 and 4 was lower than that of Pelung chickens fed on high protein. Report by Kamran et al., (2008) was that feeding broiler chicken on diets containing low CP with a constant ME:CP ratio has adversely affected the growth performance even when standard levels of critical AA were maintained in the diets. The birds provided with low-CP and low-ME diets had increased feed consumption, but this increase could not compensate for the reduced growth and did not allow for complete recovery of final BW. The difference in rate and efficiency of growth probably occurred due to poor efficiency of utilization of ME and CP, although critical AA was according to the requirements. This might be due to inadequate levels of 1 or less essential AA like Arg, Ile, and Val in the low-CP diets, because levels of these AA were not taken care, and these lesser-essential AA can be a limiting factor when CP is reduced. The chick starter feed which has a percentage of crude proteine 23%, 1.21% lysine, methionine + cystein thirosin 0.91% and 0.84% made improvement in body weight gain during posthatch period (Wang et al., 2006). Broilers fed on HP diets gained weight more

significantly than other treatment groups. These results might be due to the potential of broiler chickens. Zuprizal (2008) reported that broiler chickens in growth period of 14 to 21 days had high trypsin and protease enzymes, yet after 3 weeks the digestive enzyme would decrease. Similarly, the effect of age to intestinal absorption of amino acid, the lysine absorption of young chicken was better than that of old chicken. The implication was recently called as pre starter feeding (feed was consumed in early week of chicken growth). Pre starter feeding contains crude protein more than 25% or much more than 25%. The feeding must be highly intestinal absorption and amino acid balance mainly essential amino acid such as lysine. Pectoralis thoracicus weight and Pectoralis thoracicus muscle area in group 1 was higher ($P<0.05$) at 7 and 14 day of post hatch than all other treatments (Table 2 and 3). In group 2 and 4, Pectoralis thoracicus weight and Pectoralis thoracicus muscle area were smaller ($P<0.05$) than high-protein diet pelung chicken in group 3 (Table 2 and 3). High-protein diet broiler chick in group 1 had a greater ($P<0.05$) myofiber diameter at 7 and 14 d post hatch compared to all other treatment (Table 4 and Figure 2). Myofiber diameter of the high-protein diet Pelung chickens in group 3 was higher ($P<0.05$) than chick in group 2 and 4 at 14 d posthatch (Table 4).

Jones et al. (1986) showed that differences in muscle size can be caused by differences in the number and diameter of miofiber. Chickens in prestarter phase had an active satellite cells are responsible for the accumulation of nuclei in miofiber. Nutritional factors have an effect on these cells and contribute to muscle size and proportion miofiber broilers. Modziak et al. (2002) states the effect of nutrition on the early phases of the birth of chicken, altering satellite cell mitotic activity during the early phase of growth in young muscle has a profound impact on ultimate muscle size because myonuclear

accretion through the fusion of satellite cell nuclei is necessary for myofiber hypertrophy. Another possibility concerns for cell size at a young age appears that increases in DNA unit number through satellite cell fusions are the major determinant of ultimate muscle size (Modziak et al., 2002). Modziak et al., 2002 showed that highly digestible high protein diet could increase the number of satellite cells in Pectoralis thoracicus 3 d post hatch chickens. The significant difference on pectoralis muscle weight of broiler and Pelung chicken fed on high protein diet indicated a genetic influence on muscle growth (Burke et al., 1997).

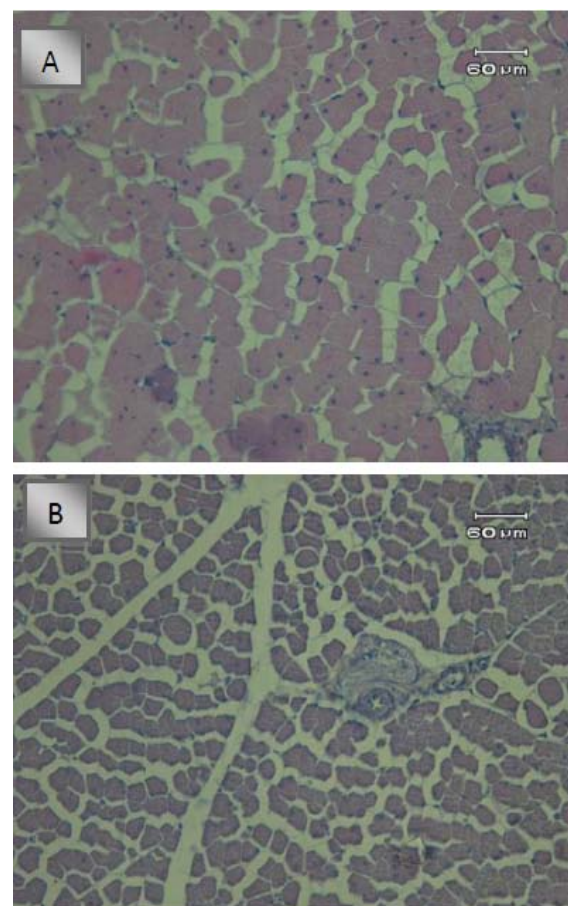


Figure 2. Histological microscopy of miofiber *Pectoralis thoracicus* muscle A. myofiber diameter of pelung chicken 14 days with high-protein diet (CP 25%). B. myofiber diameter of pelung chicken 14 days with low-protein diet (CP 10%).

Table 1. Average of broiler body weight (gram) and pelung chicken with high and low protein diet since 0 day until 14 days

Day	N	Groups			
		Broiler (high protein)	Broiler (low protein)	Pelung (high protein)	Pelung (low protein)
0	5	43.6±2.24	44±1.58	28.8±0.37	29.8±0.66
7	5	104.2±2.54	64±2.35 ^a	67.8±2.65 ^a	41.4±1.25 ^{ab}
14	5	392.2±9.94	95±4.13 ^{ab}	149±7.28 ^a	73±4.23 ^{ab}

^asignificant with broiler high protein diet (P<0,05); ^bsignificant with pelung chicken high protein diet (P<0,05)

Table 2. Average of *Pectoralis thoracicus* muscle weight (gram) from broiler and pelung chicken with high and low protein diet since 0 day until 14 days

Day	N	Groups			
		Broiler (high protein)	Broiler (low protein)	Pelung (high protein)	Pelung (low protein)
0	5	0.29±0.12	0.29±0.12	0.29±0.01	0.29±0.01
7	5	3.68±0.21	0.86±0.07 ^{ab}	1.79±0.04 ^a	0.49±0.04 ^{ab}
14	5	24.46±0.97	2.13±0.03 ^{ab}	6.66±0.47 ^a	2.57±0.45 ^{ab}

^asignificant with broiler high protein diet (P<0,05); ^bsignificant with pelung chicken high protein diet (P<0,05)

Table 3. Average of *Pectoralis thoracicus* muscle area (mm²) broiler and pelung chicken with high and low protein diet since 0 day until 14 days

Day	N	Groups			
		Broiler (high protein)	Broiler (low protein)	Pelung (high protein)	Pelung (low protein)
0	5	196±11.6	188±16.2	302±20.3	312±14.2
7	5	1088±28.17	532±18.8 ^{ab}	758±21.7 ^a	432±37.2 ^{ab}
14	5	2896±148.61	862±36.11 ^a	1232±27.46 ^a	820±105.3 ^{ab}

^asignificant with broiler high protein diet (P<0,05); ^bsignificant with pelung chicken high protein diet (P<0,05)

Table 4. Average of miofiber diameter (μm²) broiler and pelung chicken with high and low protein diet at 7 and 14 days

Day	N	Groups			
		Broiler (high protein)	Broiler (low protein)	Pelung (high protein)	Pelung (low protein)
7	5	127.11±11.86	40.06±4.06 ^{ab}	129.55±3.44	26.16±2.84 ^{ab}
14	5	368.68±22.8	60.69±3.41 ^{ab}	235.41±12.88 ^a	137.99±25.56 ^{ab}

^asignificant with broiler high protein diet (P<0,05); ^bsignificant with pelung chicken high protein diet (P<0,05)

Conclusions

1. High-protein diet with concentration of crude protein 25 % with metabolism energy (ME) about 2950-3050 Kcal/kg take a significant effect for acceleration of broiler and pelung chicken body weight
2. Weight of *Pectoralis superficialis* muscle, *Pectoralis superficialis* muscle area and

myofiber diameter of *Pectoralis superficialis* muscle broiler and pelung chicken with high-protein diet significantly different with broiler and pelung chicken with low-protein diet

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