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Phenotypic Performance of *Kambro* Crossbreeds of Female Broiler Cobb 500 and Male *Pelung Blirik Hitam*

(PERFORMA FENOTIPIK KAMBRO HASIL PERSILANGAN ANTARA BETINA BROILER COBB 500 DAN JANTAN PELUNG BLIRIK HITAM)

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ABSTRACT

This research was conducted to measure the phenotypic performance of *Kambro* crossbreeds of *Pelung Blirik Hitam* and Broiler Cobb 500. Based on Body Weight (BT) measurement, the *Kambro* population (n = 17) has an average BT of 1,244.14 ± 453.82 grams significant (p<0.01) to F_1 *Pelung* (n = 7) with an average BT of 602.88 ± 79.93 grams in 8-weeks period with *ad libitum* diet of standard feed. Phenotypic performance of *Kambro* significant to F_1 *Pelung* based on the measurement of linear bodyweight parameter, vitality parameter, PPa-PBe parameter, and phenotype parameter. *Kambro* has the phenotype combination of parental generation based on phenotype parameters. PPa parameter was suitable BT estimation model based on non-linear quadratic regression (r = 0.956) with formula 1.84E3 ±3.54E2*x+31.73*x^2. The difference between the chicken group (p<0.014) was significant to BT and the interaction between the group and linear bodyweight parameter was not significant based on ANCOVA. The mortality rate of *Kambro* was lower than F_1 *Pelung* with the absence of vaccination in a semi-intensive rearing system. As the size of the hybrid's population was limited, research findings must be validated with a larger population size of the hybrid.

Keywords: Broiler Cobb 500; grandparent stock; *Kambro*; *Pelung Blirik Hitam*; selective breeding.

ABSTRAK

Riset ini diadakan dengan tujuan mengukur performa fenotipik Kambro hasil persilangan antara Pelung Blirik Hitam dan Broiler Cobb 500. Berdasarkan pengukuran Bobot Tubuh (BT), rerata BT Kambro (n = 17) mencapai 1.244,14 ± 453,82-gram signifikan (p<0,01) terhadap F_1 Pelung (n = 7) dengan rerata BT 602,88 ± 79,93-gram pada umur 8 minggu dengan diet pakan standar *ad libitum*. Performa fenotipik Kambro signifikan terhadap F_1 Pelung berdasarkan parameter bobot tubuh linear, parameter vitalitas, parameter PPa-PBe dan parameter fenotipe. Kambro memiliki perpaduan fenotipe indukannya berdasarkan parameter fenotipe. Parameter PPa merupakan model estimasi BT Kambro berdasarkan regresi *non-linear quadratic* (r = 0,956) dengan formula 1,84E3 ± 3,54E2*x+31,73*x^2. Perbedaan grup antar grup signifikan (p<0,014) terhadap BT dan tidak terdapat interaksi antara grup dan parameter bobot tubuh linear berdasarkan ANCOVA. Tingkat mortalitas Kambro lebih rendah dibandingkan F_1 Pelung tanpa vaksinasi dengan sistem pemeliharaan semi-intensif. Sebagai akibat dari ukuran populasi hibrida terbatas, temuan riset harus divalidasi dengan ukuran populasi hibrida lebih besar.

Kata kunci: Broiler Cobb 500; *grandparent stock*; Kambro; Pelung Blirik Hitam; persilangan selektif.

INTRODUCTION

Pusat Data dan Sistem Informasi Pertanian (2015) stated that the chicken meat consumption rate of 2014 reached 4.48 kg/capita/year (total consumption of broiler chicken, post-laying layer chicken, and male layer also native chicken). The chicken poultry sector contributed around 60.73% of the demand on animal consumption needs fulfillment (Suprijatna, 2010). Ditjen PKH (2017) showed that native chicken production nationally reached 8.50 % or 284.9 thousand tons with a contribution percentage of 12.86 % to national chicken meat production. Ditjen PKH (2018) showed that Indonesia's poultry livestock populations in 2018 consisted of 1.8 billion-broiler-type/broiler chickens, 181.752-layer chickens, and 310.960-native chickens. Broiler-type and laying-type chicken poultry industry went through significant growth per year driven by improvement in income and knowledge on healthy nutritional-balance food products (Iskandar, 2017). The chicken poultry industry in Indonesia is still dependent on imported broiler caused by a short production period and rapid turnover (Nurfadillah *et al.,* 2018).

Native chicken has unlimited potential to become broiler-type, egg-type, and dual-purpose chicken candidates to fulfill domestic consumption needs of animal-based food through selective and genetic engineering (Nataamijaya, 2010; Henuk and Bakti, 2018; Kartika *et al.,* 2016). Native Indonesia chickens are called *Kampung* chickens or native (non-breed chickens) to differentiate commercial breeds such as Cobb, Hubbar, Hybro, Isa Hyline, and Hisex (Henuk and Bakti, 2018). Identification of native chicken germplasm resulted in 34 breeds of chicken consist of *Ayunai, Balenggek, Banten, Bangkok, Burgo, Bekisar, Cangehgar, Cemani, Ciparage, Gaok, Jepun, Kampung, Kasintu, Kedu (Hitam* and *Putih), Pelung, Lamba, Maleo, Melayu, Merawang, Nagrak, Nunukan, Nusa Penida, Olagan, Rintit* or *Walik, Sedayu, Sentul, Siem, Sumatera, Tolaki, Tukung, Wareng, Sabu,* and *Semau* (Henuk and Bakti, 2018). Approximately 11 native chicken breeds are categorized as candidates of broiler-type and laying-type chicken (Henuk and Bakti, 2018). Native Indonesia chickens have to be maintained optimally to support small-scale poultry industry based on native chickens. Native Indonesia chicken's germplasm can be the solution for fulfilling the increasing domestic food consumption demand (Daryono *et al.,* 2010). Ningsih and Prabowo (2017) stated that various challenges faced by poultry industry sub-sector especially broiler, besides market integration several factors including production, productivity, and competitiveness of poultry product. Nurfadillah *et al*. (2018) stated that the agribusiness problem in the subsystem of broiler chicken poultry is economic efficiency in poultry level added by high-cost production inflicted by dependence on imported raw-material of feed. Improvement of efficiency and poultry product quality are decided by the supply of superior chicken breed, feed demand fulfillment, and good rearing management system (Anggitasari *et al.,* 2016). Improvement of productivity and competitive quality of local broiler chicken can be achieved through selective breeding of native Indonesia chicken breeds. Selective breeding is aimed to produce superior chicken breed with adjusted phenotype quality based on human needs (Das *et al.,* 2008; Cheng, 2010; Oldenbroek and van der waaij, 2014; Mariandayani *et al.,* 2017; Sudrajat and Isyanto, 2018).

Pelung Blirik Hitam has several distinguished characters such as posture and body weight compared with other native breeds (Daryono *et al*., 2010). The bodyweight of males *Pelung* chicken can reach 3.37 kg and females can reach 2.52 kg (Daryono *et al*., 2010). Broiler Cobb 500 has distinguished productivity and a high growth rate in the grower phase (7 to 18 weeks). Male and female Broiler Cobb 500 can reach 1,599.17 grams and 1,540.46 grams (Hassan *et al.,* 2016). This research is aimed to measure the phenotypic performance of hybrid chicken *Kambro* based on research conducted by Tamzil *et al*. (2018) to *Cairina moschata* and Daryono *et al*. (2010) to hybrids from crossbreeds of *Pelung* with *Cemani* with the addition and adaptation of measurement parameters. Measurement parameters used in this research are estimation model of body weight, body weight growth, linear bodyweight parameter, mortality rate, phenotypes, and vitality parameter. Empowerment of native Indonesia chicken can contribute to the availability of food sources and support native Indonesia chicken germplasm conservation (Suprijatna, 2010; Sudrajat and Isyanto, 2018).

RESEARCH METHODS

This research was conducted in Pusat Inovasi Agroteknologi (PIAT), Kali Tirto, Berbah, Sleman Regency, Yogyakarta using 4 females Broiler Cobb 500 and 1 male *Pelung Blirik Hitam*, 1 female *Pelung Blirik Hitam*, 7 F_1 *Pelung* chickens, 22 Broiler Cobb 500 chickens and 17 *Kambro* (F_1 Broiler) chickens. F_1 *Pelung* was produced from crossbreeds of *Pelung Blirik Hitam* native to Cianjur, West Java (Fig. 1B). Broiler Cobb 500 was produced by the rearing of Day-Old-Chicken (DOC) Broiler Cobb 500 from Pokphand Indonesia. *Kambro* (F_1 Broiler) was produced from crossbreeds of 4 female Broiler Cobb 500 aged 6 months with a male *Pelung Blirik Hitam* (Fig. 1A). Parental crossbreeding was conducted in a brood shed (8 m^2) owned by Gama Ayam Research Team. Standard feeds produced by PT. Japfa Comfeed Indonesia, AD II (brood/juvenile, 9-22 weeks) and BR-1 (starter, 0-22 days) with *ad libitum* dietary. Supplemental vitamin *Egg Stimulant®* and *TetraChlor®* produce by Medion were needed to improve immunity and brood productivity. Egg collection from each crossbreed was hatched using an incubator. Day-Old-Chicken (DOC) was reared intensively in bamboo pens insulated by plywood and equipped with incandescent lamps (15 watts). Chicken at 4-weeks-old then transferred into a larger shed with a semi-intensive rearing system (8 m^2). Grouping of each chicken based on its crossbreeding as follows DOC F_1 *Pelung* (group I), DOC Broiler Cobb 500 (group II), and DOC *Kambro* (group III). Bodyweight growth of DOC Broiler, DOC F_1 *Pelung*, and DOC *Kambro* was measured per week with digital scale *KrisChef EK9350H* with 0.01-gram accuracy until chicken reaches 8-weeks-old. Zoometric measurement was measured with metline based on morphological guidance of chicken skeletal (Supplemental Files, adapted with modification and addition from Daryono *et al*., 2010)**.**

1. TA was measured from the digit/hallux to the tip of the comb
2. TB was measured from the digit/hallux to the end of the distal vertebrae
3. LP was measured from articular to dexter
4. PP was measured from the base of the angular process to the end of the mandibular symphysis
5. PK was measured from the supraorbital bone to the premaxilla
6. LK was measured from quadratojugal sinister to dexter
7. TJ was measured from the highest tip of the comb to the base of the comb
8. PJ was measured from the back to the front of the comb
9. PB was measured from the tip of the first thoracic vertebra to the base of the pygostyle
10. LB was measured from the base of the femoral bone to dexter
11. LD was measured from the sternal of the keel in a circle
12. PPu was measured from the thoracic vertebrae to the caudal vertebrae end
13. PS was measured from the base of the humerus to the end of the carpus
14. PL was measured from the base of the atlas to the tip of the thoracic vertebrae
15. PBe was measured from the tip of the femur to the base of the tibiotarsus
16. PPa was measured from the end of the patella to the base of the femur

Linear bodyweight parameter consists of TA (chicken height), TB (body height), PB (body length), LB (body width), PPu (dorsal length), PL (neck length), PS (wingspan) and LD (chest circumference). The vitality parameter consists of TJ (comb height), PJ (comb length), PK (head length), LK (head width), PP (beak length), and LP (beak width). Qualitative phenotype parameter including neck feather color, dorsal/ back feather color, chest feather color, body feather color, femoral feather color, shank color, comb color, comb shape, and beak color. Phenotype parameter of hybrid is identified as visual data with the black background photo. The weekly data record consists of bodyweight growth (BT) and femur-tibia length (PPa-PBe). Data is analyzed with correlation, regression, one-way ANOVA, and independent sample t-test using IBM© SPSS© *Statistics version* 21. An independent sample t-test can be used to compare average bodyweight, body growth, feed intake, feed conversion, and mortality rate between two chicken populations (Darwati *et al.*, 2016). Correlation between femur-tibia length and linear bodyweight parameter to bodyweight growth are analyzed with Pearson correlation method, linear regression, multiple linear regression, and analysis of covariance (ANCOVA). Phenotype parameter is analyzed with visual observation scoring method based on photo.

RESULTS AND DISCUSSION

Crossbreeds of female Broiler Cobb 500 with male *Pelung Blirik Hitam* produced 18 hybrids named *Kambro* consisted of 9 males *Kambro* and 9 females *Kambro* (Fig. $1A_{1\text{-}2}$). Crossbreeds of female *Pelung Blirik Hitam* with male *Pelung Blirik Hitam* produced 22 F_1 *Pelung* chickens (Fig. $1B_{1\text{-}2}$).

Day-Old-Chicken (DOC) of control populations consist of F_1 *Pelung* and Broiler Cobb 500 each with 22 chickens. The mortality rate of group III (*Kambro*), group II (Broiler Cobb 500), and group I (F_1 *Pelung*) subsequently are 5.5%, 0%, and 68.2%. The mortality rate of group I is higher than group III and II. The earliest record of death was in the group I at 2-weeks-old meanwhile in group III at 6-weeks-old. The most probable cause of death in group I and group III were caused by infection of infectious coryza (snot) through daily observation. Infectious coryza (snot) disease is caused by gram-negative bacteria *Haemophilus paragallinarum* with the symptom of rapid infection and high morbidity, declining in egg production, oculonasal conjunctivitis, face swelling, and conjunctival sac exudation (Ali *et al.*, 2013; Iskandar, 2017).

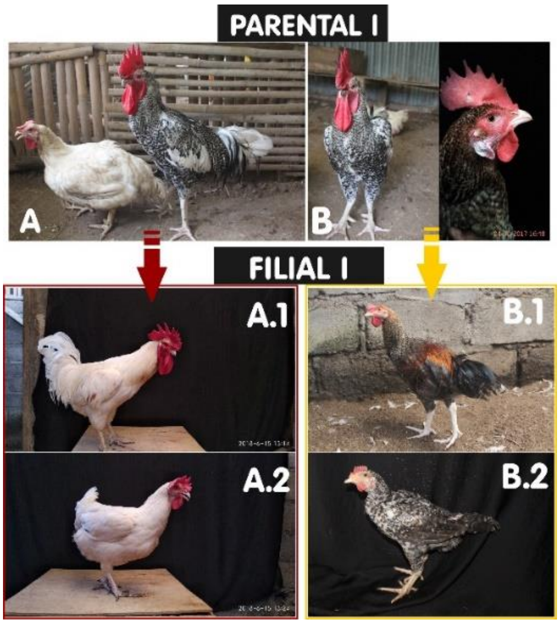

Figure 1. Chicken cross diagram. Parental I (A: female Broiler Cobb 500 and male *Pelung Blirik Hitam*; B: female *Pelung Blirik Hitam* and male *Pelung Blirik Hitam*) and Filial I (A.1: male *Kambro*; A.2: female *Kambro*; B.1: male F_1 *Pelung*; B.2: female F_1 *Pelung*) (Personal Documentation, 2017)

The absence of vaccination was a treatment to assess the immunity of each chicken group. Data of mortality from each group lead to a conclusion that the immunity resistance of group III was higher than group I. High mortality rate can be caused by the absence of vaccination in group I and III. Group II had been vaccinated since hatching by DOC producer. *Kampung* chicken has distinguished immunity resistance better than other native tropical broiler-type breeds and highest expression of antivirus gene *Mx+* (Diwyanto and Prijono, 2007; Nuroso, 2010; Kartika *et al.*, 2016; Nurhuda, 2017). *Kambro* has higher immunity resistance indicates an

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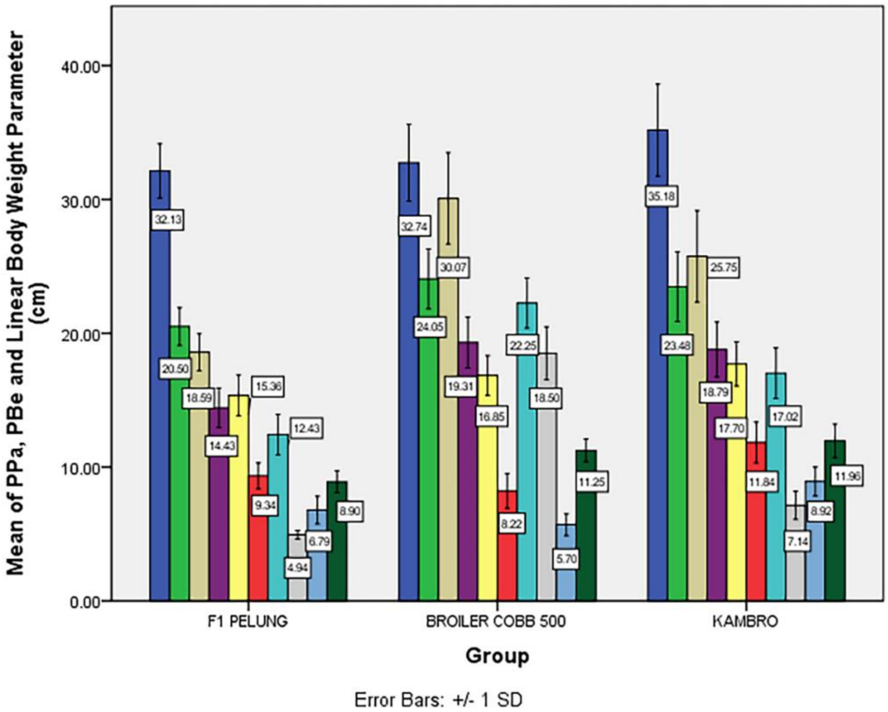
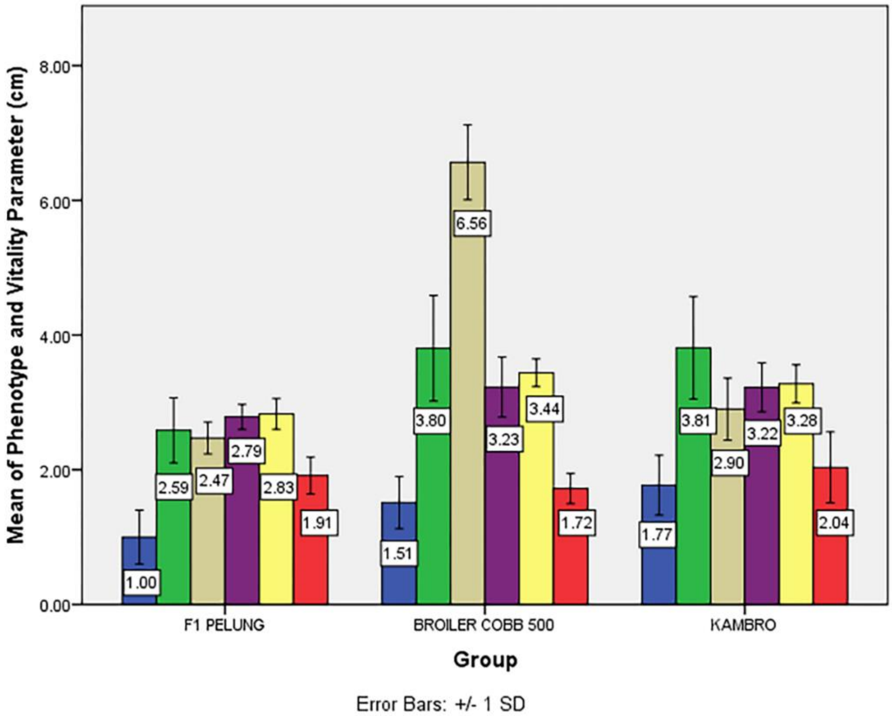
improvement of the genetic quality of native chicken through crossbreed and semi-intensive rearing system supported by management and environmental factors.

Egg collection and hatching of *Kambro* was 10 until 20 eggs per week during 6 months period (December 2017 until May 2018). Egg productivity rate was low at 20 until 22 eggs on the peak of Broiler Cobb 500 laying cycle. Female Broiler Cobb 500 (±6 months) hatchability only reaches 25% per hatching period. Several factors were influencing the fluctuation of *Kambro's* egg productivity including nutrition, stress level, sperm fertility, and egg fertility. Laying broiler productivity reaches its peak of laying cycle at the age of 23 weeks (± 6 months) (Rahman *et al.,* 2015). Female Broiler Cobb 500 egg productivity in this research can be influenced by female age. Hameed *et al.* (2016) stated that egg weight and hatchability can be influenced by female aging, declining hatchability of eggs reach 15% in female broiler at 30-weeks-old with egg weight less than 60 grams. The main factor that influenced the fluctuation of egg productivity can be caused by *ad libitum* standard feed dietary. Rahman *et al*. (2015) stated that *ad libitum* dietary can decrease egg productivity, minimizing egg hatchability, and increasing mortality rate. Feed diet restriction must be implemented to limiting bodyweight growth, maximizing egg production, and increase the female Broiler Cobb 500 fertility (Rahman *et al.*, 2015).

In Table 1 are shown the results of one-way ANOVA analysis of PPa, PBe, and BT on each chicken groups which significantly different ($p<0.01$). BT shows a highly significant ($p<0.01$) difference in three groups of chicken [F (2, 43) = 62.09, $p<0.01$, $\eta2$ = 0.743]. PPa shows a highly significant ($p<0.01$) difference in three groups of chicken [F (2, 43) = 55.09, $p<0.01$, $\eta2$ = 0.719]. PBe shows a highly significant ($p<0.01$) difference in three groups of chicken [F (2, 43) = 22.87, $p<0.01$, $\eta2$ = 0.515]. Post hoc analysis with Fisher's LSD indicates a significant difference of PPa, PBe and BT on each of chicken groups. PPa of group I (M = 6.79, SD = 1.03) significant to group II (M = 5.69, SD = 0.82) and group III (M = 8.92, SD = 1.08). PBe of group I (M = 8.9, SD = 0.82) significant to group II (M = 11.25, SD = 0.85) and group III (M = 11.96, SD = 1.2). BT of group I (M = 602.88, SD = 79.93) significant to group II (M = 1,706.82, SD = 262.54) and group III (M = 1,244.14, SD = 453.82). Conclusively group III shows a distinguished performance of BT, PPa and PBe compare with group I (Fig. 2A). BT of group III (1,244.14 ± 453.82 gram) approaches BT of group II (1,706.82 ± 262.54 gram) at 8-weeks-old. One-way ANOVA analysis of PPa, PBe, and BT is strengthened with independent sample t-test (Supplemental File 3, Table 2). PPa of group III (M = 8.92, SD = 1.08) is significant to group I (M = 6.79, SD = 1.03), t (22) = 4.446, $p<.001$). PPa of group III (M = 8.92, SD = 1.08) is significant to group II (M = 6.79, SD = 1.03), t (37) = 10.62, $p<.001$). PBe of group III (M = 8.92, SD = 1.08) is significant to group I (M = 6.79, SD = 1.03), t (22) = 5.956, $p<0.01$). PBe of group III (M = 8.92, SD = 1.08) is significant to group I (M = 6.79, SD =1.03), t (37) = 2.139, $p<0.05$). BT of group III (M = 8.92, SD = 1.08) is significant to group I (M = 6.79, SD = 1.03), t (21.66) = 9.88, $p<0.01$). Variance test with Levene's test of BT group III-I indicates a dissimilarity (F = 11.11, p = 0.003), as adjustment the degree of freedom is set from 22 into 21.66.



(A)



(B)

Figure 2. (A) Mean of PPa, PBe, and linear bodyweight parameters of group I, II, and III in 8-weeks; (B) The mean parameters of the chicken group I, II, and III vitality and phenotype in 8-weeks. The standard deviation is denoted by T-bar. In graph A, each parameter is symbolized by arrangement: **TA** ■; **TB** ■; **PB** ■; **LB** ■; **LD** ■; **PPu** ■; **PS** ■; **PL** ■; **PBe** ■; **PPa** ■. In graph B, each parameter is symbolized by arrangement: **LP** ■; **PP** ■; **PK** ■; **LK** ■; **TJ** ■; **PJ** ■

Table 1. Analysis of One-Way ANOVA PPa, PBe, and BT Chicken Groups I, II, and III at 8-weeks

Parameters	Chicken Groups			F	η2
	I (n = 7)	II (n = 22)	III (n =17)		
PPa (cm)	6.79a (1.03)	5.69b (0.82)	8.92ab (1.08)	55.09***	0.719
PBe (cm)	8.9a (0.82)	11.25b (0.85)	11.96ab (1.2)	22.87***	0.515
BT (gram)	602.88a (79.93)	1,706.82b (262.54)	1,244.14ab (453.82)	62.09***	0.743

PPa = Femur Length
PBe = Tibia Length
BT = Body Weight
* = p <0.05; *** = p <0.01. The standard deviation is listed below the mean. The averages with different subscripts in the same column differ significantly (p<0.05) based on Fisher's LSD post hoc.

The average Body Weight (BT) of *Kambro* at 8-weeks-old can be compared with other similar crossbreeds. Crossbreeding of *Sentul* chicken reached an average body weight of 896.34 ± 55.46 grams (male *Sentul*) and 736.00 ± 46.63 grams (female Sentul) for 75 days period (Solikin *et al*., 2016; Sudrajat and Isyanto, 2018). Mariandayani *et al*. (2013) stated data about bodyweight of native chicken at 8-weeks-old which including *Pelung* (male 458.23 grams and female 420.11 grams), *Sentul* (male 406.36 grams and female 355.98 grams), *Kampung* (male 411.56 grams and female 358.74 grams). From these comparisons can be concluded that *Kambro* can reach higher BT than other native chicken breeds. Hasyim (2015) stated that hybrids chicken crossbreeds of *Kampung* and Broiler at 12-weeks-old can reach 2,335 grams (male) and 1,833 grams (female). *Kambro* bodyweight growth at 8-weeks-old has not reached the inflection point whereas *Kambro* BT’s growth projection was estimated to be higher as weeks follow. The inflection point is maximum bodyweight growth, during this period a shift of growth phase occurs with declining growth. Growth can occur during weeks follow because the chicken has not reached sexual maturity (Sogindor, 2017). Suprijatna (2010) stated that the sexual maturity of *Pelung* chicken at day-165 with 12-weeks-old weight can reach 669 grams. Nurhuda (2017) stated that genetic component combination affects BT of chicken from crossbreeding with hybrids observed to have better performance than a parental generation on several characters or traits. Average BT of *Kambro* was 1,244.14 ± 453.82 grams lower than Broiler Cobb 500 which can reach 1,706.82 ± 262.54 grams at 8-weeks-old for the reason of only inherited 50% of Broiler Cobb 500 genetic components, whereas BT of F_1 *Pelung* only reached 602.88 ± 79.93 grams with the same period.

PPa, PBe, and several linear bodyweight parameters have correlations with chicken bodyweight (Ukwu *et al.*, 2014). Linear bodyweight parameters consist of shank length, chest circumference, tibia length, neck length, dorsal length, and femur length (Ukwu *et al.*, 2014). Linear bodyweight parameters used in this research consist of TA, TB, LB, PL, PS, LD, and PPu. Linear bodyweight parameter has a significant influence on the selective breeding program, also as chicken bodyweight indicator and market attraction (Ukwu *et al.*, 2014; Assan, 2015). LD and PB in group III showed significant (p<0.01) results than group II, meanwhile TA, PL, and LB in group III were superior to group II (Table 2). Performance improvement of *Kambro* to *Pelung* was shown by significant results of linear bodyweight parameter in group III and group I. PPa, PBe, and linear bodyweight parameter correlation to BT is summarized in Table 2.

Table 2. Correlation of linear bodyweight parameter, PPa, and PBe to BT in chicken group I, II, and III

		Chicken Groups		
Parameters (cm)		I (n=7)	II (n=22)	III (n=17)
Linear Body Weight Parameters	TA	-0.374^{ns}	0.444*	0.553*
	TB	-0.091^{ns}	0.380†	0.633**
	LB	0.344^{ns}	0.216^{ns}	0.629**
	PB	0.150^{ns}	0.005^{ns}	0.478†
	PL	-0.454^{ns}	0.361†	0.152^{ns}
	PS	0.792*	0.179^{ns}	0.606**
	LD	0.131^{ns}	-0.398†	0.396^{ns}
	PPu	0.431^{ns}	0.349^{ns}	0.299^{ns}
PPa		0.975***	0.932***	0.965***
PBe		0.298^{ns}	-0.064^{ns}	0.567*

† = p<0.10, *= p<0.05, **= p<0.01, ***= p<0.001. † *very slightly significant*, ns = *non-significant*

Table 3. Chicken group X linear bodyweight parameter factor (FAC1_1) ANCOVA Body Weight (BT) at 8-weeks

Source	*Df*	*F*	η2	*p*
Group	1	7.205	0.265	0.014
FAC1_1	1	2.508	0.111	0.129
Group* FAC1_1	1	0.482	0.024	0.482
Error (within groups)	20			

FAC1_1: TA, TB, LB, LD, PL, PS, PPu, and PB; p<.05

In Table 2, Pearson's correlation analysis indicated significant positive correlation between PPa and PBe to BT group III (PPa *r* (17) = 0.965, *p*<0.01; PBe *r* (17) = 0.567, *p*<0.01). In group I and group II, BT only has positive correlation with PPa (group I *r* (7) = 0.975, *p*<0.01; group II *r* (22) = 0.932, *p*<0.01). In group III, TA (0.553), TB (0.633), LB (0.629), and PS (0.606) significantly correlates (p<0.05) with BT. In group II, TA (0.444) significantly correlates (p<0.05) with BT. In group I, PS (0.792) positively correlates (P<0.05) with BT. Linear bodyweight parameters on each group have a weak positive correlation to BT meanwhile PPa has a strong positive correlation to BT (r > 0.90) within each group. Conclusively PPa can be used as a standardized BT estimation model within all chicken groups. Regression analysis was used to strengthen this conclusion as can be seen in Figure 3.

The non-linear regression model applied in this research was curvilinear quadratic because of improvement on R^2 value compare to R^2 in simple linear regression (Supplemental File 3, Table 4). PPa is the construction parameter of the prediction model suitable for a non-linear projection of BT in chicken groups I, II, and III. BT prediction model according to linear bodyweight parameter with positive weak correlation analyzed with ANCOVA in Table 3.

ANCOVA analysis between subject and factor [Chicken Group (I, II, and III); covariate: FAC1_1] showed significant group effect F (1.20) = 7.205, p = 0.014, η2 = 0.265, while FAC1_1, F (1, 20) = 2.508, p = 0.129, η2 = 0.111 was insignificant, and no interaction between group and FAC1_1, F (1.20) = 0.482, p = 0.482, η2 = 0.024. ANCOVA analysis strengthening PPa parameter as 8-weeks-old *Kambro* Body Weight (BT) prediction model. Semakula *et al.* (2011) stated that native Lake Victoria chickens' live body weight correlates with chest girth. In that research live body

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weight prediction model and chest girth is non-linear regression highest R^2 value on power model ($0.001G^{2.417}$) (Semakula *et al.*, 2011). Ukwu *et al.* (2014) stated that linear bodyweight parameters including shank length can be used as a live body weight prediction model of native Nigeria chicken. Mabelebele *et al.* (2017) stated that Broiler Ross 308 has distinguished femur and tibia length compare to Venda chicken, native South Africa chicken. A similar phenomenon can be observed in *Pelung* chicken with shorter PPa compare to Broiler Cobb 500, on the other hand, distinguished in PBe. *Kambro* chicken has PPa and PBe superior to parental generation (Fig. 2A). Mabelebele *et al.* (2017) stated that polynomial regression of Ross 308 carcass weight was inflicted 97% by femur length and 94% by tibia length, meanwhile, Venda chicken was inflicted 89% by tibia length and 37% by femur length. In this research the non-linear quadratic function for the bodyweight of Broiler Cobb 500 was affected by 97.8% PPa, F_1 *Pelung* by 96.2% PPa, and *Kambro* by 95.6% PPa. Conclusively PPa length growth coherently following BT growth in *Kambro*.

PPa function of Broiler Cobb 500 was higher than F_1 *Pelung* can be caused by intensive rearing system. *Pelung* chicken is mostly reared with the extensive system or free-range with a variation of feed diets. Thus, F_1 *Pelung* bone growth retardation can be caused by locomotion limitations. Henuk and Bakti (2018) stated that an extensive rearing system decrease native Indonesia chicken productivity because of feed diet inefficiency and a lengthy growth period of 90 days/1kg. Femur length (PPa) growth adjusted with Body Weight (BT) in Broiler Cobb 500 with extensive rearing system and non-strict feed diet impacting negatively growth performance of fast-growing broiler chickens (Pauwels *et al.*, 2015). Regression analysis of group II PPa parameter showed declining BT by increasing length of PPa (Fig. 3). Broiler locomotion was affected by BT and PPa. A strict diet can cause musculoskeletal growth delay in the broiler with further implication muscle stress of movement and locomotion (Paxton *et al.*, 2014). Shim *et al.* (2012) stated that the bone of a fast-growing broiler at 6-weeks-old is longer, wider, heavier, stronger, compact, and high calcium concentrated compared with a slow-growing broiler with the same age. Han *et al.* (2015) stated that the tibia is the longest and heaviest part compared with the femur as the longest diameter bone. The mortality rate and performance of broiler-type chicken are affected by bone structure. Bone growth abnormality can be affected by several factors including the lighting period. Van der Pol *et al.* (2015) stated that a minimum lighting period decreases the environmental stress of chickens, where extreme dim-bright lighting increase asymmetric bone growth in the broiler. PPa function of *Kambro* was lower than F_1 *Pelung* and Broiler Cobb 500 conclusively semi-intensive rearing system and non-strict combination of feed diet can be standardized as suitable *Kambro* rearing system.

Market assessments and crossbreed selection depend on visual phenotype parameter appearance (Frame, 2009; Semakula *et al.*, 2011; Assan, 2015). The visual method can be used to rapidly identify certain traits quality of chickens.

Navara *et al.* (2012) stated that phenotype appearance determines chickens' genetic succession and productivity. Based on LP group III was insignificant ($p>0.05$) to group I (Supplemental File 3, Table 2). Based on PJ, TJ, and LK group III was insignificant ($p>0.05$) to group II (Fig. 2). The comb color of group III was dominated 58.82% by red color and 41.18% rosy color (Table 4) with 100% of the single shaped comb. Navara *et al.* (2012) stated that comb color has a positive significant correlation to sperm function, on the other hand, comb size has a negative significant correlation. These findings were contradictive with other findings which stated that comb size has a positive significant correlation to vitality, sperm function, and mating signal in males (Gebriel *et al.*, 2009; El Ghany *et al*., 2011; Udeh *et al.*, 2011). The dominant male showed a larger comb dimension (PJ+TJ) with bright red color with low sperm motility (Navara *et al*., 2012). Female inclination to select dominant male can cause quality reduction of filial generation sperm quality (Navara *et al*., 2012). Frame (2009) stated that comb color involves as an indicator of the laying period with pale-color indicates laying initiation and post-laying period while bright red color indicates optimum laying period. The average PJ of *Kambro* is 3.81 ± 0.76 cm shorter than several other breed such as White Leghorn (10-16 cm), Red Junglefowl (6-12 cm), and broiler (8-14 cm) (Navara *et al*., 2012).

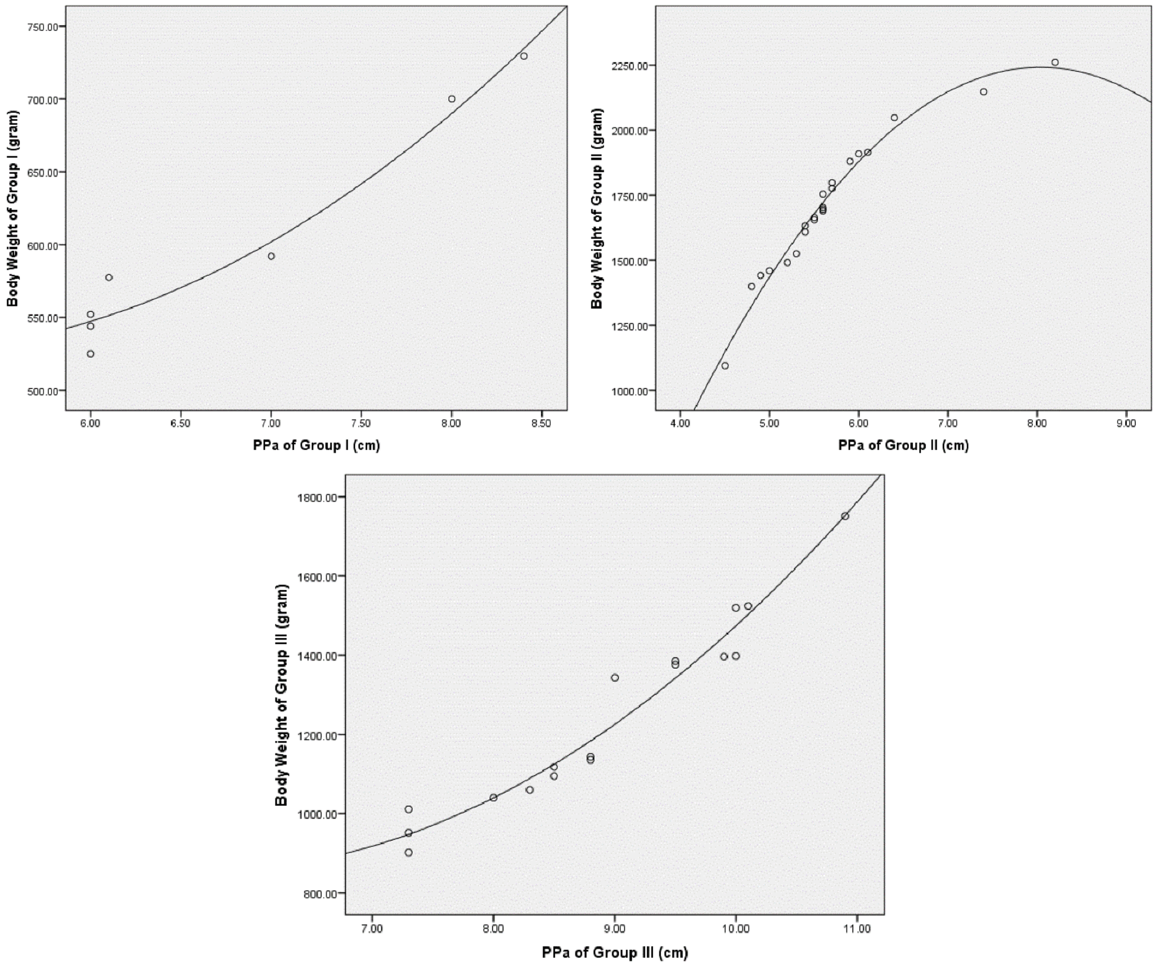

Figure 3. Curvilinear quadratic PPa model against BT chicken group I, II, and III.

Identification of comb color, PJ, and TJ in *Kambro* become parental selection guide, to sort out males with low sperm motility in future crossbreed. Based on these findings in the next crossbreed male with small PJ and TJ and female with bright red color will be chosen. Measurement on PK, LK, PP, and LP (Fig. 2B) is an indicator of dietary pattern and feed consumption rate with the correlative link between these parameter and Body Weight (BT) have been clarified by several studies (Fahey *et al*., 2007; Yakubu *et al*., 2009; Fayeye *et al*., 2013; Joller *et al*., 2018). Beak deformity has been known to affecting dietary patterns and chickens' body weight (Joller *et al*., 2018) with the genetic influence of *DEGs* gene expression (Bai *et al*., 2014). Beak color was dominated by ivory white color (70.58%) followed by white, black patterned (29.42%). Frame (2009) stated that fading of beak color from white into dull white or ivory white color indicates chicken age between 4 to 6 weeks old. Chicken shank color controlled by locus allele *Id-id* and *W-w* with *Id-* expressing white or yellow color and *idid* expressing black, gray, or green colors influenced by *GRAMD3* gene in dermal tissue of shank (Xu *et al.*, 2017). Frame (2009) stated that depigmentation of shank color is an indication of hen egg productivity during 15 to 20 weeks.

Feather expression in *Pelung Blirik Hitam* is determined by three genotypes Z^BZ^b (patterned), Z^bZ^b (plain), and Broiler Cobb 500 is determined by genotype Z^bW (plain white). Hasnelly *et al*. (2017) stated that chicken feather color is expressed by (*s*) allele for old golden color, (*S*) for silver recessive, (*b*) for plain color, (*B*) for patterned color. Feather color in broiler chicken can be classified into dominant white which can be observed in White Leghorn chicken with several variations that are smoky/grayish (*I*S*) and dun/whitish (*I*D/i*) (Kerje *et al*., 2004). Both male *Kambro* (Z^BZ^b) and female *Kambro* (Z^BW) showed 100% gene frequencies of feather color with black patterns, brown, and gray. *Pelung Blirik Hitam* and Broiler Cobb 500 shank color genotype can be categorized as *IdId*/*Id_* (white/yellow) and *idid* (black/gray/green). Both male *Kambro* and female *Kambro* shank color gene frequencies can be classified into three groups *IdId*/white (52.95%), *Idid*/white with black pattern/gray (41.17%), and *idid*/black (5.88%). Body feather color and shank color variation of *Kambro* indicate segregation of alleles in the population inherited by *Pelung Blirik Hitam* and Broiler Cobb 500. Duguma (2006) stated that bright or white body feather color has higher commercial value and qualified by market. Semakula *et al*. (2011) stated that visual judgment has a significant influence on sale value with a tendency of increasing demand for native Ugandan chickens. Suprijatna (2010) stated that native Indonesia chickens have a *niche* market, and the prevalence of customers showed a higher demand on native chickens based on their unique taste and phenotypic appearance.

Table 4. Phenotype parameters of *Kambro* at 8-weeks-old based on visual observation scoring method.

Phenotype Parameters	Characters	Gene Frequency (%) ♂/♀ (n=17)	Locus	Gene
Color of neck feather	White	100	*I-i*	q^I-q^i
Back feather color	White with black, brown, and gray strands	100	*I-i/ E-e+-e*	q^I-q^i/q^E-q^{e+}-q^e
Color of chest hair	White	100	*I-i*	q^I-q^i
Body feather color	White with black, brown and gray strands	100	*I-i/ E-e+-e/B-b*	q^I-q^i/ q^E-q^{e+}-q^e/q^B-q^b
Color of the femoral feather	White	52.95	*I-i*	q^I-
	White black or gray pattern	47.05	*E-e+-e/B-b*	q^E-q^{e+}-q^e/q^B-q^b
Shank color	White	52.95	*Id- id*	q^{Id}/q^{id}
	White black or gray pattern	41.17	*Id- id*	q^{Id}/q^{id}
	Black	5.88	*Id- id*	q^{Id}/q^{id}
Comb color	Red	58.82	-	-
	Pink	41.18	-	
Comb shape	Single	100	*P-p*	q^P/q^p
Beak color	Broken white	70.58	-	-
	White black pattern	29.42	-	-

CONCLUSION

Based on the measurement of Body Weight (BT), *Kambro* (1,244.14 ± 453.82 grams) performed significantly (p<0.01) better than F_1 *Pelung* (602.88 ± 79.93 grams) in 8 weeks with an *ad libitum* diet of standard feed. The performance escalation of *Kambro* compared with F_1 *Pelung* was significantly based on the measurement of linear bodyweight parameter, vitality parameter, femur length (PPa), tibia length (PBe), and phenotype parameter. Observation of phenotype parameter showed the resemblance of *Kambro* with parental generation. Estimation model of *Kambro* Body Weight (BT) can be measured with femur length (PPa) in non-linear quadratic regression (r = 0.956) based on this formula 1.84E3 ± 3.54E2*x+31.73*x^2. ANCOVA analysis showed no interaction between the group and linear bodyweight parameter and there was a significant difference in BT of groups (p = 0.014). The mortality rate of *Kambro* was lower than F_1 *Pelung* with the absence of vaccination in a semi-intensive rearing system. Research findings must be validated with a larger population size.

SUGGESTION

Further research with a larger number of hybrid chickens must be conducted to validate the result of this study.

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