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The Quantitative Characteristics of Cross-Bred Native Chicken (Sentul X Arab Chicken and Merawang X Arab Chicken)

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ABSTRACT

The research aims to analyze the production potential and opportunities to increase the productivity of each cross-bred animal based on its quantitative characteristics. The livestock material used in this research was 50 Sera chickens (Sentul chickens x Arabian chickens) and 50 Mera chickens (Merawang chickens x Arabian chickens). The research was carried out by raising chickens from DOC to 3 months of age. The quantitative data involve body weight, weight gain, and body measurements (head length, head circumference, head height, neck length, neck circumference, wing length, back length, back height, chest length, chest width, shank length, shank circumference, length third finger and pubic bone distance). The quantitative data that has been observed is then analyzed through the t-test. Then, PCA is used to identify body shape and size determinants in Sera and Mera chickens. Statistical analysis was carried out using Minitab software version 21. The results obtained showed that the body weights of Sera and Mera chickens were significantly different ($p<0.05$) from DOC to 3 months of age. A significant increase in productivity in crosses between Sentul chickens and Arabian chickens and Merawang chickens with Arabian chickens occurs starting at 1-2 months. Sera and Mera chickens' body sizes differed significantly ($p<0.05$). The total diversity of PC1 in Sera chickens was 79.8%, and in Mera chickens, it was 70.6%. Meanwhile, the total PC2 diversity of Sera chickens was 17.7%, and Mera chickens were 7.9%. In conclusion, Sera chickens have the highest quantitative characteristics compared to Mera chickens, and the highest body weight gain occurs at 1-2 months in both Sera and Mera chickens. Based on principal component analysis. The body size characteristic of Sera chickens is shank length, while in Mera chickens, it is chest length. The distinct shape of Sera chickens is body height, while in Mera chickens, it is shank length.

Keywords: Cross-breeding, Native chicken, Principal component analysis, Productivity

Introduction

Native Indonesian chickens, also known as local chickens, have long adapted, lived, grown, and reproduced in certain habitats and several places. Currently, local chicken is a type of livestock used as a source of animal protein in Indonesia, which always experiences an increase in production yearly. This increase in the production of local chickens is thought to be caused by people's incomes also increasing and the taste of free-range chicken products being tastier compared to purebred chicken (Mamuaja *et al.*, 2020). Until now, various local chickens, including Sentul chickens, Merawang chickens, and Arabian chickens, can be bred.

Sentul and Merawang chickens are dual-purpose chickens (broiler and laying), while Arabian chickens are egg-laying types. Even though Sentul and Merawang chickens are classified as laying types, they do not produce as many eggs as Arabian chickens. Arab chicken meat is also not widely used because its skin is black, and the meat is thinner than other local chickens. Attention to livestock performance is needed to support increased meat and egg production. Production performance is influenced by three main aspects: breed, feed, and management (Budiarto *et al.*, 2021). In breed, efforts can be made to improve genetic quality through selection or crossing to produce superior seeds.

Crossing Sentul chickens with Arabian chickens and Merawang chickens with Arabian chickens is expected to produce superior genetic quality. Crossing follows the statement by (Rowiyanti *et al.*, 2021) that crosses between local chickens are expected to pass on genes that control growth, reproduction, high production, and better meat quality. The success of this crossing program can be seen from the quantitative characteristics of the offspring. Quantitative

attributes of chickens involved head length, head circumference, wing length, back length, back height, chest length, shank length, shank circumference, and third finger length (Puteri *et al.*, 2020; Irmaya *et al.*, 2021; Depison *et al.*, 2022). Changes in body size (quantitative characteristics) can be used to estimate livestock body weight (Trisnawanto *et al.*, 2012; Sari *et al.*, 2021).

Crossing between the local chicken and the most productive local chicken lines is a tactic to improve productivity (Wang *et al.*, 2021; Depison *et al.*, 2022; Sungkhapreecha *et al.*, 2022). Measuring body weight and body size is crucial to assess the improved characteristics of crosses compared to their parents (Razuki and Al-Shaheen, 2011; Phocas *et al.*, 2016; Soliman *et al.*, 2020). Accordingly, crossing and heterosis are important parts of breeding tactics in chickens (Amuzu-Aweh *et al.*, 2015). With this research, we can discover the production potential and opportunities to increase the productivity of each animal being crossed.

Materials and Methods

The livestock used for this research were 50 Sera chickens (Sentul chickens x Arabian chickens) and 50 Mera chickens (Merawang chickens x Arabian chickens). The feed given is commercial BR1 feed, which is given according to the chicken's consumption needs based on research by Irmaya *et al.* (2021). The research was carried out by raising chickens from DOC to 3 months of age. The research method was carried out using descriptive analysis methods. The descriptive analysis method is used to present quantitative data in descriptive form. Body measurements are taken monthly; data collection time is in the morning. The variables observed were quantitative characteristics, including body weight (BW), weight gain (WG), head length (HeL), head circumference (HeC), head height (HeH), neck length (NeL), neck circumference (NeC), wing length (WiL), back length (BaL), back height (BaH), chest length (ChL), chest width (ChW), shank length (ShL), shank circumference (ShC), length third finger (ThFiL) and pubic bone distance (PuBD). HeL is measured from the base of the beak to the back of the head. HeC is measured at the highest part of the head. HeH is measured at the highest part of the head. NeL is measured from the first to the last cervical vertebra. NeC wraps a measuring tape around the neck. WiL is measured from the humerus bone to the tip of the phalange. BaL is measured from the neck's tip to the tail's base. BaH is measured from the bottom of the backrest to the back. ChL is measured from the front of the chest to the back of the chest. ChW Measurement is obtained by measuring the distance from the left to the right (widest) sternum. ShL is measured along the tarsometatarsus bone (shank). ShC around the measuring tape in the center of the tarsometatarsus (shank) bone. ThFiL is measured from the base to the tip of the third finger. PuBD was measured using digital calipers

Statistical analysis. The quantitative data collected is then analyzed using a t-test, following the research of Abdu *et al.* (2021); Gultom *et al.* (2021); Wahyuni *et al.* (2022). Then, PCA is used to identify body shape and size determinants in Sera and Mera chickens (Utama *et al.*, 2021; Ghassani *et al.*, 2022). Statistical analysis was carried out using Minitab version 21 software.

Results and Discussion

Body weight

The body weights of Sera and Mera chickens from DOC to 3 months can be seen in Table 1. The results show that the body weights of Sera and Mera chickens were significantly different ($p<0.05$) based on the t-test. Body weight is an indicator of livestock productivity, which has economic value, where body weight increases with age. The body weight of Sera chickens is greater than that of Mera chickens from DOC age to 3 months of age. This difference in body weight is thought to be caused by genetic factors in Sera and Mera chickens, indicating that there may have been a combination of essential traits between Sentul chickens and Arabian chickens and Merawang chickens with Arabian chickens, resulting in a heterosis effect in the results of this study. Crossing causes important traits from parents to be inherited; body weight is one of the effects of heterosis, which significantly influences chicken productivity. Genetic factors in Sera and Mera chickens cause the difference in body weight. According to Darwati *et al.* (2018), the heterosis effect due to crossing between 2 families of chickens influences an increase in the body weight of livestock.

The results of this study showed that the body weight of Mera chickens aged 1 and 2 months was higher compared to research by Darwati *et al.* (2018) MA (Merawang x Arab) chickens of the same age only weighed 196.65 g and 614.7 g. This difference is, of course, influenced by genetic and environmental factors when raising livestock. Genetic factors influence around 30% and environmental factors 70% (including temperature, air humidity, feed, and maintenance management), determining livestock productivity (Purwantiningsih *et al.*, 2022).

Tabel 1. Body weight

Body weight (g)	Sera	Mera
DOC	33.65 ± 1.16[a]	32.43 ± 2.19[b]
1 Month	217.69 ±10.39[a]	213.85 ± 7.43[b]
2 Months	630.54 ± 16.93[a]	616.13 ± 13.51[b]
3 Months	954.62 ± 107.22[a]	910.35 ± 75.76[b]

Different letter superscripts in the same column for each type of chicken mean significantly different ($p<0.05$).

Weight gain

Sera chickens and Mera chickens have a higher body weight than Arabian chickens. Shows that crossing Sentul chickens with Arabian chickens can increase livestock productivity. Several studies that crossbreed chickens have a higher body weight (Khawaja *et al.*, 2012; Castellini *et al.*, 2016; Rahayu *et al.*, 2021). A significant

increase in productivity in crosses between Sentul chickens and Arabian chickens and Merawang chickens with Arabian chickens occurs at 1-2 months of old, as shown in Figure 1.

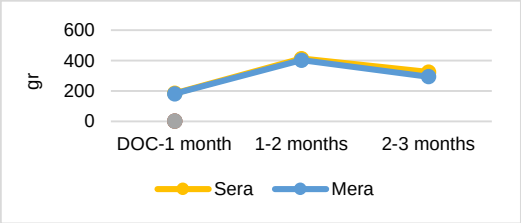

Figure 1. Weight gain.

Approximately, 1-2 months is the highest weight gain, and 1-2 months is the growth phase of starter-grower chickens. This phase needs to be given great attention because according to Darwati *et al.* (2018), the starter and grower phases are critical phases that need to be paid attention to produce superior laying local chickens. From 2-3 months of age, growth begins to decline, indicating that maximum growth has occurred, which will then decrease until sexual maturity (Trisiwi, 2017). Growth occurs before livestock reaches sexual maturity (Depison *et al.*, 2022). This growth rate forms a sigmoid curve (Irmaya *et al.*, 2021).

Quantitative characteristic

The body sizes of Sera and Mera chickens are presented in Table 2. The results showed that Sera and Mera chickens' body sizes were significantly different ($p<0.05$). Sera chickens have a taller body size than Mera chickens. The different body sizes are thought to be an expression of genetic factors, and this is because Sera chickens and Mera chickens live in the same environmental conditions. The statement is supported by the opinion of Putri *et al.* (2020) genetic factors may cause differences in the body size of chickens kept in the same environment.

Carrying out animal body measurements is crucial for determining the refinement of crossbreed characteristics from the characteristics of the parents (Razuki and Al-Shaheen, 2011; Phocas *et al.*, 2016; Soliman *et al.*, 2020). Crossing Sentul chickens with Arabian chickens has a heterosis effect, namely increasing the performance of the average production of the two crossed lines, compared to the results of research by Puteri *et al.* (2020) regarding the average body size of Sentul chickens and Arabian chickens at 3 months of age. Crossing between more productive local chicken lines is a good program to improve performance (Wang *et al.*, 2021; Sungkhapreecha *et al.*, 2022).

Table 2. Average body measurements

Body measurements	Sera chicken	Mera chicken
HeL	35.57±2.58[a]	34.55±2.05[b]
HeC	30.01±1.18[a]	29.00±3.69[b]
HeH	103.61±5.17[a]	100.04±8.71[b]
NeL	107.03±7.27[a]	103.51±5.27[b]
NeC	79.49±4.71[a]	75.03±4.03[b]
WiL	175.42±11.16[a]	170.58±10.65[b]
BaL	181.65±10.32[a]	176.12±15.45[b]
BaH	233.46±12.28[a]	227.37±5.6[b]
ChL	110.39±12.86[a]	104.47±3.81[b]
ChW	50.42±3.09[a]	48.23±2.47[b]
ShL	70.51±4.53[a]	68.87±5.15[b]
ShC	37.09±4.4[a]	34.66±2.42[b]
ThFiL	55.99±7.25[a]	50.82±3.32[b]
PuBD	15.64±0.46[a]	15.21±1.42[b]

Different letter superscripts in the same line for each type of chicken mean significantly different ($p<0.05$).

HeL = Head length, HeH = Head height, HeC = Head circumference, NeL = Neck length, NeC = Neck circumference, WiL = Wings length, BaL = Back length, BaH = Back height, ChL = Chest length, ChW = Chest width, ShL = Shank length, ShC = Shank circumference, ThFiL = Length third finger, PuBD= Pubic bone distance.

Principal Component Analysis (PCA)

The principal component analysis of the body sizes of Sera and Mera chickens is presented in Table 3. The results showed that the total diversity of the first component (PC1) of body size in Sera chickens was 79.8%, and in Mera chickens, it was 70.6%. Meanwhile, the total diversity of the second component (PC2) of the body shape of Sera chickens was 17.7%, and Mera chickens were 7.9%. Principal component analysis is quite effective because it can explain the total variation of PC1 and PC2 and shows that selection based on components with high discriminant values can provide positive results (Amao, 2018). PCA is a multivariate procedure that can solve problems related to growth and related traits.

Table 3. Principal Component Analysis

Type			Equation	TD (%)	Λ
Sera Chicken	Body Size	=	0.257 HeL + 0.278 HeC + 0.036 HeH + 0.305 NeL + 0.277 NeC + 0.163 WiL + 0.172 BaL **+** 0.303 BaH + 0.293 ChL + 0.3 ChW + **0.364 ShL** + 0.294 ShC + 0.339 ThFiL + 0.164 PuBDS	79.8	2.77
	Body Shape	=	- 0.126 HeL + 0.205 HeC + 0.389 HeH - 0.122 NeL + 0.376 NeC - 0.339 WiL - 0.067 BaL **+ 0.42 BaH** - 0.266 ChL + 0.362 ChW - 0.093 ShL - 0.162 ShC - 0.315 ThFiL - 0.053 PuBD	17.7	2.48
Mera Chicken	Body Size	=	0.247 HeL + 0.158 HeC + 0.325 HeH + 0.049 NeL + 0.25 NeC – 0.074 WiL – 0.356 BaL – 0.017 BaH + **0.407 ChL** + 0.327 ChW – 0.312 ShL + 0.319 ShC – 0.235 ThFiL + 0.291 PuBD	70.6	11.29
	Body Shape	=	0.309 HeL + 0.228 HeC + 0.09 HeH + 0.293 NeL + 0.329 NeC + 0.221 WiL + 0.304 BaL **+** 0.311 BaH + 0.242 ChL + 0.143 ChW + **0.401 ShL** + 0.018 ShC + 0.39 ThFiL – 0.146 PuBD	7.9	1.26

HeL = Head length, HeH = Head height, HeC = Head circumference, NeL = Neck length, NeC = Neck circumference, WiL = Wings length, BaL = Back length, BaH = Back height, ChL = Chest length, ChW = Chest width, ShL = Shank length, ShC = Shank circumference, ThFiL = Length third finger, PuBD= Pubic bone distance.

The value of PC1 shows the total diversity in body size of Sera and Mera chickens. The highest value in Sera chickens is shank length, while in Mera chickens, it is breast length. The results show that shank length and breast length can be used to predict the body weight of Sera and Mera chickens because they have the highest value in the chicken body size. According to Amao (2018), the shank length obtained in the PC1 results of local Nigerian birds can be used as a selection reference to increase body weight in a breeding program.

The value of PC2 shows the similarity in body shape of Sera chickens and Mera chickens. The highest value in Sera chickens is body height, while in Mera chickens, it is shank length. The results of the principal component analysis can be used to predict chicken body weight, supported by the opinion of Negash (2021) that PCA is efficient in estimating the body weight of free-range chickens in Ethiopia from body measurements taken. According to Wahyuni *et al.* (2022) body shape equation for Sentul chickens was chest width. Irmaya *et al.* (2021) stated that the highest body shape equation for Merawang chickens was wing length. The differences in body shape characteristics are strongly influenced by genetics.

Conclusion

The quantitative characteristics of Sera chickens are higher than Mera chickens, and the highest body weight gain is at 1-2 months of age. This difference in body weight indicates that there may have been a combination of essential traits from the heterosis effect in the results of this study. Body weight is one of the effects of heterosis, which significantly influences chicken productivity. The body size characteristic of Sera chickens is shank length, while in Mera chickens, it is chest length. The characteristic of the shape of Sera chickens is body height, while in Mera chickens, it is shank length. The results of the principal component analysis can be used to predict chicken body weight.

Conflict of interest

The authors have no conflict of interest to declare.

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Ethics approval

This research was approved by the commitee of ethical clearance for an animal, Faculty of Animal Science Universitas Jambi (Ref.04/UN21.7/ECC/2022).

References

Abdu, M., Gushairiyanto, and Depison. 2021. The relationship of egg weight with doc weight and doc weight with body weight of first generation of sentul chicken (g1). Jurnal Ilmu Peternakan Terpadu 9: 85–96. https://dx.doi.org/10.23960/jipt. v9i3.p279-290.

Amao, S. R. 2018. Application of principal component analysis on the body morphometric of Nigerian Indigenous chickens reared intensively under Southern Guinea Savanna condition of Nigeria. J. Environ. Issues Agric. Dev. Ctries. 10: 1–12.

Amuzu-Aweh, E. N., H. Bovenhuis, D. J. De Koning, and P. Bijma. 2015. Predicting heterosis for egg production traits in crossbred offspring of individual white leghorn sires using genome-wide SNP data. Genet. Sel. Evol. 47: 1–8. https://doi:10.1186/s12711-015-0088-6.

Budiarto, A., L. Hakim, S. Maylinda, G. Ciptadi, V. A. Nurgiatiningsih, and A. Furqon. 2021. Manajemen Pemuliaan Ternak. Media Nusa Creative (MNC Publishing).

Castellini, C., C. Mugnai, L. Moscati, S. Mattioli, M. G. Amato, A. C. Mancinelli, and A. Dal Bosco. 2016. Adaptation to organic rearing system of eight different chicken genotypes: behaviour, welfare and performance. Ital. J. Anim. Sci. 15: 37–46. https://doi:10.1080/1828051X.2015.1131893.

Darwati, S., H. Nurcahya, R. Afnan, V. S. Maulana, and P. Rohamtullah. 2018. Performance of g1 Merawang-Arab crossing growth at 1-12 weeks age. Jurnal Ilmu Produksi dan Teknologi Hasil Peternakan 6: 67–72. https://doi:10.29244/jipthp.6.2.67-72.

Depison, Gushairiyanto, and D. Irmaya. 2022. Characterization phenotype and genetic distance some of the native chicken strains in Jambi Province Indonesia. Iraqi J. Agric. Sci. 53: 1154–1166. https://doi:10.36103/ijas.v53i5.1629.

Ghassani, A. F., D. Depison, and H. Ediyanto. 2022. Association of quantitative characteristics with growth hormone gene (GH Gene) in Kerinci Duck using PCR-RFLP Method. Buletin Peternakan 46: 248. https://doi:10.21059/buletinpeternak.v46i4.75810.

Gultom, L. H. M., G. Gushairiyanto, and D. Depison. 2021. Correlation of Sentul chicken body weight at DOC age of 1, 2 and 3 months. Jurnal Sain Peternakan Indonesia 16: 273–276. https://doi:10.31186/jspi.id.16.3.273-276.

Irmaya, D., Depison, and Gushairiyanto. 2021. Quantitative characteristics of Indonesian native chickens at the age of 4 months. Livest. Anim. Res. 19: 108–119. https://doi.org/10.20961/lar.v19i1.43150.

Khawaja, T., S. H. Khan, N. Mukhtar, and A. Parveen. 2012. Comparative study of

growth performance, meat quality and hematological parameters of Fayoumi, Rhode Island Red and their reciprocal crossbred chickens. Ital. J. Anim. Sci. 11: 211–216. https://doi:10.4081/ijas.2012.e39.

Mamuaja, C. L., B. Rorimpandey, E. Wantasen, and S. Dalie. 2020. Faktor-faktor yang mempengaruhi permintaan daging ayam buras di Pasar Tradisional Kota Manado. Zootec. 40: 20–29. https://doi:10.35792/zot.40.1.2020.26717.

Negash, F. 2021. Application of principal component analysis for predicting body weight of Ethiopian indigenous chicken populations. Trop. Anim. Health Prod. 53: 1–7. https://doi:10.1007/s11250-020-02526-w.

Phocas, F., C. Belloc, J. Bidanel, L. Delaby, J. Y. Dourmad, B. Dumont, P. Ezanno, L. Fortun-Lamothe, G. Foucras, B. Frappat, E. González-García, D. Hazard, C. Larzul, S. Lubac, S. Mignon-Grasteau, C. R. Moreno, M. Tixier-Boichard, and M. Brochard. 2016. Review: Towards the agroecological management of ruminants, pigs and poultry through the development of sustainable breeding programmes. II. Breeding Strategies. Animal. 10: 1760–1769. https://doi:10.1017/S1751731116001051.

Purwantiningsih, T. I., R. Binsasi, and O. C. Araujo. 2022. Pengaruh modifikasi lingkungan terhadap status fisiologis sapi perah di lahan kering. Livest. Anim. Res. 20: 11. https://doi:10.20961/lar.v20i1.55158.

Puteri, N. I., G. Gushairiyanto, and D. Depison. 2020. Growth patterns, body weight, and morphometric of KUB Chicken, Sentul Chicken and Arab Chicken. Bull. Anim. Sci. 44: 67–72. https://doi:10.21059/buletin peternak. v44i3.57016.

Putri, A. B. S. R. N., Gushariyanto, and Depison. 2020. Bobot badan dan karakteristik morfometrik beberapa galur ayam lokal. Jurnal Ilmu dan Teknologi Peternakan Tropis 7: 256–263.

Rahayu, F. F., Depison, and Gushairiyanto. 2021. Performance of Kampung Super chicken and Bangkok chicken first generation (G1) until the age of 12 weeks. Livest. Anim. Res. 19: 326–336.

Razuki, W. M. and S. A. Al-Shaheen. 2011. Use of full diallel cross to estimate crossbreeding effects in laying chickens. Int. J. Poult. Sci. 10: 197–204. https://doi:10.3923/ijps.2011.197.204.

Rowiyanti, W. O., Junaedi, and Suparman. 2021. Bodyweight growth of chicken from cross breed of Kampung chicken with Bangkok chicken. Jurnal Sains dan Teknologi Peternakan 3: 8–11. https://doi:10.31605/jstp.v3i1.1300.

Sari, M., Gushairiyanto, and E. Wiyanto. 2021. The relationship between egg weight with hatching weight and hatching weight with body weight g1 of merawang chicken aged up to 4 months. Jurnal Peternakan 18: 147–159.

Soliman, M. A., M. H. Khalil, K. El-Sabrout, and M. K. Shebl. 2020. Crossing effect for improving egg production traits in chickens involving local and commercial strains. Vet. World. 13: 407–412. https://doi:10.14202/vetworld.2020.407-412.

Sungkhapreecha, P., V. Chankitisakul, M. Duangjinda, and W. Boonkum. 2022. Combining abilities, heterosis, growth performance, and carcass characteristics in a diallel cross from Black-Bone chickens and Thai native chickens. Animals 12: 1–13. https://doi:10.3390/ani 12131602.

Trisiwi, H. F. 2017. Pengaruh level protein pakan pada masa pertumbuhan terhadap penampilan pada awal peneluran ayam betina hasil persilangan ayam kampung jantan dan ayam ras petelur betina. Jurnal Ilmu dan Teknologi Hasil Ternak 12: 61–68.

Trisnawanto, R. Adiwinarti, and W. S. Dilaga. 2012. Correlation of body measurements and body weight of male Dombos. Anim. Agric. J. 1: 653–668.

Utama, M., Depison, Gushairiyanto, and Helmi Ediyanto. 2021. Comparison of fertility, hatchability and quantitative characteristics between KUB chicken and Kampung chicken (G1). Jurnal Ilmu dan Teknologi Peternakan Tropis 9: 95–103. https://doi:10.33772/ jitro.v9i1. 19736.

Wahyuni, Depison, and Gushariyanto. 2022. Comparison of productivity of sentul and kampung chickens until the age of 3 Months in the first generation selection population (G1). Bull. Anim. Sci. 46: 23–30. https://doi:10.21059/buletinpeternak.v46i1. 67045.

Wang, Q., T. Yan, Z. Long, L. Y. Huang, Y. Zhu, Y. Xu, X. Chen, H. Pak, J. Li, D. Wu, Y. Xu, S. Hua, and L. Jiang. 2021. Prediction of heterosis in the recent rapeseed (*Brassica napus*) polyploid by pairing parental nucleotide sequences. PLoS Genet. 17: 1–22. https://doi:10.1371/journal.pgen. 1009879.