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# MORPHOLOGY CHARACTERISTICS COMPARISON OF F1 AND F2-BACKCROSS OF LOCAL AND PEKIN DUCKS IN INDONESIA

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**ABSTRACT**: The purpose of this study was to evaluate the comparison of morphology characteristics of two groups (the F1 and F2 backcross of Local and Pekin ducks at 25 weeks of age) in South Sulawesi Indonesia. The research material used 14 ducks males and 10 ducks females of F1 and 7 ducks males and 14 ducks females of F2-backcross. The data were measured on live weight, shank length, bill length, bill width, wing length, chest circumference, neck length, drumstick length, and thigh length. All mean differences of quantitative data from those two groups were analyzed using Independent T-test. The results showed that the performance of body dimensions of the F1 and F2-backcross of male and female ducks were relatively equal in performance concerning live weight, shank length, bill length, and neck length, respectively. The highest and positive correlation exists between shank length with chest circumference and drumstick (r=0.78) of F1 backcross female duck, between live weight with shank length (r=0.72) of F2-backcross female duck, between shank length with chest circumference (r=0.59) of F1 male duck and between live weight with chest circumference (r=0.84) of F2-backcross male duck, respectively. All measured variables had a coefficient of variation on both generations were less than 15%, except the bill width of the F1 male duck (41.79%) and both sex of thigh length of the F1 duck (24.68% and 23.68%, respectively).

**Keywords:** Breeding, Genetics, Morphology characteristic, Local duck, Pekin duck.

## INTRODUCTION

Local ducks in Indonesia are one ancestor but there are several types of local ducks scattered throughout the archipelago with various names according to their respective regions or locations (Su, 2022). Several local duck breeds in Indonesia, namely the Alabio duck, Bayang duck, Magelang duck, Mojosari duck, Pegagan duck, Pitalah duck, Rambon duck, Tegal duck, and Turi duck (Hariyono et al., 2019). Those were included as important assets by the Indonesian Ministry of Agriculture and play an important role in a socio-economic aspect as they provide a livelihood to smallholders as well as food for humans. Each type of local duck has a very diverse variation. Phenotypic variation can be caused by uncontrolled crossbreeding, even though the parental generation is used to be one family (Besbes, 2009).

Many indigenous animal breeds, including local ducks from South Sulawesi Province Indonesia, still require scientific documentation and characterization to be conserved. As genetic resources, local ducks of South Sulawesi were kept traditionally and cultivated as dual-purpose ducks (as egg producer/laying type) and meat producers/meat type). The weakness of the local South Sulawesi duck is its relatively slow growth character, low live weight, and a large variety of performance compared with meat-type duck (Mahsyar, 2016). Genetic and morphometric diversity are important for breeding management and increasing the productivity of Local ducks of South Sulawesi. Unfortunately, there was limited information regarding the quantitative traits of Local ducks in South Sulawesi province.

There is traditional cuisine (*Nasu Palekko*) from South Sulawesi that uses the meat from rejected female or male of local duck as raw material. Therefore, the meat quality and quantity of Local ducks tend to be lean, tough, and less than optimal. On the other hand, *Nasu palekko*'s consumers love the distinctive smell and toughness of local duck meat (Bugiwati et al., 2021). The specific meat-type of local ducks from South Sulawesi are needed to meet the demand for meat in traditional culinary delights. There are some broiler ducks in Indonesia, such as the Pekin duck from China which is commonly known as a good meat-type duck and has the advantages of several characteristics (large size and body weight, fast growth, high carcass weight, and good carcass quality).

Unfortunately, the meat characteristics of Pekin duck are less favored by expert consumers (Bugiwati et al., 2021; Baéza et al., 2022). Therefore, it is necessary to have a new line of specific meat types of Local duck from South Sulawesi which has better meat quantity and quality, and good adaptability to tropical climatic conditions but still has the specific characteristics smell, and flavors like Local duck meat. It means that the genetic potential of local ducks in South Sulawesi needs to improve to have better meat quality and quantity that is more oriented towards meat-type ducks.



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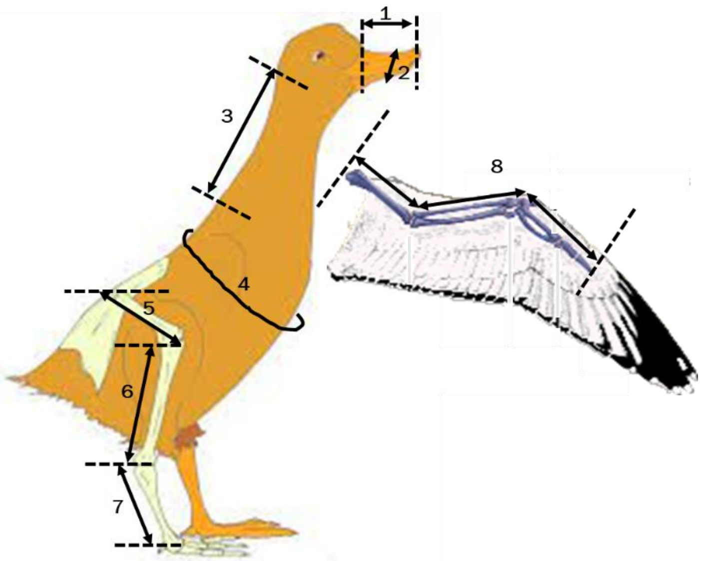
The first step that can be taken to develop the genetics of the Local duck of South Sulawesi is through exploration of the genetic resources of the Local duck. Crossbreeding and back-cross methods will be tried to improve the quality and quantity of Local ducks in South Sulawesi. A backcross hybrid is one method to improve growth and production potentials through the exploitation of heterosis besides forming a new composite meat-type duck line in South Sulawesi. A backcross hybrid is a progeny derived from F1-hybrid mating with a member of one of its parental species and forming an F2-backcross hybrid. Morphometric measurements of different generations can be used as study data for local ducks of South Sulawesi to know genetic characteristic differences inter-generational. The current trend in the improvement of Local ducks relies on the variation between and within breeds of certain traits (Maharani et al., 2019). The aim of this research was to investigate the morphological features of the F1-hybrid and F2-backcross hybrid of crossbreeding between Local with Pekin ducks under intensive management conditions. The study was also conducted to identify the level of phenotypic correlation that exists between the body weight and body measurement of two different generations (F1-hybrid and F2-backcross hybrid of crossbreeding between Local with Pekin ducks) at 25 weeks. The results of this study are expected to provide basic information for the possibility of developing new meat-type Local ducks of South Sulawesi.

## MATERIALS AND METHODS

The data used for this study were progeny from Local and Pekin breeding ducks as a parental generation. The progenies of those parental generations (F1). Then the F1 mated back-cross with their parents (Peking ducks) and produced F2 offspring (F2-backcross). Finally, we used 24 ducks of F1 and 21 ducks of F2-backcross. Each generation was divided into two subgroups, with 14 ducks male and 10 ducks female of F1 and 7 ducks male and 14 ducks female of F2-backcross.

All ducks were reared under an intensive management system at Duck Research Center, Laboratory of Animal Breeding and Genetics, Faculty of Animal Science, Hasanuddin University, Makassar, Indonesia from July 2021 to September 2022. All ducks were kept in a colony cage and used separate fences between groups of ducks. The size cage is nine meters long, and six meters wide with 60 cm of insulated fence. All pens have a concrete floor which is covered by wood shaving and are provided with a feeding and watering space for each pen. Duck feed ration (for 100 kg) contains 33 kg pollard, 30 kg bran, 15 kg corn, 20 kg concentrate, and 2 kg mineral mix. The feed nutrition contents are crude protein min 16%, crude fat min 3%, crude fiber max 8%, calcium 4.25%, phosphor 1%, lysine min 0.70%, methionine min 0.30%, methionine + cysteine min 0,5% and tryptophan min 0.15%, respectively. The total feed base on the wet feed system was 200 g per bird/day and was provided two times a day. Throughout the study, ducks had unrestricted access to water.

The morphometric characteristics data were collected from the F1 and F2-backcross of Local and Pekin Duck. Live weight and all body measurements were always taken in the morning before supplying feed and water to make the homogeneity of data. The morphometric characteristic measured were shank length (cm), bill length (cm), bill width (cm), wing length (cm), chest circumference (cm), neck length (cm), drumstick length (cm), and thigh length (cm), respectively were measured on spot by using a standard measuring tape calibrated in centimeters with an accuracy of 1 mm. Ducks were individually weighed every two weeks with an electronic hook scale to within 5 g up to the 25$^{th}$ week of age. The anatomical reference points were shown in Figure 1.




1. Bill length
2. Bill width
3. Neck length
4. Chest circumference
5. Thigh length
6. Drumstick length
7. Shank length
8. Wing length

**Figure 1 -** Main measurement taken on duck

### Statistical analysis

Arithmetic means and standard deviation of the mean (collectively for both groups) were calculated for each tested trait. In the first stage of the analysis, the Shapiro-Wilk test and Kruskal Wallis normality test were applied to the data set. The homogeneity test was analyzed with the Levene test. A coefficient of variation for the data on quantitative traits at various duck populations was performed. The simple correlation (r) between live weight and body measurements was calculated. The differences between the mean values of all compared generations, as well as between males and females, were determined using Independent Sample T-test and be considered significant at *p<0.05*. SPSS package (version 25) was used for the statistical analysis. Animal care and maintenance were performed in accordance with the Protocol stated in the Republic of Indonesia's law (number 41-2014) regarding guidelines of Animal Welfare Standards for Research Treatment in Indonesia.

## RESULTS AND DISCUSSION

Table 1 shows descriptive statistics for all morphometric characteristics of the male and female F1 and F2-backcross duck. F1 ducks were considerably significantly (p<0.05) and longer in bill length (female), wing length (male), chest circumference (male and female), drumstick length (male and female), and thigh length (male), respectively than F2-backcross duck. There were no marked differences in live weight, shank length, bill width, and neck length (both male and female) and for bill length (male), wing and thigh length (female), respectively of F1 and F2-backcross ducks.

**Table 1** - Mean, standard of deviation, and coefficient of variation of morphometric traits of male and female F1 and F2-backcross duck (at 25 weeks of age).

| Traits | Sex | Generation | | | | Level of sig. |
|---|---|---|---|---|---|---|
| | | F1[1] | CV (%) | F2-backcross[1] | CV (%) | |
| Live weight (kg) | M | 1.54 ± 0.15 (14) | 9.74 | 1.39 ± 0.18 (7) | 12.94 | NS |
| | F | 1.38 ± 0.14 (10) | 10.15 | 1.27 ± 0.13 (14) | 10.23 | NS |
| Shank length (cm) | M | 5.98 ± 0.60 (14) | 10.03 | 5.63 ± 0.48 (7) | 8.53 | NS |
| | F | 5.59 ± 0.57 (10) | 10.19 | 5.34 ± 0.67 (14) | 12.56 | NS |
| Bill length (cm) | M | 6.76 ± 0.32 (14) | 4.73 | 6.55 ± 0.59 (7) | 9.01 | NS |
| | F | 6.55 ± 0.28 $^{a}$ (10) | 4.28 | 6.25 ± 0.34 $^{b}$ (14) | 5.44 | * |
| Bill width (cm) | M | 3.23 ± 1.35 (14) | 41.79 | 2.70 ± 0.16 (7) | 5.93 | NS |
| | F | 2.65 ± 0.24 (10) | 9.06 | 2.63 ± 0.14 (14) | 5.23 | NS |
| Wing length (cm) | M | 27.54 ± 2.05 $^{a}$ (14) | 7.44 | 24.70 ± 2.75 $^{b}$ (7) | 11.13 | * |
| | F | 25.90 ± 3.19 (10) | 12.32 | 25.03 ± 0.79 (14) | 3.16 | NS |
| Chest circumference (cm) | M | 30.08 ± 1.54 $^{a}$ (14) | 5.12 | 27.81 ± 1.18 $^{b}$ (7) | 4.24 | * |
| | F | 28.57 ± 1.43 $^{a}$ (10) | 5.01 | 26.96 ± 1.50 $^{b}$ (14) | 5.56 | * |
| Neck length (cm) | M | 20.31 ± 2.79 (14) | 13.74 | 19.44 ± 2.31 (7) | 11.88 | NS |
| | F | 19.08 ± 1.36 (10) | 7.13 | 18.21 ± 1.66 (14) | 9.12 | NS |
| Drumstick length (cm) | M | 12.04 ± 0.57 $^{a}$ (14) | 4.73 | 11.09 ± 0.79 $^{b}$ (7) | 7.12 | * |
| | F | 11.60 ± 0.88 $^{a}$ (10) | 7.59 | 10.39 ± 0.75 $^{b}$ (14) | 7.22 | * |
| Thigh length (cm) | M | 9.36 ±2.31 $^{a}$ (14) | 24.68 | 7.70 ± 0.71 $^{b}$ (7) | 9.22 | * |
| | F | 8.53 ± 2.02 (10) | 23.68 | 7.51 ± 0.84 (14) | 11.19 | NS |

[1] values in the parentheses indicate the number of observations; $^{a,b}$= Means within a column with different superscripts differ significantly (*p<0.05). NS= not significant; M: Male; F: Female; CV= Coefficient of Variation

Body dimensions will significantly determine the body size of the animal. Therefore, it can be used as a parameter in growth. Differences in body size parts in various breeds of ducks are influenced by the environment in which these ducks live and the genetic influence of each breed.

The average live weights were 1.54 kg of duck male F1, 1.39 kg of duck male F2-backcross, 1.38 kg of female duck of F1, and 1.27 kg of female duck F2-backcross, respectively. There are no significant differences between those generations. A similar result was reported on the Talang Benih female duck at 1.38 kg (Kususiyah and Desia, 2008). Hidayati and Desrita (2021) reported the results body weight of Sawang female duck (1.45 kg). El-Deghadi et al. (2022) reported a rather similar live weight (1.667 kg) of the Domyati duck breed at 20$^{th}$ weeks of age compared with male duck F1 at 25$^{th}$ weeks of age. The average live weight of F1 and F2-backcross ducks was lower than Morduzzaman et al. (2016) who reported average adult body weight of Nageswari duck was 1.66 kg in males and 1.51 kg in females.

In the present observation, the shank length of the F1 and F2-backcross was recorded as 5.98 cm Vs 5.63 cm (male duck) and 5.59 cm vs 5.34 cm (female duck), respectively. There are no significant differences between those generations. Shorter shank lengths were shown by a female duck (4.75 cm) of Sawang duck (4.38 cm; Hidayat and Desrita, 2021).

The average bill length was found to be 6.76 cm (male duck) and 6.55 cm (female duck) for F1 and 6.55 cm (male duck) and 6.25 cm (female duck) for F2-backcross. There are no significant differences between male duck grups. Ajit et al. (2009) reported relatively similar bill lengths in Chara duck (6.70 cm) and Chemballi ducks (6.80 cm). Matitaputty (2012) also found a long bill length of the Cihateup duck (6.79 cm). Ajit et al. (2009) showed that Chemballi female ducks have nearly similar bill lengths (6.30 cm) compared to the F2 backcross of female ducks. Matitaputty (2012) reported that Alabio male ducks (6.59 cm) have longer bill lengths than F1 (female) and F2-backcross (male and female). Shorter bill lengths were reported on the Nageswari male duck (5.87 cm) in Bangladesh (Morduzzaman et al, 2016). A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similar finding of shorter bill length for Nageswari duck of Bangladesh (5.54 cm) (Morduzzaman et al., 2016), and Cirebon duck (5.55 cm) (Maharani et al., 2019), respectively.

Wing lengths of both F1 and F2-backcross ducks were shorter than those of the Cihateup duck (28.87 cm of males and 26.83 cm of females) (Matitaputty and Suryana, 2015), respectively. But the Cihateup female duck (21.6 cm) has a shorter wing length compared with F1 or F2-backcross. The chest circumference of the F1 duck is different from the F2-backcross duck (male of 30.08 cm vs. 27.81 cm) and female (28.57 cm vs. 26.96 cm). These results were lower compared to Magelang duck male (33.57 cm) (Rahayu et al., 2022)

In the present study, the average neck length (cm) recorded was no significant difference between the F1 and F2-backcross (male of 20.31 cm and 19.44 cm and female of 19.08 cm and 18.21 cm), respectively. Those results were shorter than the Cihateup duck male 24.36 cm and female 20.93 cm (Matitaputty, 2012), and the Cihateup duck male of 25.5 cm (Dudi, 2007), respectively. The overall mean value of neck length of female F1 and F2-backcross were longer than Alabio female duck (17.14 cm), Magelang female duck (14.83 cm), Rambon female duck (15.45 cm), Pegagan female duck (16.51 cm), and Pitalah female duck (16.40 cm), respectively (Maharani et al., 2019). The variation in bill length and neck length might be due to the differences in the breed. The neck length of the Indian local duck breed tended to be shorter than the Indonesian Local duck breed. Morduzzaman et al. (2016) found that the neck length of the Nageswari duck ranged between 23.46 cm (male) and 21.59 cm (female), which was longer than the current study. Matitaputty (2012) reported that Cihateup male ducks have longer drumsticks (12.32 cm) than those of the F1 and F2-backcross. However, both sexes of Cihateup duck show shorter thigh lengths (male of 6.45 cm and female of 7.26 cm) than those of the F1 and F2-backcross.

Our results revealed that generation and mating effects on some traits were significantly different ($p<0.05$). Many backcrosses are required to produce a new cultivar. The reciprocal crosses among breeds of ducks increased the morphometric measurements (Henrik et al., 2018). Ayorinde and Oke (1995) reported that variation in body weight within a flock can be attributed to genetic variation and environmental factors that influence an individual's performance. The differences in the value of morphometric characteristics might be due to the variation in the duck size, age, and conformation of the distinct variety of duck breeds, differences in genetic ability among those breeds include the effect of hybrid groups besides feeding and management practices. On the other, the difference in the body dimension of different varieties of indigenous local ducks might be attributed to the variation among indigenous germplasm and adaptability to the rearing environment.

All measured variables have a coefficient of variation is less than 15 % except bill width (male F1 of 41.79%) and thigh length (male and female F1 of 24.68% and 23.68%, respectively). These results show that the variance of traits is relative homogeny. This indicates that the size of all the variables is uniform. It is stated that it is recommended to do crossbreeding to improve the genetic quality and quantity of local ducks in South Sulawesi. The genetic diversity level will produce quantitative and qualitative phenotypes in ducks. This information can be used as one of the breeding decisions. Conventional duck breeding activities can be based on production performance related to certain phenotypic traits. The variation of a trait within a population could be the basis for the implementation of selection for the implementation of livestock breeding programs. Reciprocal crosses can trigger the emergence of phenotypic variations in the morphometric traits of ducks due to the heterosis results of reciprocal crosses (Henrik et al., 2018).

### Correlations among live weight and some linear body measurements

The relationships existing among linear body measurements provide useful information on performance, productivity, and carcass characteristics. The phenotypic correlations between live weight and linear body measurement traits of F1 and F2-backcross of Local and Pekin ducks male and female at 25 weeks of age are presented in Table 2. The results of F1 male duck showed that chest circumference was significant ($p<0.05$) and positively correlated with shank length (0.59) and with drumstick length (0.57). Neck length was significantly ($p<0.05$) and negatively correlated with body length (-0.62) and drumstick length (-0.55). The results of the F1 female duck showed that shank length was high significantly ($p<0.01$) and positively correlated with chest circumference (0.78) and with drumstick length (0.78). Live weight was significant ($p<0.05$) and positively correlated with wing length (0.76), shank length with body length (0.65) and neck length (0.64), body length with wing length (0.64). The value obtains for the coefficient of correlation at 25 weeks of live weight and wing length agreed with literature values reported by Ologbose and Mbara (2020) using Muscovy duck at week 4 (0.71) and Mallard duck at 4 weeks (0.75), respectively. Significant ($p<0.05$) but negative correlation showed at live weight with shank length (-0.66) and highly significant ($p<0.01$) and negative correlation showed at neck length with drumstick (-0.77).

Positive and significant ($p<0.05$) correlation of F2-backcross female duck only existed between chest circumference with live weight (0.84). This result is in line with the report of Ologbose and Mbara (2020) who recorded positively high phenotypic correlation estimates in mallard ducks. Positive and significant ($p<0.05$) correlation of F2-backcross male showed at shank length with live weight (0.72), with body length (0.59), and with neck length (0.56). It was also observed that chest circumference was positively correlated with body length (0.58), and neck length with wing length (0.57). This positive and mostly significant phenotypic relationship between live weight and some body measurements indicates that an improvement in one trait could lead to an improvement in the other if they do demonstrate a positive association (Olanwumi et al., 2011).



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**Table 2** - Phenotypic correlation among traits of F1 and F2-backcross of Local and Pekin duck at 25 weeks of age.

| | LW | SL | BL | BW | WL | CC | NL | TL | DL |
|---|---|---|---|---|---|---|---|---|---|
| LW | | - 0.66* | -0.73* | NS | 0.76* | NS | NS | NS | NS |
| | | 0.72* | NS | NS | NS | NS | NS | NS | NS |
| SL | NS | | 0.65* | NS | NS | 0.78** | 0.64* | NS | 0.78** |
| | NS | | 0.59* | NS | 0.68** | NS | 0.56* | NS | NS |
| BL | NS | NS | | NS | 0.64* | NS | NS | NS | NS |
| | NS | NS | | NS | NS | 0.58* | NS | NS | NS |
| BW | NS | NS | NS | | NS | NS | NS | NS | NS |
| | NS | NS | NS | | NS | NS | NS | NS | NS |
| WL | NS | NS | NS | NS | | NS | NS | NS | NS |
| | NS | NS | NS | NS | | NS | 0.57* | NS | NS |
| CC | NS | 0.59* | NS | NS | NS | | NS | NS | NS |
| | 0.84* | NS | NS | NS | NS | | | NS | NS |
| NL | NS | NS | -0.62* | NS | NS | NS | | NS | -0.77** |
| | NS | NS | NS | NS | NS | NS | | NS | NS |
| TL | NS | NS | NS | NS | NS | NS | NS | | NS |
| | NS | NS | NS | NS | NS | NS | NS | | NS |
| DL | NS | NS | NS | NS | NS | 0.57* | -0.55* | NS | |
| | NS | NS | NS | NS | NS | NS | NS | NS | |

Female: above the diagonal; Male: under the diagonal; Upper: F1 ; Below: F2-backcross; *P<0.05; NS = not significant; LW: Live Weight, SL: Shank Length, BL: Bill Length, BW: Bill Width, WL: Wing Length, CC: Chest Circumference, NL: Neck Length, TL: Thigh Length, DL: Drumstick Length

The coefficient of correlation from this study varied from strong to moderate, positive, and significant to most of the generations considered. Correlation coefficients indicate the strength of a linear relationship between traits and thus provide valuable information about the traits involved in breeding and improvement plan. The results show favorable relationships exist among traits with higher correlation coefficients. Generally, there are no significant differences between F1 and F2-backcross in their morphological characteristics. Those results revealed that the body dimensions of the F1 and F2-backcross are relatively equal in performance in relevancy to live weight, shank length, bill length, and neck length for each sexual. Pekin duck can also be used to upgrade local ducks of South Sulawesi for better performance in a systematic breeding program. Therefore, present information could aid the management, conservation, future selection, and breeding programs of local ducks from South Sulawesi.

## CONCLUSION

The morphological characteristics of the F1 and F2-backcross of Local and Pekin ducks were relatively similar. Improving the genetic quality and quantity of local ducks in South Sulawesi should use the crossbreeding method. It is advisable to research the optimal growth age of duck (1-8 weeks of age)

## DECLARATIONS

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**Authors' contribution**

SRA. Bugiwati led and fully managed the research project and was responsible for data collection, data analysis, the write-up of the manuscript, and the publication process; MIA. Dagong contributed to interpreting research data and the write-up of the manuscript; L. Rahim contributed to the provision of library resources and translation process; M. Malloangeng, A. As, and M. Zulkifli were responsible for data collection and data input.

**Conflict of interests**

The authors have declared no conflict of interest.

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