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Research Article

Growth Curve and Heterosis Effect of Egg Weight, Doc Weight, Fertility and Hatchability from Crossing of Sentul Debu and Kulawu Chicken at Poultry Breeding Jatiwangi

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Abstract | This study aim is to know the growth curve and the heterosis effect of egg weight, Day Old Chicken weight, fertility, and hatchability from crossbreeding of Sentul Debu and Sentul Kulawu in Poultry Breeding Jatiwangi. The layer period was examined using a sample of 319 chickens selected from two different groups. The first group consisted of 13 males and 147 females Sentul Debu chicken aged 11 months, while the second group consisted of 13 males and 146 females Sentul Kulawu chicken aged 14 months. The hatching eggs produced from breeding one line and crossbreeding were hatched for 21 days, resulting in fertility, and hatchability was calculated as a value of the heterosis effect. Each DOC was identified by wing tagging as identification in body weight at 1-12 weeks. These data are needed to calculate the heterosis effect and measure the growth curve to estimate body weight using the Logistic model. The study showed that the Sentul Kulawu male line of Sentul chickens had the highest body weight of 931.58 grams at 12 weeks of age. In contrast, the crossbreeding between Sentul Kulawu males and Sentul Debu females, produced by Sentul males, had the highest body weight of 973.62 grams at the same age. The research methodology used to measure the heterosis effect involved comparing the average parent with the average crossbreeding in terms of egg weight, DOC weight, fertility, and hatchability parameters. The results indicated that the crossbreeding between Sentul Debu and Sentul Kulawu chicken lines had a negative heterosis effect value for egg weight, DOC weight, and fertility, but a positive heterosis effect for hatchability.

Keywords | Growth curve, Heterosis, Sentul debu, Sentul kulawu, Hatchability, Poultry

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INTRODUCTION

Sentul chicken is one of 32 local chicken breeds in Indonesia originally from Ciamis, West Java (Nataamidjaya, 2000). Sentul chicken types, categorized by the color of their feathers, include Sentul Geni (reddish ash), Sentul Batu (blackish ash), Sentul Kulawu (plain ash), Sentul Debu (ash Debu), Sentul Jambe (ash with orange-red), and Sentul Emas (gold-yellowish ash). Sentul chickens have superior traits compared to local chickens, due to their relatively fast growth and high egg production. The Sentul Debu chicken is more commonly referred to as the Sentul Kulawu chicken. When raised in an indolent manner, its body weight at 10 weeks reaches 1.10 kg-1.20 kg on finisher chickens. Male Sentul Kulawu chickens have a faster growth rate than females, so male Sentul Kulawu chickens at the same age have a more significant body weight than females. If the female Sentul Kulawu chicken has reached culling age around 2-2.5 years old, it can be sold with a body weight of around 1.5-2.75 kg.

Sentul Debu chicken has almost the same characteristics as Sentul Kulawu chicken, only the color difference, but the advantage of Sentul Debu chicken is that it is easy to breed. Thus, the fertility and hatchability are higher than Sentul Kulawu chicken.

Sentul Debu chickens have the advantage of an earlier age of egg production compared to the Sentul Kulawu chickens. Sentul Debu and Sentul Kulawu chickens are not susceptible to disease due to their good immune system coupled with optimal biosecurity handling. The Sentul Debu chicken's clean appearance, attractive exterior, and lighter colored feathers and meat make it a preferred choice among consumers. However, Sentul Kulawu chicken also began to attract consumers after selecting the performance of meat color and shank color, which was initially rather dark in color, is now lighter in color.

The definition of growth is a normal process of increasing the size and consistency of the tissue of origin. Growth can occur by increasing the number of cells, called hyperplasia, and can also increase the size of cells, called hypertrophy. There are two basic things in animal growth: weight gain, called growth, and changes in shape, called development. Growth is one of the essential factors to determine the development of body weight. This growth is an irreversible process of cell increase and is a quantitative trait because it can be known through weight gain.

The growth rate reflects an individual animal's ability to display its genetic potential and the development of body parts until adulthood. Growth curves are one way of looking at personal growth rates. This curve has many models, ranging from simple linear regression curves to complex curves such as nonlinear curves. Nonlinear curve models commonly used to estimate growth include the Gompertz, Logistic, Brody, Weibull, Morgan Mercer Flodien (MMF), and Richards models (Inounu *et al*., 2007).

Selection of both male and female Sentul chickens by crossbreeding to produce Sentul chickens get better production results than their parents. The results of crossing the two types of Sentul will be known how much difference the increase in productivity of its parents. In addition to crossbreeding, it must also be considered in its maintenance starting from the initial production performance, such as the parent's age, body weight, egg weight, days-old chick (DOC) weight, fertility, and hatchability. Early performance is the key to the success of subsequent production performance.

The objective of this study is to explore the possibility of heterosis in the offspring produced from crosses between Sentul Debu and Sentul Kulawu chicken breeds, for various important production traits. The study also intends to determine the growth rate of Sentul Chickens from these crosses by analyzing growth curves. The research will focus on investigating the growth curve and heterosis effect of egg weight, DOC weight, fertility, and hatchability in Sentul Debu and Kulawu chicken breeds' crosses at Poultry Breeding Jatiwangi.

MATERIALS AND METHODS

Materials of research

This study utilized 319 breeder chickens, comprising of Sentul Debu and Sentul Kulawu Chickens. Egg production from Sentul Debu and Sentul Kulawu Chickens from male and female crosses at the Poultry Breeding Development Center (BPPT) Jatiwangi Majalengka, West Java. The chickens used in this study were raised in two postal cages with litter bedding, measuring 4x5 meters, at the Jatiwangi Poultry Development and Breeding Center. Layer cages for brooders and starter cages for 1 day old or DOC until 6 weeks old then at 6-12 weeks old moved to grower cages. Density of local chicken cages with postal system < 3 weeks 40 chicken/m^2; 3-6 weeks 20 chickens/m^2; 6-18 weeks 10 chickens/m^2; > 18 weeks 5-6 chickens/m^2. Feed was provided ad libitum, but given in four equal portions throughout the day (morning, afternoon, evening, and night), while water was provided ad libitum. The complete feed given to Sentul chickens in this study is made from several feed ingredients, namely corn, bran, soybean meal, meat and bone meal, wheat fractions, canola, calcium, phosphorus, vitamins, trace minerals, and anti-oxidants. Animal handling was conducted by research staffs who were animal specialists with either a PhD or MS in Animal Science, as well as veterinary practitioners.

Research methods

The research was conducted using quantitative descriptive statistical analysis. For maintenance and data collection was carried out at the Poultry Breeding Jatiwangi Majalengka West Java on the performance of Sentul Chickens from the crossbreeding of Sentul Debu and Sentul Kulawu males and females studied. Data collection was carried out every day weighing egg weights, body weight every week, recording fertility and hatchability.

Statistical analysis

Research data were collected and then analyzed using statistical methods to answer problem identification. The research data were calculated using descriptive statistics, including minimum value, maximum value, average, standard deviation, and coefficient of variation (Sujana, 2005). Sentul chicken body weight data from Sentul Debu and Sentul Kulawu crosses for growth curves were analyzed using descriptive statistical analysis using the Curve Expert Logistic model program. This logistic curve

has the advantage of accuracy and is very good at describing growth (Anang *et al.*, 2017). The logistic model has the highest coefficient of determination at 99.95%.

Logistic model: y= a/(1+bc)^(-cx)

Description: y: Estimated body weight (g), x: Age of livestock (weeks), a: Maximum growth response (asymptote), b: Scale parameter related to initial weight, c: Intristic growth rate, e: Natural number (2.7182).

The calculation of the presumptive body weight is obtained from the logistic equation by reducing the presumptive body weight at the weekly weighing to be sought minus the body weight in the previous week. In determining the standard body weight, it is necessary to calculate the standard error (Se) and the coefficient of determination (R) and take the minimum average body weight. The smaller the Se value, the better the prediction, and the closer to 1 the value of R2, the more precise the estimation.

Standard error: $Se=\sqrt{(s^2/n)}$

Description: Se: Standard error, s: Variation, n: Number of data.

Coefficient of determination: R^2 = (JK Reg)/(JK Total)

Standardized body weight and minimum body weight gain is Y - Se.

Heterosis effect data were analyzed on egg weight, doc weight, fertility and hatchability of the crosses of both Sentul Debu and Sentul Kulawu Chickens. Heterosis is a term used to describe the phenomenon of a cross whose average offspring superiority exceeds that of its parents. The heterosis (%)of the reciprocal cross between the selected Sentul Debu and Sentul Kulawu chickens was calculated according to the formula proposed by Poehlman and Sleper (1995):

$$\text{Heterosis (\%)} = ((F1-MP)/MP) \times 100$$

Where F1 is the mean value of F1 and MP is the mean value of two parents involved in the cross. So, the formula for the Sentul Debu and Sentul Kulawu chickens:

Heterosis (%)=(the average of the cross (DK) - the average of the elders (DD and KK))/(the average of the elders (DD and KK)) x 100%
Heterosis (%)=(the average of the cross (KD) - the average of the elders (DD and KK))/(the average of the elders (DD and KK)) x 100%

Notes: KD = Sentul Kulawu Chicken ♂ x Sentul Debu Chicken ♀, DK = Sentul Debu Chicken ♂ x Sentul Kulawu Chicken ♀, DD = Sentul Debu Chicken ♂ x Sentul Debu Chicken ♀, KK = Sentul Kulawu Chicken ♂ x Sentul Kulawu Chicken ♀.

RESULTS AND DISCUSSION

Body weight

Body weight data of Sentul Debu and Sentul Kulawu chickens for 12 weeks in this study are presented in Table 1. Based on the table, the highest body weight from the cross of male Sentul Kulawu (JK) and female Kulawu (BK) produced Sentul male chicken with a weight of 931.58 grams with an average of 462.68 grams/week. The highest body weight of the reversed cross (between strains) came from the cross of Kulawu males (JK) and Debu females (BD), with the male sex of 973.62 grams and an average body weight of 471.24 grams/week.

The calculation of body weight at 12 weeks of age from the crossing of male Sentul Debu chicken (JD) and female Debu (BD), the lowest was shown by the female sex, which was 765.57 grams with an average body weight achieved of 379.99 grams/week. The body weight of the reversed cross (between strains), the lowest, was obtained from the cross of male Debu (JD) and female Kulawu (BK), which was 686.49 grams with an average body weight of 351.47 grams/week. This is consistent with the research of Suryana *et al.* (2011), which suggests that body weight gain is influenced by sex, feed, and genetic factors. Additionally, Prayogo *et al.* (2017) stated that livestock growth is affected by genetic factors such as strain, sex, and environmental factors such as feed, climate, and maintenance management and their interactions.

In breeder chickens, the feed used is based on the principle of low nutrition for optimum reproduction, this is to ensure optimal egg production and fertility during the production cycle. Female broiler breeders must meet a minimum nutrient intake prior to photostimulation to ensure subsequent egg production and fertility (Walsh and Brake, 1997). The same may apply to male broiler breeders in maintaining their reproductive performance (de Reviers and Seigneurin, 1990). Excessive nutrient intake after peak can lead to overweight birds, reduced production and fertility as they age (Meijerhof, 2011). Feed management must be strictly controlled during the rearing and breeding phases.

Measurement of body weight of male sentul chickens resulting from crossbreeding of male Sentul Debu-Female Sentul Kulawu (JD-BK) and crossbreeding of male Sentul Kulawu-Female Sentul Debu (JK-BD)

The growth curve of male Sentul JD-BK chicken can be

seen in Figure 1. The Figure shows no significant difference between the expected and actual body weights. The difference between the estimated and accurate body weight data is relatively small. The correlation coefficient (r) value obtained is 0.998. This result shows a high match with the data obtained in this study. Sembiring (2003) states that the value (r) in the regression model, which is close to 1.00, indicates that the level of fit of the data with the model is getting better. The lower the SE value in a regression model, the better the regression model will predict the dependent variable. A reasonable model estimate is described with an r value close to 1. The standard error (SE) in this study is 17.65. The closer the r value is to 1, the smaller the SE value, the better the model.

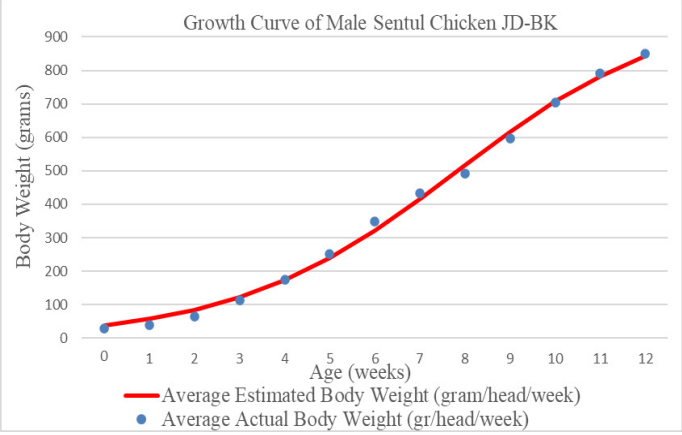

Figure 1: The estimation growth curve of body weight in male Sentul chickens crossed between female Kulawu-Debu (JD-BK) lines.

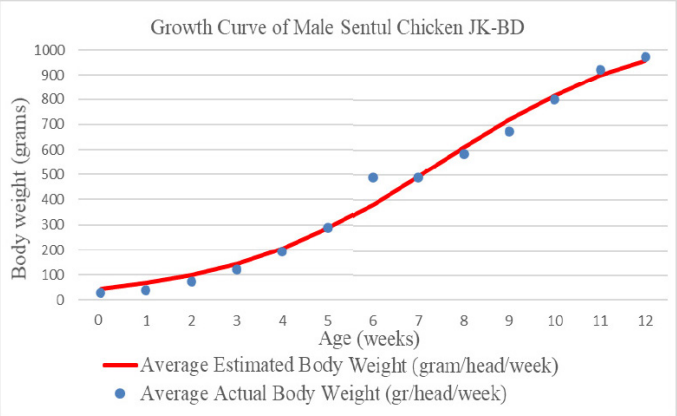

Figure 2: The estimation growth curve of body weight in male Sentul chickens crossed between male Kulawu and female Debu (JK-BD) lines.

Based on Figure 2, the coefficients a, b, and c are known as determinants of the shape of the curve model used, namely (a) of 1100.247, then the value of the scale parameter associated with the initial weight (b) of 23.589 and the value of the intrinsic growth rate (c) of 0.423. The value of x indicates the animal's age (weeks), and y indicates the estimated body weight (grams).

Measurement of body weight of female sentul chickens resulting from crossbreeding of male Sentul Debu-Female Sentul Kulawu (JD-BK) and crossbreeding of male Sentul Kulawu Female Debu (JK-BD)

Based on Figure 3 the maximum growth response value (a) is 793.129, while the scale parameter value related to initial weight (b) is 21.549, and the intrinsic growth rate value (c) is 0.421. The value of x indicates the age of the animal (weeks), and y indicates the presumptive body weight (grams). Body weight is depicted through a red striped curve. Actual body weight is shown with blue dots. There is little difference between the presumptive and actual body weights; thus, the natural and hypothetical body weights tend to be the same.

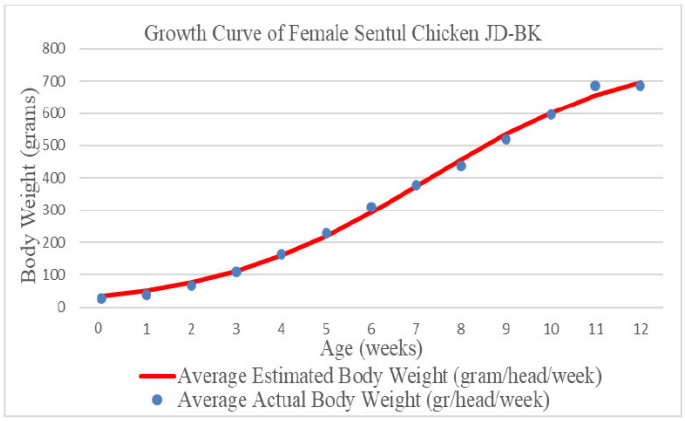

Figure 3: The estimation growth curve of body weight in female Sentul chickens crossed with male Sentul Debu and female Sentul Kulawu (JD-BK) lines.

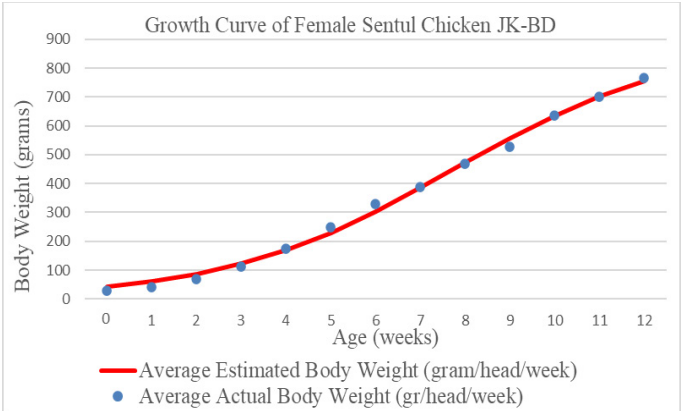

Figure 4: The estimation growth curve of body weight in female Sentul chickens crossed with male Kulawu and female Sentul Debu (JK-BD) lines.

Based on Figure 4 the coefficients a, b, and c determine the shape of the growth curve model used. The maximum growth response value (a) is 893.062, then the scale parameter value associated with the initial weight (b) is 20.517, and the intrinsic growth rate value (c) is 0.392. The value of x indicates the age of the animal (weeks), and y indicates the estimated body weight (grams).

Table 1: Average body weight of Sentul chickens aged 1-12 weeks.

Age (weeks)	Body weight							
	DD male	DD female	Male KK	Female KK	JD-BK male	JD-BK female	JK-BD male	JK-BD female
	Gram							
Hatching weight	30.21	30.48	29.56	29.13	28.65	28.11	28.36	28.21
1	48.26	47.39	48.30	47.09	39.63	39.96	40.03	41.33
2	84.25	80.95	86.47	81.06	64.68	66.18	72.26	69.25
3	140.85	128.62	141.51	129.40	112.63	108.51	120.10	112.50
4	208.52	190.10	216.23	193.56	174.82	162.98	193.44	175.50
5	299.87	266.87	307.51	272.66	250.95	227.58	289.26	248.88
6	401.05	345.62	405.72	351.51	347.45	310.93	491.77	328.96
7	483.64	409.07	512.16	435.41	433.87	377.80	491.77	387.88
8	590.33	482.56	544.19	534.35	492.47	437.22	584.79	469.54
9	679.55	554.59	704.09	587.19	597.26	518.91	674.51	527.33
10	785.00	627.87	803.51	676.47	704.65	595.60	803.21	635.71
11	793.33	660.66	850.88	695.59	790.31	685.44	920.08	701.67
12	960.00	765.57	931.58	777.94	848.84	686.49	973.62	765.54
Average/Week	456.22	379.99	462.68	398.52	404.80	351.47	471.24	372.01

Description DD male = crossing of Debu parents (one strain) produced Sentul males; DD female= crossing of Debu parents (one strain) produced Sentul females; Male KK= crossing of Kulawu parents (one strain) produced Sentul males; Female KK = crossing of Kulawu parents (one strain) produced Sentul females; JD-BK male = crossing of Debu males with Kulawu females (inter-strain) produced Sentul males. JD-BK female= crossing of Debu males with Kulawu females (inter-strain) produced Sentul females; JK-BD male = crossing of Kulawu male with a Debu female (inter-strain) produced a Sentul male. JK-BD female = crossing a Kulawu male with a Debu female (inter-strain) produced a Sentul female.

Heterosis effect

The average egg weight, DOC weight, fertility, and hatchability of Sentul chicken matings of single strains and crosses between strains are shown in Table 2. The egg weight of Sentul chicken crossing one Kulawu strain is higher than crossing one Debu strain, which is 43.91 grams and 43.54 grams. Based on the average egg weight of the cross between strains, the egg weight of the cross of Debu males and Kulawu females is higher than the cross of Kulawu males and Debu females, which was 43.25 grams and 42.97 grams.

Table 2: Mean egg weight, DOC weight, fertility and hatchability of single-grain and inter-grain sentul chicken crosses.

Parameters	Average value of each cross			
	DD	KK	JD-BK	JK-BD
Egg weight (gram)	43.54	43.91	43.25	42.97
DOC weight (gram)	30.48	29.15	26.00	28.00
Fertility (%)	82.00	79.20	76.20	73.63
Hatchability (%)	68.53	65.02	71.56	71.74

Description: DD = cross of female Sentul Debu and male Debu (one strain). KK = cross of female Sentul Kulawu and male Sentul Kulawu (one strain). JD-BK = cross between male Sentul Debu and female Sentul Kulawu chicken (between strains). JK-BD = cross between male Sentul Kulawu and female Sentul Debu (between strains).

DOC weight in single-strain mating and crossing between Sentul Debu and Sentul Kulawu chicken strains was highest in single-strain mating of Sentul Debu chicken, single-strain mating of Sentul Kulawu then crossing between strains. The DOC weight of one strain of Sentul Debu and Sentul Kulawu is 30.48 grams and 29.15 grams. The highest inter-strain DOC weight was the crossing of Sentul male and female Kulawu compared to the crossing of male Sentul Debu and female Sentul Kulawu, namely 28 grams and 26 grams. Hatching weight is a weight obtained from the weighing of newly hatched chicks (DOC). This weighing is done after the DOC feathers have dried.

Based on Table 2 the results of the study obtained the average value of fertility both mating one strain or crossing between strains as follows: the average value of fertility is 82%; Sentul Kulawu chicken one strain 79.20%; Sentul chicken between strains Sentul male Debu female Kulawu 76.20%, crossing Sentul chicken between strains male Kulawu female Debu 73.63%. Fertility is strongly influenced by several factors, including climate, breed or variety of chickens, mating system, feed, health, parent age, male-female ratio during mating, egg management before entering the hatching machine, including the selection of hatching egg weight and hatching egg storage (Rahayu *et al*., 2005; Budi *et al*., 2008; Suryani *et al*., 2012; Sari, 2012; Zakaria, 2010).

The average percentage of hatching weight of one-strain and inter-strain Sentul chickens is in line with Dewanti (2014), that hatching weight ranges from 60-65% of egg weight while the decrease in egg weight to hatching weight is about 12%. The average hatchability of one-strain matings was lower than the average hatchability of inter-strain crosses. The average hatchability values of Debu and Kulawu single-strain starts were 68.53% and 65.02%, respectively. The average hatchability value for crosses between strains is the highest for Sentul male kulawu and female debu chickens, 71.74%, followed by crosses of male Sentul Debu and female Sentul Kulawu, 71.56%.

Heterosis effects on egg weight, DOC weight, fertility and hatchability in female crosses between Sentul Debu and Sentul Kulawu chicken breeds

Heterosis effects of non-additive genetics (dominant, over dominant, epistasis) will usually always be more apparent (Wawro *et al*., 2004). This study aims to determine the heterosis effect on the crossing results of Sentul Debu and Sentul Kulawu chickens between males and females (between strains) against the performance value of their parents (one strain). Sentul chicken is one of the local dual-purpose chicken breeds. Sentul chicken has been purified and strictly selected at BPPTU Jatiwangi. The chicken has been mated in a directed manner. Sentul Debu chicken is required for egg production, while Sentul Kulawu chicken is for meat production. Both Sentul chicken strains have gone through the purification stage until the 6th generation, according to the strain, without ever crossbreeding between the two. This study included trials for crosses between strains. The heterosis value of the crossing effect of Debu-female Kulawu male and Kulawu-female Debu male can be seen in Table 3.

Table 3: Heterosis value of the crossing effect of male Debu-female Kulawu and male Kulawu-Female Debu.

Parameters	JD-BK	%	JK-BD
Egg weight	-1.09		-1.74
DOC weight	-0.06		-0.05
Fertility	-5.44		-8.65
Hatchability	7.17		7.44

Based on Table 3 the average egg weight of the cross of Sentul Debu and Sentul Kulawu chickens of one strain is higher than that of Sentul chickens between strains. The results of crossing between strains cause a diversity of production results because they have yet to experience the seed selection period as in the generation of pure Sentul Debu and Sentul Kulawu chickens. The heterosis value for egg weight of the cross between strains, namely male Debu and female Kulawu and male Kulawu and female Debu, was -1.09% and -1.747%, respectively. These results indicate that the egg weight of the cross-between strains does not show better performance when compared to the mating of one strain. This is due to the cross between strains made in the same livestock breed. Cassady *et al*. (2002) stated that the value of the heterosis effect is positive and negative. The positive heterosis effect is the average appearance of a character of the offspring of a cross that exceeds the average appearance of the two parents. In comparison, the negative heterosis effect is the average appearance of a symbol of the offspring of a cross that is lower than the average appearance of the two parents. Production-related performance generally results in a positive heterosis effect, while reproductive performance typically has a negative impact.

The average DOC weight resulting from the mating of Sentul Debu and Sentul Kulawu chickens of one strain is higher than the DOC weight of Sentul chicken crosses between strains. The results of crossing between strains cause a diversity of production results because they have not experienced the seed selection period as in the generation of pure Sentul Debu and Sentul Kulawu chickens. The heterosis values for egg weight between strains, Debu males and Kulawu females and Kulawu males and Debu females, were -0.06% and -0.05%, respectively. The results showed a negative heterosis value in female DOC weight. The negative value obtained for the average heterosis of DOC weight in crosses between strains in Sentul Debu and Sentul Kulawu chickens is due to crosses made in the same nation with a level of kinship that is not too far away. Heterosis occurs due to the interaction of the meeting between additive genes and the combination of gene activity in a favorable environment or suitable environment (Xu and Zhu, 1999; Sutiyono *et al*., 2011).

The average fertility of the results of the mating of Sentul Debu and Sentul Kulawu chickens of one strain was higher than the fertility of the cross of Sentul chickens between strains. The results of crosses between strains produced low values of fertility (Sutiyono *et al*., 2011). The nature of the dominant gene, dominant and epistasis, is a non-additive genetic trait that is a more visible influence on the emergence of the heterosis effect. To improve the diastatic activity of genes that give rise to the desired heterosis effect, it is necessary to carry out rigorous and repeated selection on both parents on the trait to be combined to obtain both elders who are really good at giving rise to good heterosis as well (Cassady *et al*., 2002; Wawro *et al*., 2004; Baeza, 2006).

The average hatchability of the cross of Sentul Debu and Sentul Kulawu chickens between strains is higher than the fertility of the mating of Sentul chickens of one strain. This can be caused by the survival of Sentul chicken embryos between strains being more vital than the survival of Sentul

chicken crossing embryos of one strain. The results of the study (Astomo *et al*., 2016) are not in line with Hasnelly *et al*. (2013); hatchability is always related to fertility. The higher the fertility, the higher the relative hatchability, and vice versa. However, high fertility only sometimes results in high hatchability because, in addition to fertility, hatchability is also influenced by egg quality and hatchery management. The results of this study follow the statement of Lasmi *et al*. (1992) in Astomo *et al*. (2006) that the high and low hatchability depends on the quality of the eggs, the hatching facilities, the skill of the implementer, and the length of egg storage.

The heterosis values for egg weight between strains, Debu males and Kulawu females and Kulawu males and Debu females, were 7.174% and 7.443%, respectively. According to Djanah (1984) and Astomo *et al*. (2006), some factors that affect hatchability are technical at the time of selecting hatching eggs or hatching egg selection (egg shape, egg weight, shell condition, air space in the egg, and length of storage) and technical operations of officers who run the hatching machine (temperature, humidity air circulation, and egg rotation) as well as factors that lie in the parent used as seed. Sex ratios of 1:5, 1:7, and 1:9 did not affect hatchability because hatchability is more related to the treatment and environment after egg collection until hatching.

Good environmental conditions at the time of hatching will produce good hatchability. The hatchability in this study was lower than the results of Suyasa's (2006) research, which is the breeding of native chickens with a sex ratio of males and females of 1:5, resulting in a hatchability of 71.43%. This is considered the type of chicken used and different maintenance management. On the other hand, embryo mortality and hatchability are interrelated factors because, in general, fertile eggs that are hatched will have two possibilities, namely hatching and embryo death. So, if the hatchability rate is high, embryo mortality decreases and vice versa.

CONCLUSIONS AND RECOMMENDATIONS

The body weight of male Sentul chickens (JD-BK) crossed between strains at 12 weeks of age is 848.84 grams. The growth curve of these males can be modeled using a logistic equation, where y =992.661/(1+(24.691x2.72)^(-0.4112x)). The maximum growth response (a) was 992.66, the initial weight (b) was 24.69, and the intrinsic growth rate value (c) was 0.41. For male Sentul chickens (JK-BD) at 12 weeks of age have an average body weight of 973.62 grams. The logistic model of growth curve where y =1100.247/(1+(23.589x2.72)^(-0.423x)), with a maximum growth response (a) of 1100.247, initial weight (b) of 23.589, and intrinsic growth rate value (c) of 0.423.

Similarly, the body weight of female Sentul chickens (JD-BK) at 12 weeks of age is 686.49 grams. The logistic model was used to form a growth curve where y =793.129/(1+(21.549x2.72)^(-0.421x)) with a maximum growth response (a) was 793.129, initial weight (b) was 21.549, and the intrinsic growth rate value (c) was 0.421.

Additionally, the body weight of female Sentul chickens crossed between strains (JK-BD) at 12 weeks is 765.54 grams. Logistic model of growth curve where y =893.062/(1+(20.517x2.72)^(-0.392x)), with a maximum growth response (a) of 893.062, initial weight (b) of 20.517, and intrinsic growth rate value (c) of 0.392.

The process of crossbreeding the matrilineal strains of female Sentul Debu chickens and Sentul Kuwalu chickens yielded a negative heterosis effect for egg weight, female DOC, and fertility. Nevertheless, the heterosis effect for hatchability was positive. These discoveries provide significant scientific insights into the growth and crossbreeding of Sentul chickens.

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NOVELTY STATEMENT

This study used local Indonesian chicken which had never been done before.

AUTHOR'S CONTRIBUTION

Heni Indrijani: Data curation, formal analysis.
Asep Anang and Muhammad Farhan Fadilah: Formal analysis.
Nena Hilmia: Formal analysis, methodology, resources.
Maya Fitriani: Data curation, formal analysis, methodology, resources.

Conflict of interest

The authors have declared no conflict of interest.

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