

## Weight Performance of 4<sup>th</sup> Generation IPB-D3 Local Chickens Aged 1-3 Months and It's Heritability Value

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### ABSTRACT

IPB University local chicken which named IPB-D3 is a prospective male line obtained from the chicken selection program IPB-D1. The establishment of IPB-D3 chickens aims to produce local chickens with fast growth weight. This research aims to evaluate the performance of local chickens from IPB-D3 Generation 4 (G4) and its heritability values. The observed samples include 10 males and 30 females of IPB-D3 chickens of Generation 3 (G3) aged 21-40 weeks as parent and 100 Day Old Chickens (DOC) IPB-D3 G4 up to 12 weeks old. The results obtained that IPB-D3 G4 chickens show an average body weight for males 1021.44 g and females around 648.33 g at the age of 12 weeks. The feed given to IPB-D3 G4 chickens is the same as the parents, namely it has nutrients below commercial feed because the feed given uses a mixture of local feed which are bran and corn which already used in Sinar Harapan Farm Sukabumi. Weight gain is the change in body weight that occurs over a specific period, and the weight gain of IPB-D3 G4 chickens is relatively fast, especially from the 2nd to the 3rd month, with a weight gain rate reaching 406.27 g. Growth rate from IPB-D3 G4 chickens experiences a slowdown at the age of 2 months and falls below their optimal growth rate. Another aspect to report is the mortality rate of IPB-D3 G4 chickens, which is quite high at the DOC and female age due to environmental conditions and disease attacks. However, the mortality rate decreases with the increasing age of the chickens, and no deaths are found in 12 weeks old male chickens. The heritability value of body weight in IPB-D3 G4 chickens is high at the age of 4 weeks and can be used as a basis for selection based on body weight.

**Keywords:** IPB-D3 chickens, body weight, heritability, mortality

### ABSTRAK

Ayam lokal institute pertanian bogor yang diberi nama IPB-D3 merupakan ayam calon galur jantan yang diperoleh dari program seleksi ayam IPB-D1. Pendirian ayam IPB-D3 untuk menghasilkan ayam lokal IPB dengan tujuan agar pertumbuhannya lebih cepat. Penelitian ini bertujuan untuk mengevaluasi performa ayam lokal IPB-D3 Generasi 4 (G4) dan nilai heritabilitasnya. Sampel yang diamati adalah 10 ekor pejantan dan 30 ekor betina ayam IPB-D3 Generasi 3 (G3) umur 21-40 minggu sebagai induk dan 100 ekor DOC (*Day Old Chicken*) hingga berumur 12 minggu. Hasil yang diperoleh ayam IPB-D3 G4 memiliki rata-rata bobot badan jantan 1021.44 g dan betina 684.33 g pada umur 12 minggu. Pakan yang diberikan pada ayam IPB-D3 G4 sama dengan indukannya yaitu memiliki nutrisi dibawah pakan komersial karena pakan yang diberikan menggunakan campuran pakan lokal yakni dedak dan jagung yang telah digunakan di Sinar Harapan Farm Sukabumi. Pertambahan bobot merupakan perubahan bobot badan yang terjadi dari waktu ke waktu tertentu, pertambahan bobot badan ayam IPB-D3 G4 tergolong pesat karena di bulan ke-2 hingga bulan ke-3 tingkat pertambahan bobot mencapai 406.27 g. Laju pertumbuhan ayam IPB-D3 G4 memiliki perlambatan pada umur 2 bulan karena dibawah laju pertumbuhan optimal. Hal lain yang dapat dilaporkan adalah tingkat mortalitas pada ayam IPB-D3 G4 cukup besar pada umur DOC dan betina yang disebabkan kondisi lingkungan dan serangan penyakit namun, tingkat mortalitas tersebut semakin bertambah kecil seiring umur ayam bertambah, bahkan pada ayam jantan umur 12 minggu tidak ditemukan kematian sama sekali. Nilai heritabilitas bobot badan pada ayam IPB-D3 G4 memiliki hasil yang tinggi pada umur 4 minggu dan dapat dijadikan dasar seleksi berdasarkan bobot badan tersebut.

**Kata kunci:** Ayam IPB-D3, bobot badan, heritabilitas, mortalitas

## INTRODUCTION

The native chicken is a local Indonesian chicken derived from the domesticated red jungle chicken. Native chickens have advantages such as high adaptation to the environment, good disease resistance, and carcasses with unique texture and flavor compared to purebred chickens, however, native chickens still have low growth (Yaman 2013). Such low growth underlies efforts to improve native chickens through crossbreeding with superior breeds, selection of native chickens, use of quality feed, and better management.

The diverse genetic traits of native chickens and the low growth rate are some of the characteristics that have long been attached to native chickens. One effort that has been made is the crossing of PSKB chickens (Pelung Sentul X Kampung Broiler) by the Bogor Agricultural Institute which produces IPB-D1 chicken line with better growth rates than other local chickens (Sumantri and Darwati 2017). IPB-D1 local chickens weight around 1100-1200 g for males and 900-1000 g for females at 10 weeks of age and this weight exceeds the KUB chicken from the livestock center which is 800-900 g (PUSLITBANG 2014) which is harvested after 12 weeks however, the feed used is 100% commercial feed. This will certainly make it difficult for the local chicken breeding program in the rural community.

IPB-D3 local chickens are chickens with prospective male line produced by a selection program from IPB-D1 chickens. Salsabila *et al.* (2022) mentioned that the growth of IPB-D3 chickens is very fast because IPB-D3 local chicken made it over 1 kg before 3 months old. Male IPB-D3 chickens with an age of 10 weeks can reach a weight of 1256 g and females with a weight of 1042 g in first and second generation. This reflects the selection program for IPB-D1 chickens to produce IPB-D3 chickens with faster growth. IPB-D3 chickens have reached the fourth generation in 2023 so, it is necessary to conduct an updated analysis of the body weight growth performance of the fourth generation IPB-D3 chickens. Determination of heritability value is also needed in evaluating IPB-D3 G4 chickens. Heritability itself is part of the diversity of traits caused by genetic differences in IPB-D3 chickens. Heritability is also a reflection of the comparison between genetic and phenotypic variation. Heritability has a close relationship with breeding value (Noor 2008). The value of heritability can determine the value of breeding in IPB-D3 G4 chickens. This study aims to observe how the IPB-D3 G4 weight performs and analyze the level of heritability.

## MATERIAL AND METHODS

### Research Time and Location

The research was conducted from October 2022 to August 2023. The locations used were Sinar Harapan Farm Sukabumi and the Breeding and Genetics Field Laboratory, Faculty of Animal Science, Bogor Agricultural University.

### Equipment and Material

The equipment in this study was a 150 cm × 175 cm × 200 cm breeding cage. Other tools used for maintenance are

feeders, drinkers, dippers, buckets, egg trays, wingbands, flashlights, and hatching machines. Data collection was carried out with a weighing tool with an accuracy of 0.01 g for DOC weights, weighing tools with an accuracy of 0.1 g for the weight of chickens older than 1 month, and recording tools.

The materials used in this study included 40 IPB-D3 chickens 3<sup>rd</sup> Generation (G3) with 10 males and 30 females aged over 20 weeks as broodstock, and 100 third-generation IPB-D3 offspring (IPB-D3 G4) reared from DOC age to 3 months. Other materials used were Bravo 511 commercial feed for 1 month-old DOC, grower feed for chicks above 1-month-old (Saripakan grower 40%, bran 30% and corn 30%), layer feed for layer period (Saripakan 60%, bran 20%, and corn 20%), water, vita chick, vita stress, husk, ND vaccine, and Rodalon for enclosure disinfectant.

## Methods

### Breeding

IPB-D3 G3 chicken is crossed again to obtain the IPB-D3 G4 chicken. An illustration of the crossing can be seen in Figure 1.

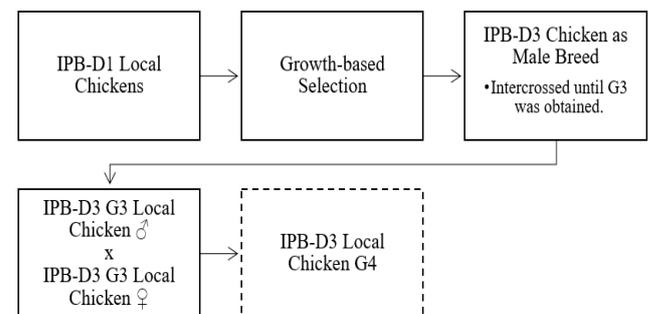


Figure 1. Illustration of the chicken crosses studied and part (---) was the observed chicken.

### Feeding and drinking

Feed that has been provided to Day-Old Chicks (DOC) is initially 10 g, increasing by 10 g per week per chick for one month. For grower chickens, they are given 50 g initially, increasing by 10 g per week, and it stops at 100 g per chicken per day and same for layer chicken. DOC is given Bravo 511 commercial feed, and the grower feed for chickens above 1 month old (Saripakan grower 40%, bran 30%, and corn 30%). The feed for layer periode consists of 60% commercial feed (Saripakan), 20% bran (dedak), and 20% corn (jagung). The feed for IPB-D3 G4 chickens is matched with their parents (IPB-D3 G3) at the same age to avoid additive variations due to feed affecting heritability outcomes. Water was provided ad libitum. The nutritional content of the feed used can be seen in Table 1.

### Data Collection

Data on the body weight of IPB-D3 G3 chickens was collected for 3 months, then the chickens were crossed to produce IPB-D3 G4 chickens. IPB-D3 G4 chickens were kept, observed, and weighed for 3 months. IPB-D3 G4 chickens were analyzed for body weight, body weight growth rate, mortality, and heritability values with Halfsib system.

Table 1. Nutrient Content of Feed

Feed Content	DOC Feed - 1 Month	1-3 months old	Broodstock Feed
	Starter Bravo 511	40% Grower feed Saripakan, 30% Bran, 30% Corn	60% Layer feed Saripakan, 20% Bran, 20% Corn
Dry Weight	86%	86,37%	88.42%
Ash	8%	4,46%	4.638%
Crude Protein	22%	14,37%	15.261%
Crude Fiber	5%	11,84%	9.723%
Crude Fat	5%	3,42%	4.191%

Source : Proximate analysis of Saraswanti Indo Genetech Bogor Laboratory

### Data Analysis

#### Body weight

Data analysis included mean ( $\bar{x}$ ), standard deviation (SD), and coefficient of variation. Growth rate for optimal estimation according to Broddy in Parks (2012) as follows:

$$Wt = Wo \cdot e^{kt}$$

Description:

- Wt = Body weight age t (grams)
- Wo = Body weight age 0 (gram)
- t = Age (Week)
- k = growth rate coefficient
- e = constant (Natural number = 2.7183)

#### Growth Rate

The formula for the relative growth rate (k) according to Broddy in Parks (2012) is as follows:

$$k = \frac{\ln Wt - \ln Wo}{(t2 - t1)}$$

Description:

- k = Growth rate coefficient
- Wt = Body weight at age-t
- Wo = Initial age body weight
- t1 = Age 4 weeks before weighing
- t2 = Age at weighing

#### Mortality

Analysis was also conducted on the mortality rate of IPB-D3 generation 3 and 4 chickens to obtain the percentage of mortality. Mortality rates were calculated based on each age, namely 1 month, 2 months and 3 months. Estimation of the percentage of mortality uses the following formula (Bell and Weaver 2002):

$$P = \frac{X}{Y} \times 100\%$$

Description:

- P = Percentage of mortality
- X = Number of dead chickens
- Y = Number of living chickens

#### Heritability

The parameters measured were heritability of body weight and body weight growth in a broad sense. Heritability was calculated based on halfsib correlation using the formula (Elrod 2007) as follows:

$$h^2 = \frac{2\sigma^2_s}{\sigma^2_s + \sigma^2_w}$$

Description:

- h<sup>2</sup> = Heritability;
- $\sigma^2_s$  = Variety of overall growth in body weight of elders; and
- $\sigma^2_w$  = Variety of offspring body weight growth.

Heritability is also measured in a narrow sense, namely based on the heritability derived from male or female elders. Heritability in maternal and paternal halfsib is also done using the formula (Elrod 2007) as follows:

$$h^2 = \frac{2\sigma^2_s}{\sigma^2_s + \sigma^2(x)}$$

Description:

- h<sup>2</sup> = Maternal heritability;
- $\sigma^2_s$  = Growth Variance of body weight of female elders; and
- $\sigma^2_x$  = Variety of offspring body weight growth.

$$h^2 = \frac{2\sigma^2_s}{\sigma^2_s + \sigma^2(y)}$$

Description:

- h<sup>2</sup> = Paternal heritability;
- $\sigma^2_s$  = Growth Variance of male elders' body weight;
- $\sigma^2_y$  = Variety of offspring body weight growth.

## RESULTS AND DISCUSSION

### Body Weight of 4th Generation IPB-D3 Chicken

IPB-D3 chickens are IPB chickens produced from the selection of IPB-D1 chickens with the aim of high body weight growth as male line. Research conducted by Salsabila *et al.* (2022) mentioned that male IPB-D3 chickens can reach a weight of 1256 g and a weight of 1042 g for females in the first to second generation IPB-D3 chickens. This is greater than the results obtained. IPB-D3 G4 chickens have an average body weight of 1021.44 g in males and 684.33 g in females at 12 weeks of age (Table 2).

The obtained results may be influenced by other factors such as feed nutrition, management, environmental influences, and the adaptation of chickens to consume feed and cage environment. Dameanti *et al.* (2020) stated that the influence of environmental factors on local chickens is significant. The environmental conditions for maintaining IPB-D3 G3 chickens vary, with temperatures average from 17 °C in the morning, 29-30 °C during the day, and 20-26 °C in the evening, while Gunawan and Sihombing (2004) reported that the optimum environmental temperature for chickens is between 18 °C and 25 °C. This variation can certainly affect the physical condition of the chickens,

Table 2. Mean ± sd, coefficient of variation of body weight of 4<sup>th</sup> generation IPB-D3 chickens

Age	Sex	Body Weight (grams) ± Standar deviation	Coefficient of Variance (%)
DOC	-	27.1 ± 4.41	16.31%
4 Weeks	Male	301.221 ± 47.22	17.42%
	Female	266.82 ± 48.91	18.12%
8 Weeks	Male	521.33 ± 39.21	17.83%
	Femal	369.35 ± 45.7	21.96%
12 Weeks	Male	1021.44 ± 60.05	17.01%
	Female	684.33 ± 63.33	12.41%

especially their weight. Rajab and Papilaya (2012) reported that the variation in the body size of local chickens can be influenced by different environmental and climatic conditions.

Factors such as feed also have a significant role in the body weight of local chickens (Trianty *et al.* 2022). The feed provided to IPB-D3 G4 chickens initially consisted of Bravo 511 feed from Day-Old Chicks (DOC) to 1 month, and then the ration was changed to grower feed with a mixture of commercial feed (40% rice bran, 30% bran, and 30% corn) from 1 month to 3 months (Table 1). Feed nutrition is also highly likely to have an impact on the body weight produced in IPB-D3 G4 chickens.

#### Weight Gain and Growth Rate of 4th Generation IPB-D3 Chicken

The weight gain of IPB-D3 G4 chickens showed an increase of 127.68 g in 0 month to first month, 103.53 g from first month to second month, and 406.27 g from second month to third month (Figure 2). The gain of body weight in chickens is significantly influenced by numerous genes such as Growth Hormone Receptor (GHR), Insulin-like Growth Factor (IGF), Somatostatin (SST), Growth Hormone (GH), Myostatin (MSTN), Thyroid Hormone Receptor (THR), Prolactin (PRL), and Insulin (INS). These genes play a significant role in the increase and growth rate of IPB-D3 G4 chickens, with GH being the only gene experiencing a

significant mutation (Khaerunisa *et al.* 2015).

The results of the measurements on the significant increase and growth rate of weight gain in IPB-D3-G4 chickens during the second to third month are highly influenced by the GH[Eco721 gene, which is likely to undergo a mutation in intron 5 and activated after 2 months old that allowing for a faster increase in weight gain. This gene regulates the economic traits of daily body weight growth in local chickens (Khaerunnisa *et al.* 2015). Physiologically, it is also possible that local chickens IPB-D3 G4 can optimally consume feed in the second month or 8 weeks. Pamungkas *et al.* (2005) mentioned that local chickens exhibit normal weight gain, starting slowly, then rapidly, and slowing down again.

IPB-D3 G4 chickens have a different growth rate compared to IPB-D1 and KUB chickens, which have relatively stable growth. The growth rate of IPB-D3 G4 chickens gradually increases, then rapidly, and stops (Figure 3). The results also indicate that the growth rate of IPB-D3 G4 chicken weight is below the optimal growth line at the age of 2 months to three months.

The weight growth of IPB-D3 G4 chickens experiences a slowdown in the growth rate at 2 months age because the growth rate of male weight (blue line) touches the reflection point of the optimal male weight growth rate (red line), and the growth rate of female weight (yellow line) touches the reflection point of the optimal female weight growth rate (purple line) (Figure 3). This growth is below the optimal male weight growth rate ( $W_t = W_o \times e^{-0.036}$ ) and the optimal female growth rate ( $W_t = W_o \times e^{-0.038}$ ) that should be achieved. This could be due to the fact that, in the first month, IPB-D3 G4 chickens undergo an adaptation phase to the provided feed, experiencing a slowdown in growth due to changes in the received nutrition. Sudibya *et al.* (2022) mentioned that local chickens go through an adaptation phase to feed that undergoes changes in the ration and nutrition. The change in the provided feed has a significant impact on IPB-D3 G4 chickens, resulting in a slowdown in body weight growth. However, this change in feed is intended to ensure that the heritability values

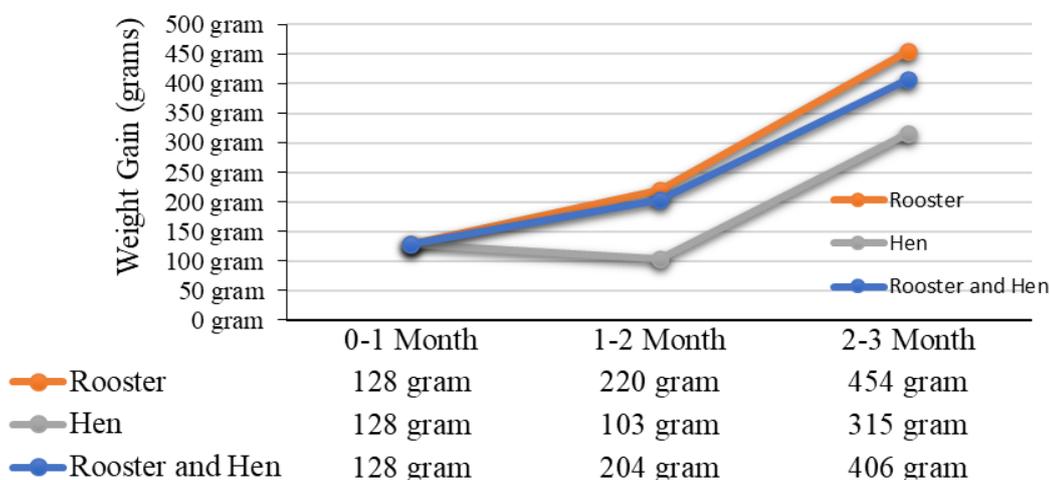


Figure 2. Graph of weight gain of 4th Generation IPB-D3 chickens every month

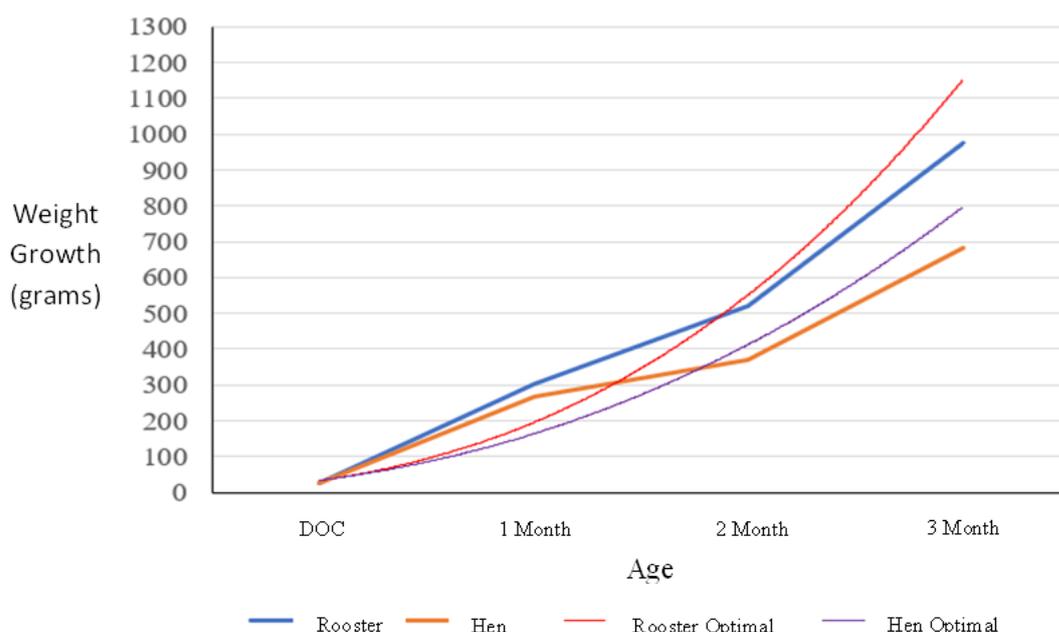


Figure 3. Weight growth chart of 4th Generation IPB-D3 chickens

produced are not affected by additive variations, as the feed given is matched with their parent (IPB-D3 G3 chickens).

#### Mortality of 4th Generation IPB-D3 Chickens

Mortality in IPB-D3 G4 chickens was 8.57% from DOC to 4 weeks old, 2.9% in males and 8.5% in females from 4 to 8 weeks old, and no mortality in males and 2.2% in females from 8 to 12 weeks old (Table 3). Mortality of chickens reared due to disease in DOC up to 12 weeks was caused by picornavirus which causes temporary paralysis in IPB-D3 G4 chickens. Amer *et al.* (2009) stated that the maintenance of chickens in cages with high density and inadequate air circulation can cause chickens to contract diseases. Despite that, the limited space, mixing of males and females, and intense competition for food between males and females make females lose the competition to get food from male chickens that makes the mortality rate a little bit high on 8 weeks old for females chicken. Beside that, the ideal cage for local chickens is supposed to be 150 m<sup>2</sup> for 100 chickens or 1.5 m<sup>2</sup> per chicken (Urfa *et al.* 2017). However, in the study, there was a limitation in the cage which led to a denser arrangement of chickens. Those causes contribute to a relatively high mortality rate for females at the age of 8 weeks that reaching 8.5%. IPB-D3 G4 chickens are kept in high density and this is very likely to happen despite general vaccinations such as ND and gumboro.

Table 3. Mortality of 4th Generation IPB-D3 chickens

Age	Sex	Mortality Rate
4 weeks	-	8.57%
8 Weeks	Rooster	2.90%
	Hen	8.50%
12 Weeks	Rooster	0
	Hen	2.20%

The mortality rate in IPB-D1 chickens averages 10-15% from Day-Old Chicken (DOC) until the age of 12 weeks (Habib *et al.* 2020). Mortality rate IPB-D1 Mortality of IPB-D3 G4 chickens is smaller than IPB-D1 chickens, which makes IPB-D3 chickens have good growth with better body resistance adaptation to feed than IPB-D1 chickens. This is possible because the selection process has been carried out on IPB-D3 G3 chickens to produce IPB-D3 G4 chickens.

#### Heritability of 4th Generation IPB-D3 Chicken

Heritability is one of the most important things in livestock evaluation in the field of selection and crossbreeding. Heritability itself is very important in the aspect of genetics because the value of heritability can accelerate the selection and crossing process carried out in improving livestock performance. Elrod (2023) mentioned that heritability value obtained is divided into three, which are low 0-0.20, medium 0.21-0.40, and high for more than 0.40 in livestock. Heritability values can be divided into extensive and narrow meanings. Heritability in the extensive meaning considers the total genetic diversity in relation to phenotypic diversity while in the narrow meaning got same mean but looks more specifically at the effect of additive variation such as sex (maternal and paternal), feed, treatment, and environment on the phenotypic variation possessed by the observed sample (Noor and Kinghorn 2019).

Table 4 shows data about IPB-D3 G4 local chickens have a high heritability value of weight in extensive meaning at the age of the fourth week which is 0.43 extensively, 0.43 maternally, and 0.56 paternally. However, the heritability values for IPB-D3 local chickens experienced a downrow at 8 and 12 weeks of age. This indicates that selection based on body weight can be conducted for both male and female IPB-D3 chickens in the next generation at the

Table 4. Heritability value IPB-D3 G4 chickens

Age	Heritability			
	Extensive Meaning	Narrow Meaning		
		Maternal	Paternal	Rate
4 Weeks	0.43	0.43	0.56	High
8 Weeks	0.26	0.27	0.34	Moderate
12 Weeks	0.12	0.13	0.16	Low

age of 4 weeks. It can be mentioned that the genotypic characteristics of male parents are larger compared to the female parents for IPB-D3 G4 chickens. These results proved the purpose of the formation of IPB-D3 chickens is the result of selection from IPB-D1 chickens which have fast growth to get the male line. Those results also showed that IPB-D3 G4 chickens are strongly influenced by genetic factors compared to the environment. Jameela *et al.* (2014) mentioned that high heritability values indicate that genetic diversity appears compared to environmental factors and Wahyuni (2020) mentions the same thing about high heritability value if there is no additive interference provided by humans such as feed and management. This indicates that IPB-D3 G4 chickens can be selected by body weight in the 4th week without any additive variation such as sex, feed, management, and environment. Martojo (2009) mentioned that high heritability can be used as a basis for selection in the population to be efficient and effective because it gives hope for better genetic progress.

The heritability value of IPB-D3 G4 chickens at week 8 became moderate and at week 12 decreased significantly. The decrease indicates the presence of additive variation factors that begin to affect genetic diversity in IPB-D3 G4 chickens. This can be due to gender, adaptation from chickens for consume feed changes after 4 weeks old, cage management and environmental factors such as climate, and temperature so that IPB-D3 G4 chickens weight at the age of 8 and 12 weeks old cannot be considered as a selection factor. Kearsy and Pooni (2020) state that heritability is one of the biggest factors that directly affect genetic progress. That makes the selection for IPB-D3 chickens can be done by looking at the IPB-D3 chicken's weight at the age of 4 weeks old in the next generation, especially for male chickens.

### CONCLUSION

IPB-D3 G4 chickens can reach a weight of 1021.44 g for males and 684.33 g for females at 12 weeks old but still had high weight gain after adaptation at 8 weeks old with the limited feed nutrition condition. The weight growth rate of IPB-D3 G4 chickens slows down at the age of 2 months. The mortality rate of IPB-D3 G4 chicken showed that IPB-D3 G4 DOC is susceptible to diseases and IPB-D3 G4 female chickens were unable to compete in the food competition with crowded enclosures with male chickens but after 12 weeks old the mortality rate for IPB-D3 G4 chickens became lower. The heritability value of IPB-D3 G4 showed that chicken weight at 4 weeks old can be considered as a factor selection, especially for male chickens.

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