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Production Performance of Debu and Kelabu Sentul Chicken at Different Igy Concentrations

Performansi Produksi Ayam Debu dan Kelabu Sentul pada Konsentrasi Igy yang Berbeda

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ABSTRACT

Sentul chicken is one of Indonesia's native chickens that has high potential for meat and egg production performance. The production of Sentul chicken breeds with high body resistance is one of the solutions to fulfill this potential. This research aimed to ascertain the impact of various IgY concentrations (high, medium, and low) on the production of 90 Debu and 90 Kelabu Sentul chickens. Parameters observed included pre-laying and laying performance. Six replications of a completely randomized design were used to conduct the experiment. The Anova test was used to analyze the data that was collected. The findings revealed that different strains and sex of Debu and Kelabu Sentul chickens did not significantly affect the value of IgY concentration. In the entire population studied, only 12.09% of Debu Sentul chickens and 11. 32% of Kelabu Sentul chickens had low Igy concentration values. In pre-laying period, the difference in the types of chicken strains has no significant effect on the body weight gain and the feed convertion. Chickens with high IgY concentrations performed worse during the laying phase than hens with low IgY concentrations. The research found that the population of Kelabu Sentul chickens with high IgY concentration value is more than Debu Sentul chickens, which makes them suitable to be used as breeders.

Keywords: IgY, Performance Production, Debu and Kelabu Sentul chicken

ABSTRAK

Ayam sentul merupakan salah satu ayam asli Indonesia yang memiliki potensi produksi daging dan telur yang tinggi. Produksi ayam ras sentul dengan daya tahan tubuh yang tinggi merupakan salah satu solusi untuk memenuhi potensi tersebut. Penelitian ini bertujuan untuk mengetahui pengaruh berbagai konsentrasi IgY (tinggi, sedang, dan rendah) terhadap produksi 90 ekor ayam Debu dan 90 ekor ayam Kelabu Sentul. Parameter yang diamati meliputi penampilan pratelur dan petelur. Enam ulangan dari rancangan acak lengkap digunakan untuk melakukan percobaan. Uji Anova digunakan untuk menganalisis data yang terkumpul. Hasil penelitian menunjukkan bahwa perbedaan strain dan jenis kelamin ayam Debu dan Kelabu Sentul tidak berpengaruh nyata terhadap nilai konsentrasi IgY. Dari seluruh populasi yang diteliti, hanya 12,09% ayam Debu Sentul dan 11,32% ayam Kelabu Sentul yang memiliki nilai konsentrasi Igy rendah. Pada masa pra bertelur, perbedaan jenis galur ayam tidak berpengaruh nyata terhadap pertambahan bobot badan dan konversi pakan. Ayam dengan konsentrasi IgY tinggi tampil lebih buruk selama fase bertelur dibandingkan ayam dengan konsentrasi IgY rendah. Dari penelitian diketahui bahwa populasi ayam Kelabu Sentul dengan nilai konsentrasi IgY tinggi lebih banyak dibandingkan dengan ayam Debu Sentul sehingga cocok untuk dijadikan sebagai indukan.

Kata kunci: IgY, Performance Production, Ayam Debu dan Kelabu Sentul

INTRODUCTION

One of the poultry products with a great potential to increase the availability of animal-origin protein in the form of meat and eggs is native chicken. The population, meat production, and egg production of Indonesian local chickens in 2021 according to Statistics Indonesia were 317,054,290 heads; 272,001.20 tons of meat; and 381,612.83 tons of eggs. Research results from the Indonesian Institute of Sciences (LIPI), which has identified various local chickens in Indonesia using molecular techniques of mitochondrial D-loop DNA fragments, showed that Indonesia is one of the centers of chicken domestication in the world after China and India (Sulandari *et al.* 2007). However, the attention and utilization of local chickens in Indonesia is still low. Some factors that cause the low utilization of local chickens include the scarcity of superior seeds, slow growth, and high mortality due to disease. The production of local chicken breeds with high body resistance is one of the solutions to fulfill this potential.

Sentul chicken is one of the local native chickens that have the potential to be developed. Sentul chicken according to the Decree of the Minister of Agriculture Number 698/ Kpts/PD.410/2/2013 is a local Indonesian chicken family that has a body weight of 2.0-2.6 2.6 kg males & 1.3-1.6 kg females; egg weight 40.7 3.8 g; egg production 118-140 eggs/year. Jatiwangi Poultry Breeding Development Center with Dr.agr Asep Anang, M.phil. IPU since 2012 has been developing and breeding the potential of Sentul chicken. Sentul Debu and Kelabu chickens are two strains of chickens developed to be used as female lines (Debu) and male lines (Kelabu). Each pure strain has specific characteristics, such as egg production strains for female strains and fast growth strains for male strains. The formation of pure strains can be done from the same clump or different clumps. This dual-purpose chicken has the potential to be further investigated for production performance and livestock body resistance so that female and male breeds look more specific from feather color patterns.

Immunity is a response of the body to protect itself against the entry of foreign bodies such as bacteria, viruses, fungi, parasites, and protozoa that can infect the body (Abbas *et al.* 2021). The body's immune response to disease is influenced by the environment and genetics. Environmental influences include feed, and maintenance management, while genetics are controlled and influenced by genes. Chickens are resistant to infection by disease agents, one of which is due to the ability of chickens to produce antibodies and transfer antibodies from mothers to their offspring. The immune system plays a role in fighting disease seeds (bacteria, viruses, parasites, fungi, and others) that cause decreased productivity and even livestock death. Chickens that produce antibodies due to exposure to disease agents (antigens) are called active immune formations. This occurs after chickens are vaccinated or exposed to disease from their environment. Chickens that receive antibodies from the mother through the egg are called passive immunity. Antibodies (IgY) passed from mother to offspring come from the yolk of the chicken egg (Lee *et al*. 2009). Antibodies (IgY) other than in eggs are also found in blood serum.

Antibodies work to neutralize/inhibit disease-causing antigens/agents so that they cannot infect the host. Antibodies thus play an important role in controlling or preventing infection with disease agents in farm animals (Yegani and Korver 2010). IgY Antibody concentration in chicken blood serum is 515 mg mL-1, while in egg yolk is 1025 mg mL-1 (Gaetani *et al.* 2017). Chickens with high IgY concentrations are expected to have high body resistance, meaning that they are more resistant to infection with diseased seeds so their performance is higher than chickens with low IgY concentrations. Regar *et al.* (2013) stated that livestock that has high resistance (high total IgY) produce good performance (production and reproduction). High IgY concentrations are expected to be passed on to the offspring through the egg yolk. Studies on the relationship between serum IgY concentration and the body resistance and performance of chickens have not been conducted, especially in Sentul chickens. The aims of this study on identification is expected to produce sentul chicken breeds with high endurance and high performance.

MATERIALS AND METHODS

Livestock Maintenance

A total of male and female Sentul chickens were observed 90 for the Debu strain and 90 for the Kelabu strain. The test chickens were kept in an intensive system. Chickens were reared from DOC until 28 weeks of age. The test chickens were given a wing band on the wing as a marker. Vaccination was conducted at 4 days, 12 days, and 25 days of age for ND/tetelo vaccine; 7 days, and 18 days of age for the gumboro vaccine; 35 days of age for the coryza vaccine; and 41 days of age for AI/bird flu vaccine.

Feeding is done once a day in the morning. The feed used is BR11 complete feed for the starter phase and BR5 for the finisher phase produced by PT Charoen Pokphand. The complete feed is made from several feed ingredients, namely corn, bran, coconut meal, soybean meal, meat meal, bone meal, wheat fractions, canola, calcium, phosphorus, vitamins, trace minerals, and antioxidants. Drinking water is given ad libitum. Drinking water and feed bins are cleaned daily. The cages used in maintenance at the Jatiwangi Poultry Development and Breeding Center are postal cages measuring 3x3 m with rice husk litter. Starter cages for ages 0 to age 6 weeks then at the age of 6-12 weeks are moved to grower cages.

Blood Sampling

Blood sampling was conducted at the Poultry Breeding Development Center in Jatiwangi. A 3 mL syringe was used to draw 3 mL of blood from the Brachial Vein for the blood samples. The samples taken were 90 Debu Sentul chickens and 90 Kelabu Sentul chickens. Chicken blood was taken at the age of 12 weeks.

Treatment Assignment of IgY Concentration

IgY concentration testing was conducted on 90 Debu Sentul chickens and 90 Kelabu Sentul chickens. Testing of

total IgY in serum was carried out using the indirect enzyme-linked immunosorbent assay (ELISA) method according to Yokoi *et al.* (2002). Total IgY from all samples was then averaged and then grouped based on high (>10); medium (8-10) and low (<7.5) concentration values.

Observed Variables

The variables observed in this study were production performance (feed consumption, feed conversion, weight gain, egg production, and egg weight), and IgY concentration. The methods were as follows:

Production Performance

Production performance that will be studied in the pre-layer and layer periods are:

1. Feed consumption was measured based on the amount of feed given each day minus the amount of feed remaining on that day.
2. Body weight gain is calculated by subtracting the final body weight from the starting weight, then dividing by seven days.
3. Feed conversion (pre-layer) was measured by calculating the average feed consumption divided by the average body weight gain.
4. Feed conversion (layer) was measured by calculating the average feed consumption divided by the egg mass.
5. Egg production (grains) was measured by summing up the total egg production of each hen produced during rearing.
6. Weight of eggs was measured by weighing the eggs obtained each day.

Data Analysis

The study was designed using a completely randomized design (CRD) with three different IgY concentration treatments (high, medium, and low), each treatment was repeated six times. The observed variables included pre-layer and layer performance in male and female Debu and Kelabu Sentul chickens. Performance aspects consisted of feed consumption, body weight gain, egg weight, egg production, FCR, and mortality. Performance aspects (except FCR and mortality) were analyzed for variance (ANOVA), with the following mathematical model:

$$Yij = \mu + \tau i + €ij$$

Yij = observed value of i IgY concentration and j replicate;
μ = general mean;
τi = the effect of i IgY concentration;
$€ij$ = treatment error of i IgY concentration and j replicate (Mattjik and Sumertajaya 2006).
FCR and mortality were analyzed descriptively.

RESULTS AND DISCUSSION

IgY Concentration Values between Debu and Kelabu Sentul Chicken Breeds

Debu and Kelabu Sentul chicken strains are native chickens from Ciamis that have advantages in egg and meat production. Purification of Debu and Kelabu Sentul chickens at the Jatiwangi Poultry Breeding Development Center has been carried out since 2012 and continues to be developed (Fitriati *et al*. 2021). Good body resistance is one of the aspects needed to support the purification program. Immunoglobulin (Ig) is a glycoprotein called antibody, which is secreted by plasma cells in response to antigen exposure and is considered a product that largely affects humoral immunity (Amro *et al*. 2017). Yolk immunoglobulin (IgY) is the most abundant available immunoglobulin found in serum and deposited in the yolk (Darmawi *et al*. 2010). Information on the value of IgY concentration can indicate the level of animal body resistance. IgY concentration test results between Debu and Kelabu Sentul chicken strains are presented in Table 1.

Table 1. IgY Concentration between Debu and Kelabu Sentul Chicken Breeds

Value	Debu	Kelabu
Average	9.30 ± 1.06ns	9.40 ± 1.75ns
Minimal	2.47	2.51
Maksimum	14.26	12.66

ns = not significant (P>0.05).

Data on IgY concentration values in Debu and Kelabu Sentul chickens strains showed that both strains have resistance values with medium IgY concentration values. Kelabu Sentul chicken has a total IgY concentration of 9.40 mg mL-1 higher than that of Debu Sentul chicken. The IgY concentration value of Sentul chicken, both Debu and Kelabu strains, showed lower than that of IPB-D2 G0 chicken (Lestari 2021). IPB-D2 chicken elders although Sentul chicken, the high concentration value of IPB-D2 G0 chicken is due to the results of the selection that has been done.

IgY Concentration Values between Sexes

Chicken serum's total IgY concentration may serve as a sign of the health, fitness, and nutrition of the hens (Sun et al. 2013). Body IgY concentrations of male and female Debu and Kelabu Sentul chickens strains are shown in Table 2.

IgY concentration of male and female in Debu and Kelabu Sentul chicken strains both showed the category of medium IgY concentration values (8-10 mg mL^{-1}). Male Sentul chickens in the Debu strain showed a lower value of 9.28 ± 1.90 mg mL^{-1} compared to the female Debu strain, but it was different in the Kelabu strain where the male IgY concentration was higher at 9.53 ± 1.67 mg mL^{-1} compared to the female Kelabu strain. The lowest minimum and highest maximum concentration values were found in the female Debu strain group. Chicken groups that have low IgY concentrations are thought to experience infections that cause immunodeficiency conditions. Low immunoglobulin (Ig) titers are indicative of humoral immunodeficiency. Humoral immunodeficiency syndrome can occur as a congenital disorder, with deficiencies in all or only some immunoglobulin classes (Quintela *et al.* 2008).

Table 2. IgY Concentration by Sexes

Value	Debu		Kelabu	
	Male	Female	Male	Female
Average	9.28 ± 1.90ns	9.33 ± 1.91ns	9.53 ± 1.67ns	9.28 ± 1.83ns
Minimal	4.50	2.47	4.35	2.51
Maksimum	13.37	14.26	11.92	12.66

ns = not significant (P>0.05).

Percentage of IgY Values in the Population

The results showed that the number of animals categorized as having low IgY concentration values in the population is relatively small at 12.09% for the Debu strain and 11.32% for the Kelabu strain or equivalent to 10-15 animals from the population. This condition shows that the majority of the Sentul chicken population, both Debu and Kelabu strains, have high IgY concentration values. The results of this research are in line with Lestari (2021) which showed that genetically, local chickens have high IgY concentration values. This is supported by Setyawati's (2018) research which states that the IgY concentration value of Sentul chickens tends to be high and is suitable for keeping in Indonesia because it has high resistance to disease agents. The percentage of IgY concentration values of Debu and Kelabu Sentul chicken strains are presented in Table 3.

Table 3. Percentage of IgY Values in the Population

Percentage	Debu	Kelabu
High IgY (%)	37.36	41.51
Medium IgY (%)	50.55	47.17
Low IgY (%)	12.09	11.32

Pre-layer Production Performance of Debu Sentul Chicken

The pre-layer performance of local chickens has a major value in rearing. This value relates to the ability of local chickens to optimize limited production performance as a result of low genetic quality and high disease prevalence. The results of the pre-layer performance analysis of Debu Sentul chickens from the study are presented in Table 4.

According to the statistical analysis, there were no appreciable differences between the three strains of Debu Sentul chickens in terms of body weight gain or feed conversion. Debu Sentul chicken strains at low IgY concentrations are more efficient than Debu Sentul chicken strains with high and medium IgY concentrations. This occurs because the chickens with low IgY concentrations are easier to optimize metabolism for body weight productivity compared to maintaining body resistance to disease. According to Lamont *et al*. (2003), resistance characteristics and production are negatively correlated. Technical aspects of the cage, such as how tightly the chickens were packed in and sampling for other observations, had an impact on mortality.

Layer Production Performance of Debu Sentul Chicken

The layer period is the period when chickens enter egg production. Layer production performance of 7-month-old Debu Sentul chickens under 31 days of observation is presented in Table 5.

Debu Sentul chickens with low IgY concentrations showed efficiency in converting feed to egg weight. This occurs because the metabolism of livestock is focused on production activities compared to maintaining body resistance so that livestock optimize egg production activities. This is in accordance with Lamont *et al.* (2003) assertion that resistance characteristics and production are negatively correlated. According to Jamilah *et al*. (2013), feed nutrients are utilised for productivity and antibody production. High body resistance chickens typically lay less eggs because some of the nutrients they consume are utilised more for the development of their immunity. When a chicken's bodily resistance is low, more of the nutrients in the feed are utilised to produce eggs (Rauw *et al.* 1998). Due to this, feed conversion is less effective during the layer phase in chickens with high and medium IgY concentrations. The findings of this study support those of Kogut (2009), who claimed that chickens with high production levels have weak immune systems. Technical aspects of the cage, such as how tightly the chickens are packed in and sampling for other observations, have an impact on mortality.

Pre-layer Production Performance of Kelabu Sentul Chicken

The pre-layer period is the period where chickens are heading toward the production preparation phase

Table 4. Production Performance of Sentul Debu Chicken Prelayers during 12 weeks of rearing

Variable	IgY		
	High	Medium	Low
Body weight gain (g chicken^{-1} day^{-1})	9.91 ± 1.68ns	9.90 ± 1.71ns	10.58±1.68ns
Feed Conversion	7.27 ± 1.29ns	7.26 ± 1.22ns	6.74 ± 0.96ns
Morbidity	0	0	0
Mortality	2.2%	4.4%	2.2%

ns = not significant (P>0.05).

Table 5. Layer Production Performance of Debu Sentul Chickens

Variable	IgY		
	High	Medium	Low
Feed Conversion	2.56 ± 0.28s	2.59 ± 0.32s	2.44 ± 0.20s
Egg production (chicken^{-1} month^{-1})	7.94 ± 7.09s	11.26 ± 8.29s	17.8 ± 5.36s
Egg weight (g chicken^{-1} month^{-1})	39.58 ± 4.19s	39.17 ± 4.29s	41.22 ± 3.36s
Morbidity	0	0	0
Mortality	1.1%	0%	0%

s = significant (P>0.05).

Table 6. Pre-layer Production Performance of Kelabu Sentul Chicken during 12 weeks of rearing

Variable	IgY		
	High	Medium	Low
Body weight gain (g chicken^{-1} day^{-1})	9.81 ± 1.79ns	9.80 ± 1.59ns	9.96 ± 1.62ns
Feed Conversion	7.33 ± 1.20ns	7.33 ± 1.14ns	7.21 ± 1.17ns
Morbidity	0	0	0
Mortality	2.83%	1.89%	0.90%

ns = not significant (P>0.05).

(body weight). Production performance in local chickens has an important meaning in maintenance. This is related to the ability of local chickens to maximize production is quite limited, as a result of low genetic quality and high prevalence of disease (Pagala *et al*. 2013). Observations of pre-layer production performance were made at 12 weeks of age because the average slaughter age of Sentul chickens is at 12 weeks (Ermansyah *et al.* 2015). The results of the pre-layer production performance of Kelabu Sentul chickens are presented in Table 6.

The results showed that the production performance of Kelabu Sentul chicken at high, medium, and low IgY concentrations was not significantly different. Livestock at high IgY concentrations had good feed efficiency and body weight gain. This shows that Kelabu Sentul chickens at high IgY concentrations can balance the body's immune conditions well, which has a good impact on the chicken's production performance. Chickens with a good level of fitness tend to be able to resist disease attacks, resulting in better production performance (Knap and Bishop 2008). Mortality was influenced by technical factors in the cage, such as the chickens being squeezed in the cage and sampling for other observations.

Layer Production Performance of Kelabu Sentul Chicken

Egg production obtained in the study is the initial period of laying eggs so the amount of egg production is still relatively low. This is consistent with the claim made by Scenes *et al.* (2004) that egg production starts out low for chickens and gradually increases until a certain point. Sulandari et al. (2007) reported that Sentul chickens in one laying period (25-35 days) produce 12-30 eggs. Layer production performance of 7-month-old Kelabu Sentul hens in 31 days of observation (one month) is presented in Table 7.

Based on the observation, it showed that Kelabu Sentul chickens at medium IgY concentration have the best feed efficiency value to egg weight compared to Kelabu Sentul chickens at high and low IgY concentrations. Kelabu Sentul chickens have superior genetic potential in feed conversion efficiency and egg weight. Environmental factors have less of an impact on egg weight than genetic factors do (Bell and Weaver 2002). Chickens with high IgY concentrations produced the highest amount of egg production with an egg weight of 40.93 ± 4.14 g chicken^{-1} month^{-1} compared to Kelabu Sentul chickens at medium

Table 7. Layer Production Performance of Kelabu Sentul Chicken

Variable	IgY		
	High	Medium	Low
Feed Conversion	2.47 ± 0.24s	2.41 ± 0.16s	2.41 ± 0.20s
Egg production (chicken^{-1} month^{-1})	9.43 ± 7.72ns	7.52 ± 8.20ns	8.50 ± 7.01ns
Egg weight (g chicken^{-1} month^{-1})	40.93 ± 4.14s	41.74 ± 2.74s	41.80 ± 3.17s
Morbidity	0	0	0
Mortality	2.63%	1.20%	1.40%

ns = not significant (P>0.05).

s = significant (P>0.05); ns = not significant (P>0.05).

and low IgY concentrations. This indicates that the layer performance of Kelabu Sentul chicken strains at high IgY concentrations has the potential for superior breeds in the value of egg production with a fairly high egg weight but needs the right feed formulation to meet a more efficient feed conversion value. The egg weight in this study was higher than the 38.3 g grain^{-1} investigation on Sentul chicken Sulandari *et al.* (2007). According to Rodenberg *et al.* (2006), the environment, genetics, nutrition, egg composition, laying period, age of birds, and body weight of parents all have an impact on egg weight. Mortality was influenced by technical factors in the cage, such as the chickens being squeezed in the cage and sampling for other observations.

CONCLUSIONS

The results showed that Kelabu Sentul chickens generally have higher IgY concentration values than Debu Sentul chickens, making them suitable for seed selection of Sentul chickens based on body resistance values. Kelabu Sentul chicken males and Debu Sentul chicken females have high IgY concentration values making them suitable for breed selection of Sentul chickens based on body resistance values. Kelabu Sentul chickens have the potential for high egg production with a high IgY concentration value.

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REFERENCES

Abbas, A. K., A. H. Lichtman, & S. Pillai. 2021. Cellular and Molecular Immunology, 6th ed. Saunders (UK): Elsevier. [accessed 2022 Jun 20]

Amro, W. A., W. Al-Qaisi, & F. Al-Razeem. 2017. Production And Purification Of IgG Antibodies From Chicken Egg Yolk. Saunders (UK): Elsevier. [accessed Jan 2022];16(1):99-103.

BPS (Statisitc Indonesia). 2021. Chicken Meat Production. www.bps.go.id

Bell, D. D., & J. R. Weaver. 2002. Commercial Chicken Meat and Egg Production. 5th ed. New York (US): Springer Science and Business Media Inc.

Darmawi, U. Balqis, R. Tiuria, M. Hambal, & Samadi. 2010. Purification of Yolk Immunoglobulin in chickens vaccinated against excretory stage L3 Ascaridia galli. Agripet. 10(2):9-15.

Ermansyah, G., W. Tanwiriah, & I. Y. Asmara. 2015. Effect of Providing Tofu Dregs Flour in the Ration on Slaughter Weight, Carcass Weight and Income Over Feed Cost of Sentul Chicken. Students e-Journal Faculty of Animal Husbandry, Padjadjaran University. 4(4):1-6.

Fitriati, M., H. Indrijani, & T. Widjastuti. 2021. Livestock Performance and Body Weight Growth Curve of Sentul Chicken Breeds with Dust and Gray Feather Color at BPPT Unggas Jatiwangi. Journal of Animal Science, Padjadjaran University. 21(2):79-86.

Gaetani, C., E. Ambrosi, P. Ugo, & M. L. Moretto. 2017. Electrochemical Immuno Sensor for Detection of Immunoglobulin Yolk in Food and Food Supplements. J Chem.

Jamilah, N. Suthama, & L. D. Mahfudz. 2013. Production performance and body resistance of broilers fed step-down diets with the addition of citric acid as an acidifier. JITV. 18(4):251-257.

Decree of the Minister of Agriculture. 2013. Sentul Chicken. Decree of the Minister of Agriculture Number 698/Kpts/PD.410/2/2013.

Knap, P. W., & C. Bishop. 2008. Relationship between genetic change and infectious disease in domestic livestock. An occasional publication of the British society of animal science. Br Sec Anim Sci. Midlothian (UK). pp 65-80.

Kogut, M. H. 2009. Impact of nutrition on the innate immune response to infection in poultry. JAPR. 18(1):111-124.

Lamont, S. J., Pinard-van, M. H. deer Laan, A. Cahaner, Van, J. J. Der Poel, & H. K. Parmentier. 2003. Selection for disease resistance: the direct selection on the immune response. in Muir WM, Anggrey SE, editors Poultry genetic breeding and biotechnology. Oxford (UK): CAB International. pp 399-418.

Lee, S. H., H. S. Lillehoj, D. W. Park, S. I. Jang, & A. Morales. 2009. Protective effect of hyperimmune egg yolk IgY antibodies against Eimeria tenella and Eimeria maxima infections. Vet. Parasitol. 163:123-149.

Lestari, D. 2021. Identification of Dma Gene Diversity and Its Association with Total IgY Concentration and ND Antibody Titer of IPB-D2 Chickens. [Thesis]. Bogor (ID): Bogor Agricultural University.

Pagala, M. A., Muladno, C. Sumantri, & S. Murtini. 2013. Association of mx gene genotype with antiviral and production traits in tolaki chicken. Int J Poult. Sci. 12(12):735-739.

Quintela, A. G., R. Alende, F. Gude, J. Campos, J. Rey, L. M. Meijide, C. F. Merino, C. Vida, & A. Murai. 2013. Maternal transfer of immunoglobulin into the avian egg yolk. Japan Massum MHA, Khan MHZI, Nasrin M, Siddiqi MNH, Ibna Khan MZ, Islam MDN. 2008. Serum levels of immunoglobulins (IgG, IgA, IgM) in the general adult population and their association with alcohol consumption, smoking, and general metabolic abnormalities. Clinical Experience Immunology. 151(1):42-50.

Rauw, W. M., E. Kanis, S. E. N. Noordhuizen, & F. J. Grommers. 1998. Undesirable side effects of selection for high production efficiency in farm animals: a review. Livest Sci. 56(1):15-33.

Regar, N. M., R. Mutia, D. S. Widhyari, & S. H. Y. Kowel. 2013. Feeding Herbal Combination Ration with Zinc Mineral on the Performance of Broiler Chicken Infected with Escherichia coli. Zootek: 33(1):35-40.

Roderberg, T. B., M. B. M. Bracke, J. Berk, J. J. M. D. G. Cooper, G. Guy, A. Harlander, T. Jones, U. Knierim, K. Kuhnt, H. Pirngel, K. J. S. Reiter, & M. A. W. Ruis. 2006. The welfare of ducks in European duck husbandry systems. Poult Sci. 61(4):633-647.

Scenes, C. G., G. Brant, & M. E. Ensminger. 2004. Poultry Science. 4th ed. New Jersey (US): Pearson Education.

Setyawati, M. P. 2018. Production performance, reproduction, and body resistance of female Sentul chickens at different IgY concentrations. [Thesis]. Bogor (ID): Bogor Agricultural University.

Sulandari, S. M. S. A., S. Zein, T. Paryanti, M. Sartika, T. Astuti, E. Widjiastuti, E. Sujana, S. Darana, I. Setiawan, & D. Garnida. 2007. Local Genetic Resources. Biodiversity of Indonesian Local Chicken Biological Resources: Benefits and Potential. Indonesian Institute of Sciences. Bogor.

Sun, H. S., X. Chen, G. Cai, Xu, & Q. Lujiang. 2013. Correlation analysis of total IgY levels in chicken serum, egg yolk, and offspring serum. Journal of Animal Science Biotechnology. 4(1):10-14.

Yegani, M., & D. R. Korver. 2010. Application of egg yolk antibodies as a replacement for antibiotics in poultry. World's Poult Sci J. 66(1):27-38.