Jurnal Ilmu Produksi dan Teknologi Hasil Peternakan
ISSN 2303-2227 eISSN 2615-594X
Accredited by National Journal Accreditation No. 105/E/KPT/2022

Vol. 12 No. 1 January 2024, Page: 8-13
DOI: https://doi.org/10.29244/jipthp.12.1.8-13
Available online at https://journal.ipb.ac.id/index.php/ipthp/index

Egg Production and Quality of IPB D3 Chicken and It's Repeatability Estimation

M. F. Hawari*, C. Sumantri, & S. Darwati
Department of Animal Production and Technology, Faculty of Animal Science, IPB University
Jl. Agatis, Kampus IPB Dramaga Bogor 16680, Indonesia
*Corresponding author: muhammadfahriza@apps.ipb.ac.id
(Received 11-10-2023; Revised 08-11-2023; Accepted 01-12-2023)

ABSTRACT

High egg production and good egg quality for IPB D3 chicken is very important to produce a lot and quality DOC, then a high repeatability value is also needed to maintain continuous DOC availability. The purpose of this study was to examine the estimated repeatability value of egg production and egg quality as well as the production performance and quality of chicken eggs IPB D3. The observed poultry were 30 IPB D3 G3 females and 90 eggs. Repeatability values were analyzed using a variance table and egg production and quality data were analyzed descriptively. The repeatability value of egg production is 0.42 (high), the Haugh unit repeatability of egg is 0.40 (medium), the egg weight repeatability value 0.67 (high), the egg yolk score repeatability value 0.40 (medium) and the egg index repeatability value 0.95 (high). Egg weight 40.76 g, Haugh unit value 76, and egg production 44.8%.

Keywords: egg production and quality, IPB D3 chicken, repeatability

ABSTRAK

Produksi telur yang tinggi serta kualitas telur yang baik untuk ayam IPB D3 sangat penting untuk menghasilkan DOC yang banyak dan berkualitas, kemudian dibutuhkan juga ripitabilitas produksi telur yang tinggi untuk menjaga ketersediaan DOC secara kontinyu. Tujuan dari penelitian ini adalah untuk mengkaji nilai ripitabilitas produksi telur dan kualitas telur serta performa produksi dan kualitas telur ayam IPB D3. Ternak yang diamati sebanyak 30 ekor betina IPB D3 G3 dan telur sebanyak 90 butir. Nilai ripitabilitas dianalisis tersarang dan data produksi serta kualitas telur dianalisis secara deskriptif. Nilai ripitabilitas produksi telur 0.42 (tinggi), nilai ripitabilitas Haugh unit telur 0.40 (sedang), nilai ripitabilitas bobot telur 0.67 (tinggi), nilai ripitabilitas skor kuning telur 0.40 (sedang) dan nilai ripitabilitas indeks telur 0.95 (tinggi). Bobot telur 40.76 g, nilai Haugh unit 76, dan produksi telur 44.8%.

Keyword : ayam IPB-D3, produksi dan kualitas telur, ripitabilitas

INTRODUCTION

Local chicken is the most commonly kept commodity by people in rural areas. According to BPS (2020) the local chicken population for the last three years, namely in 2018 reached 300.877.882, then in 2019 there was an increase to 301.761.386 or around 0.29%, and in 2020 it increased again to 308,476.957 or about 2.23%. Local chicken is popular with the community but is constrained by low productivity, both body weight growth and egg production compared to other chicken (Putri *et al.* 2020).

One of the local chickens being developed is the IPB chicken. The IPB D1 chicken was the result of crossing a Pelung rooster with a Sentul hen to produce Pelung-Sentul (PS) as the male line and a cross between Kampung chicken and Cobb parent stock Broiler to produce Kampung-Broiler (KB) as the female line (Sumantri *et al*. 2017). Furthermore, the selected IPB D1 G9 chickens are used as broodstock to produce IPB D2 generation 0 chicken which are expected to have high resistance (Lestari 2021). IPB D3 chicken is a selection of chicken resulting from IPB D1 chicken breed which have fast body weight growth, with males weighing 1.3 kg and females weighing 1.1 kg at 10 weeks of age (Sumantri *et al*. 2017)

One way to improve genetic quality is to predict the breeding value of each individual in a group or population. Various methods have been developed to predict breeding values, this of course requires complete recording. After that, a selection is carried out in which it is hoped that

there will be genetic progress in mating between livestock that have the best genetic quality with the best (best to best).

Repeatability is one of the genetic parameters to determine the repeatability of a trait possessed by an individual as long as the individual is alive (Darwati *et al*. 2019). The repeatability value according to Noor (2008) is between 0-1. Repeatability can be expressed as a measure of the degree of relationship between the first period's production and the next period's production of livestock and can also predict permanent environmental influences. This value describes the ability of livestock to repeat production now in the next period. High egg production and good egg quality for local chickens is very important to produce a lot and quality DOC, then a high repeatability value is also needed to maintain continuous DOC availability. Egg quality, which can be seen from egg weight and egg index, has a positive relationship with DOC quality, the heavier the egg, the more DOC will be produced with a high hatching weight (Yuniarinda *et al*. 2019). Therefore, there is a need for research to estimate the repeatability value of egg production and egg quality for prospective IPB D3 chicken lines to determine the production potential and egg quality of IPB D3 chickens. The purpose of this study was to examine the repeatability value of egg production and egg quality of IPB D3 chickens and to examine the production performance of IPB D3 hens, namely egg production and quality of eggs produced.

MATERIAL AND METHODS

Material

This research was conducted from October 2022 to June 2023. The location and process for collecting research data took place at the Animal Molecular Genetics Field Laboratory, Department of Animal Production and Technology, Faculty of Animal Husbandry, Bogor Agricultural University.

The tools used in this study included 100 pcs wing bands (numbers 201-300) for numbering chickens, and scales for weighing chickens and eggs. Writing tools are used for data recording, incubators are used to incubate chicken eggs, and laptops are used for data analysis. The materials used in this study were 40 IPB D3 third generation (G3) chickens with 10 males and 30 females, commercial feed, drinking water, and other needs such as vita stress.

Methods

The maintenance of IPB D3 chicken was carried out at the Sinar Harapan Farm (SHF). 100 IPB D3 Chickens aged 1 month were weighed and numbered with wing bands, then reared for 14-15 weeks. The chickens are weighed every month to determine body weight and body weight gain as the basis for the selection process for IPB D3 chicken parents. After 14-15 weeks, the prospective parents were re-selected into 40 individuals (10 males and 30 females) for IPB D3 chickens.

After the selection process, the chickens were transferred to the mating cage located in the Field Laboratory of the Faculty of Animal Husbandry IPB with a ratio of 1 male and 3 females. At the time of rearing, the chickens are still weighed every month until the hens start laying eggs. The resulting eggs are weighed and numbered and then observed until they hatch.

Observed Variables

1. Egg production, egg production produced by chicken for 3 months;
2. Egg index (%), obtained by measuring the length and width of the egg and then calculated using the formula = egg width/length x 100% (Dako *et al*. 2019);
3. Physical composition of the egg, egg weight and the weight of the egg parts (egg white weight, egg yolk weight and egg shell weight), then the percentage of each egg part is calculated to the egg weight;
4. Egg yolk index, obtained by comparing the height of the egg yolk with the center line of the egg yolk and egg white index, obtained by comparing the height of the egg white with the average diameter (Koswara 2009);
5. *Haugh Unit* (HU), obtained by measuring the height of the egg white (H), then entered into the HU formula according to Stadelman and Cotterill (1977):

$$Haugh\ Unit = 100 \log (H+7.57-1.7\ W0.37)$$

Information :
H: Height of thick egg white (mm); and
W: Egg weight (g).

6. Thick shells, shells without membranes are measured with a screw micrometer;
7. The color of the egg yolk is measured by equalizing the color of the egg yolk with the Roche Yolk Color Fan tool with a score of 1-15 with 15 kinds of colors;
8. Fertility and hatchability of egg, egg fertility is measured by the number of fertile eggs in terms of the number of eggs produced, while egg hatchability is measured by the number of eggs that hatch in proportion to the number of fertile eggs ;
9. The repeatability of egg production is estimated by including the productivity of the number of eggs laid for three months with calculations using the variance table according to (Becker 1985); And
10. The repeatability of egg quality is entered by entering egg haugh unit, egg index, egg weight and yolk colour data with calculations using the variance table according to Becker (1985).

Analysis

Egg Production, Egg Characteristics, and Quality

Egg production data, egg characteristics, and quality were analyzed descriptively by presenting the average (X), standard deviation (SD), and coefficient of variation (KK).

Repeatability

The repeatability value is a value that describes the value of livestock to repeat its performance in the future. According to Noor (2008), repeatability values range from 0-1. The variables measured were the repeatability value of egg production where the laying period was used as a repeat (the change in period was calculated after the chicken had

a 10 day egg laying break) and egg quality for 3 months where each month was used as a repeat. Analysis of variance for repeatability uses tables of variance (Becker 1985) as presented in Table 1.

Table 1. Variance estimation of repeatability value

Source of Diversity	DF	SS	MS	EMS
Between Individuals	N-1	SSw	MSw	$\delta_e^2 + k\,\delta_w^2$
Between Measurements in Individuals	m = N	Sse	Mse	δ_e^2

Source: Becker (1985)

N = Number of individuals
m = The total number of measurements

$$\delta_w^2 = \frac{MS_w + Ms_e}{k}$$

$$R = \delta_e^2 + k\,\delta_w^2$$

$$k = \frac{1}{m-1}\left(m - \frac{\sum m_k^2}{m}\right)$$

$$SE(R) = \sqrt{\frac{2\,(1-R)^2[1+(k-1)R]}{k\,(k-1)(N-1)}}$$

δ_e^2= MS

RESULTS AND DISCUSSION

IPB D3 Chicken Egg Production

Local chicken egg production is quite low, Native chicken at the age of 23 weeks produces 26 eggs/8 weeks (46.43%). Supardi *et al*. (2020) reported that the egg production of SenSi chicken was 27.27% and KUB chicken 32.84%. The low production of local chicken egg is due to genetic factors and also feed. The egg production obtained from IPB D3 chicken can be seen in Table 2, which is 44.8%, lower than in the literature and also lower than IPB D1 chicken which achieved a production of 49.22%. The low egg production of IPB D3 chicken is probably caused by the observed generation of IPB D3 chicken still in the 3rd generation, while in the literature IPB D1 chickens have entered the 7th generation. It can be seen from Table 3. Egg production in the first month reached 50%, in the second month it decreased with production of 40% and in the third month egg production reached 45%.).

The coefficient of diversity of chicken egg production IPB D3 still varies, as can be seen in Table 2. The value of the coefficient of variation per month ranges from 46.89 to 66.12, but the coefficient of variation in total production has a value of 40.31. The high coefficient of diversity is because the egg production of each individual IPB D3 chicken is still very diverse, with the highest individual production being 65 eggs and the lowest being 5 eggs, this is what causes the high value of the coefficient of diversity. The low egg production in some individuals is due to the brooding nature of the poultry.

Table 2. Mean ± sd (CV) of chicken egg production IPB D3

	Month			Total
	1	2	3	
Individual Production per day (egg)	15 ± 7.03 (46.89)	11.7 ± 7.73 (66.12)	13.2 ± 8.27 (62.68)	13.3 (40.31)
Percentage (%)	50	40	45	44.8

Increasing egg productivity is important to increase production efficiency. In this study, it is hoped that basic data will be obtained to determine the selection of chicken breeds that have good egg production so that IPB D3 chickens are expected to have high egg production in the future, accompanied by feed standardization and good management.

IPB D3 Chicken Egg Quality

A good egg is when a new egg comes out of a hen that hasn't experienced much decline in egg quality. One of the things that can be used as a reference for eggs that are still in good condition, one of which is the Haugh egg unit. The parameters of the index and quality of IPB D3 chicken eggs can be seen in Table 3.

Table 3. Mean ± sd (KK) quality of IPB D3 chicken eggs

Parameter	Average
Weight (g)	40.76 ± 5.77 (14.15)
Index (%)	76.56 ± 3.63 (4.74)
Albumen Index (%)	0.06 ± 0.01 (18.19)
Yolk Index (%)	0.76 ± 0.05 (6.59)
Albumen Weight (g)	21.00 ± 3.17 (15.08)
Yolk Weight (g)	15.22 ± 3.30 (21.71)
Shell Weight (g)	4.54 ± 0.55 (12.08)
Shell Thickness (mm)	0.31 ± 0.02 (6.47)
Yolk Score	7.87 ± 0.43 (5.47)
Haugh Unit	76.00 ± 4.90 (6.59)

The average weight of IPB D3 chicken egg is 40.76 g, not much different from the literature Marlya *et al*. (2021) which states that the egg weight of Arab chicken is 39.82 g, Native chicken egg weight 40.36 g, and Kettaras chicken egg weight are between 41-43 g. The results of Darwati *et al*. (2019) research found egg weight results of 39.14 g for chicken from the MerawangArab x Arab (MAA) cross, 46.40 g for chicken from the MerawangArab x MerawangArab (MAMA) cross and 48.59 g for chicken from the Arab x MerawangArab cross (AMA), when compared with other local chickens, the size of IPB D3 chicken egg is relatively not much different.

Egg quality is one way to determine whether an egg is good or bad. Haugh unit is one of the parameters to determine egg quality. A Haugh unit value of more than 72 is categorized as an AA quality egg, a Haugh unit value of 60-72 is an A quality egg, a Haugh unit value of 31-60 is a B quality egg, and a Haugh unit value of less than 31 is categorized as a C quality egg (Mountney 1976). The Haugh unit value of IPB D3 chicken units is 76 which can be categorized as AA (Very good) quality eggs. The Haugh unit value of IPB D3 chickens was lower than the literature Restu *et al*. (2021) which found a unit haugh value of 87.45 in IPB D1 chickens. It is important to evaluate the quality of eggs so that people generally know that the eggs they consume are of good quality.

The IPB-D3 chicken egg shell thickness was obtained with an average of 0.31 mm, this result is the same as in the

literature Restu *et al*. (2021) which found IPB D1 chicken shell thickness with an average of 0.30. The thickness of the eggshell is affected by the strain of the hen, the age of the brood, feed, stress, and disease (Yuwanta 2010). The egg albumen index obtained in this study was an average of 0.06, this result is by Kurtini (2014) which states that new egg has a albumen index ranging from 0.050 to 0.174, this index can decrease due to storage. The egg yolk index in this study was 0.76, higher than Kurtini (2014) which stated that the egg yolk index ranged from 0.33 to 0.50 (Kurtini *et al*. 2014). The yolk index belongs to the high category, Koswara (2009) states that the standards for the egg yolk index are 0.22 (bad), 0.39 (medium), and 0.45 (high).

Repeatability of Egg Production and Egg Quality

Repeatability is a genetic parameter to determine the repeatability of a trait that an individual has as long as the individual lives (Darwati *et al*. 2019). The value of repeatability ranges from 0-1. Values 0-0.20 (low), 0.21-0.40 (medium), and > 0.40 (high) (Noor 2008). The higher the repeatability value means the greater the chance that the livestock will repeat its production in the future. The repeatability value of egg production, egg haugh unit, egg weight, egg yolk score and egg index can be seen in Table 4.

Table 4. Repeatability value of egg production, egg haugh unit, egg weight, egg yolk score, and egg index

Characteristic	Repeatability Value
Egg Production	0.42
Egg Haugh Unit	0.40
Egg Weight	0.67
Egg Yolk Score	0.40
Egg Index	0.95

The repeatability of IPB D3 chicken egg production obtained was 0.42 (Table 5), higher than Restu (2021) which stated that the repeatability value of IPB D1 chicken egg production was 0.20. Toye *et al*. (2012) found a repeatability value of 0.22 in Harco chicken and 0.20 in Lohmann chicken. The repeatability value of IPB D3 chicken egg production was categorized as high. The repeatability value of 0.42 means that the repeatability of IPB D3 chicken egg production is 42% influenced by genotypic variation and permanent environment and the other 58% is influenced by the variety of other genes and the variety of genes caused by the environment. By knowing that the repeatability value of egg production is high, it can be interpreted that the IPB D3 chicken has a high chance of repeating its egg production. IPB D3 chickens have egg production repeatability high to that of laying breed chickens, this IPB D3 chicken could possibly be developed as a local egg producing chicken.

The egg Haugh unit repeatability of IPB D3 chicken obtained was 0.40 (Table 6), higher than Restu (2021) which stated that the egg Haugh unit repeatability value of IPB D1 chicken was 0.31, but still in the same category, namely medium. The repeatability value of 0.40 means that the repeatability of IPB D3 chicken egg haugh unit is 40% influenced by permanent genotypic and environmental variations and the other 60% of diversity is influenced by other gene variations and gene variations caused by the environment. By knowing that the egg haugh unit repeatability value is medium, it can be interpreted that the opportunity for this IPB D3 chicken to repeat the Haugh unit of egg is medium. The egg Haugh unit is a reference for determining whether the quality of the egg is good or not. Several factors can influence the egg Haugh unit, such as the age of the egg, storage time and protein content in the feed.

The repeatability of IPB D3 chicken egg weight obtained was 0.67 (Table 7), the IPB D3 chicken egg weight repeatability value was categorized as high. The IPB D3 chicken egg weight repeatability value is lower than the results of research Darwati *et al*. (2019) which states that the MerawangArab x MerawangArab (MAMA) chicken egg weight repeatability value is 0.86, but the IPB D3 chicken egg weight repeatability value is in the same category, namely in the high category. The repeatability value of 0.67 means that the repeatability of IPB D3 chicken egg weight is 67% influenced by permanent genotypic and environmental variations and the other 33% of diversity is influenced by other gene variations and gene variations caused by the environment. By knowing the high repeatability value of this egg weight, it can be interpreted that the IPB D3 chicken has a high chance of repeating its egg weight.

The repeatability of the IPB D3 chicken egg yolk score obtained was 0.40 (Table 8). The IPB D3 chicken egg yolk score repeatability value was categorized as medium. The repeatability value of 0.40 means that the repeatability

Table 5. Repeatability of egg production of IPB D3 chicken

	DF	SS	MS	Variety w	Variety e	Repeatability Value
SS Between Individuals	29	9848.45	130.2	21	29.15	0.42
Error	115	3775.87	29.15			
Total	144	3352.68				

Table 6. Repeatability of egg Haugh unit value of IPB D3 chicken

	DF	SS	MS	Variety w	Variety e	Repeatability Value
SS Between Individuals	29	5569.6	0.34	0.07	0.11	0.4
Error	30	9.73	0.11			
Total	89	6.7				

Table 7. Repeatability of egg weight of IPB D3 chicken

	DF	SS	MS	Variety w	Variety e	Repeatability Value
SS Between Individuals	29	1422.77	8569.74	2029.8	1006.7	0.67
Error	236	248522.46	1006.7			
Total	265	237580.51				

Table 8. Repeatability of yolk score of IPB D3 chicken

	DF	SS	MS	Variety w	Variety e	Repeatability Value
SS Between Individuals	29	5569.6	0.34	0.08	0.11	0.4
Error	30	9.73	0.11			
Total	60	6.67				

Table 9. Repeatability of egg index of IPB D3 chicken

	DF	SS	MS	Variety w	Variety e	Repeatability Value
SS Between Individuals	29	526747.7	39.25	12.85	0.7	0.95
Error	30	1138.12	0.7			
Total	60	41.93				

of the IPB D3 chicken egg yolk score was 40% influenced by permanent genotypic and environmental variations and the other 60% of the diversity is influenced by other gene variations and gene variations caused by the environment. By knowing that the repeatability value of this egg yolk score was medium, it can be interpreted that the opportunity for this IPB D3 chicken to repeat its egg yolk score is medium. Egg yolk color is one of the parameters in determining egg quality. The color of egg yolk is measured using a color fan (color fan roche yolk) with a number level of 1 to 15 or from pale yellow to deep orange. The higher the egg yolk score, the better the egg quality (Anas *et al*. 2022).

The repeatability index of IPB D3 chicken egg obtained was 0.95 (Table 9), higher than the research of Darwati *et al*. (2019) which states that the repeatability value of the chicken egg index for the (MAMA) MerawangArab x MerawangArab is 0.30. The repeatability indeks value of IPB D3 chicken egg is categorized as high. The repeatability value of 0.95 means that the repeatability of IPB D3 chicken egg index is 95% influenced by permanent genotypic and environmental variations and the other 5% of diversity is influenced by other gene variations and gene variations caused by the environment. By knowing the high repeatability value of this egg index, it can be interpreted that the IPB D3 chicken has a high chance of repeating its egg index. Egg index affects egg hatchability, so it is hoped that with a high egg index repeatability value and standardization of hatching egg index achieved, IPB D3 chickens can continuously produce DOC (*Day Old Chick*).

CONCLUSION

IPB D3 chicken egg production is 44.8%. The repeatability value of egg production was high with a value of 0.42 (high), the egg Haugh unit repeatability was high with a value of 0.40 (medium), the egg weight repeatability value was high with a value of 0.67 (high), the egg yolk score repeatability value was medium with a value of 0.40 (high) and the egg index repeatability value was high with a value of 0.97 (high). IPB D3 chicken egg production is still relatively the same as other local chicken, with a high repeatability value. The egg quality of IPB D3 chicken is categorized as good for hatching egg, with repeatability values in the medium to high range.

ACKNOWLEDGEMENT

Thank you to the LPPM DRI IPB institution with research AKSI no SK 31735/IT3.D10/PT.01.03/P/B/2023 which has assisted with research funds during the research.

REFERENCES

Abbas, A. K., A. H. Lichtman, & S. Pillai. 2015. Celluler and Molecular Immunology (6th ed.). Singapore : Elsevier.

Anas, Q., A. Suci, A. Hifizah, M. Irmawati, & B. Baharuddin. 2022. Perbandingan kualitas telur ayam ras di berbagai negara. J. Pet. 6(02), 72-78. Universitas Islam Negeri Alaudin : Makassar.

Becker, W. A. 1985. Manual of Quantitative Genetics. Washington (US) : Washington State University.

BPS. 2020. Populasi ayam buras. Jakarta : Kementrian Pertanian.

Dako, S., F. Ilham, N. K. Laya, S. Fathan, S. Masili, & M. Azar. 2019. Produktivitas persilangan ayam Kampung dan ayam ras Leghorn strain Isa Brown. J. Pet. 16 (01) : 1-9.

Darwati, S., R. Afnan, H. Nurcahya, & N. Widayanti. 2019. Produksi telur dan reproduksi ayam silangan antara ayam merawang dengan ayam arab serta pendugaan nilai ripitabilitasnya. J. Pet. Indonesia. *21*(2) : 102–108.

Hendartono, B. P. 2019. Persentase karkas dan potongan komersil ayam IPB-D1. Bogor :Institut Pertanian Bogor.

Koswara, S. 2009. Teknologi Pengolahan Telur. (EBook Pangan).

Kurtini, T., K. Nova, & D. Septinovan. 2014. Produksi Ternak Unggas. Aura Printing : Lampung.

Kurtini, T., Widi, A, & D. Septinova. 2016. Pengaruh Sex Ratio Ayam Arab Terhadap Fertilitas, Daya Tetas, Dan Bobot Tetas. J. Ilm. Pet. Ter. *4*(1) : 6-12.

Lestari, D. 2021. Polymorphism of DMA (DM a Chain) gene in IPB-D2 chicken. IOP Conference Series Earth and Environmental Science. 788 (1) : 012018.

Marlya, D. Kaharuddin, & Kususiyah. 2021. Kualitas fisik telur ayam arab, ayam kampung dan ayam ketarras serta aksepbilitas telur ayam ketarras setara telur ayam kampung. Bul Trop Anim Sci. *2* (2) : 103–111.

Mountney, G. I. 1976. Poultry Technology (2nd ed.). Wesport (US) : The Avi Publishing Inc.

Noor, R. R. 2008. Genetika Ternak. Bogor : Penebar Swadaya.

Putri, A., & D. Gushairiyanto. 2020. Bobot badan dan karakteristik morfometrik beberapa galur ayam lokal. JIPT. *7*(3) : 256–263.

Restu, H., G. N. Oktaningrum, M. H. Fatikasari, & Subiharta. 2021. Kualitas sensoris nugget ayam Kub Kub Chicken Nugget sensorical quality. MEDIAGRO. 17 (2) : 146–153.

Sumantri, C., & S. Darwati. 2017. Perkembangan terkini riset ayam unggul IPB-D1. Prosiding Seminar Nasional Indonesia Peternak. Institut Pertanian Bogor. 3–7.

Toye, A. A., F. E. Sola-Ojo, & L. L. Ayorinde. 2012**.** Egg production, egg weigh and egg mass repeatability, and genetic gain rom use of multiple time-spaced records in Black Harco and Lohman Brown layers. Centrepoint.J. 18 (2) : 147-156.

Yuniarinda, C., K. Edy & K. Sri. 2019. Pengaruh bobot telur terhadap daya tetas dan bobot tetas itik Magelang generasi ke-4. J.Unhas. 7 (2) : 1-4.

Yuwanta, T. 2010. Telur dan Kualitas Telur. Yogyakarta : Gadjah Mada University Press.