Vol. 10(1): 101-113, March 2022 DOI: https://dx.doi.org/10.23960/jipt. v10i1.p101-113

Jurnal Ilmiah Peternakan Terpadu

Journal homepage: https://jurnal.fp.unila.ac.id/index.php/JIPT

p-ISSN: 2303-1956
e-ISSN: 2614-0497

Pengaruh Lama Penyimpanan pada Suhu *Refrigerator* terhadap Kualitas Eksternal dan Internal Telur Herbal Ayam Ras Layer Fase Kedua

The Effect of Long Storage of Temperature Refrigerator to The Eksternal and Internal Quality of Herbal Egg Layer Second Phase

Syahrio Tantalo[1]*, Sri Suharyati[1]

[1] Department of Animal Husbandry, Faculty of Agriculture, University of Lampung. Jl. Soemantri Brodjonegoro Bandar Lampung, 35145, Lampung, Indonesia
* Corresponding Author. E-mail address:syahrio1961@gmail.com

ARTICLE HISTORY:
Submitted:12 October 2021
Accepted: 10 March 2022

KATA KUNCI:
Kualitas eksternal dan internal
Lama simpan
Layer fase kedua
Telur herbal
Refrigerator

ABSTRAK

Penelitian ini bertujuan untuk mengetahui pengaruh lama penyimpanan pada suhu *refrigerator* terhadap kualitas eksternal dan internal telur herbal ayam ras layer fase kedua. Penelitian ini dilaksanakan pada 21 Mei – September 2021 bertempat di Laboratorium Produksi Ternak, Jurusan Peternakan, Fakultas Pertanian, Universitas Lampung. Penelitian ini dilakukan secara eksperimental dengan menggunakan rancangan lingkungan Rancangan Acak Lengkap (RAL) yang terdiri atas 9 perlakuan dan 4 ulangan. Setiap ulangan terdiri atas 3 butir telur. Data yang diperoleh dianalisis sidik ragam (*Analysis of Variance*) pada taraf nyata 5%, jika hasil sidik ragam berbeda nyata dilanjutkan uji Beda Nyata Terkecil. Hasil penelitian ini menunjukkan bahwa telur herbal mengalami penurunan berat telur secara nyata (P<0.05) dengan semakin lamanya penyimpanan, yaitu selama 8 minggu berkisar antara 0.90% – 5.82%; indeks *albumen* juga mengalami penurunan dan pada penyimpanan telur herbal selama 0 minggu (0.073) nyata (P<0,05) lebih tinggi dibandingkan dengan penyimpanan selama 1 – 8 minggu (0.061 – 0.036); indeks *yolk* pada penyimpanan telur herbal selama 0 – 1 minggu (0.420 – 0.411) nyata (P<0,05) lebih tinggi dibandingkan dengan penyimpanan selama 2 – 8 minggu (0,388 – 0,358); ukuran diameter rongga udara menunjukkan semakin lama waktu penyimpanan semakin meningkat, yaitu selama 8 minggu berkisar antara 1,409 cm—3,058 cm; **m**utu telur herbal tergolong baik berdasarkan rata-rata nilai HU (52,25 – 72,55). Kesimpulan penelitian yaitu 1) semakin lama penyimpanan pada suhu lemari pendingin dapat menurunkan berat telur, indeks albumen, indeks kuning telur, diameter rongga udara, dan Haugh Unit serta dapat meningkatkan ukuran diameter rongga udara telur herbal ayam petelur fase kedua; dan 2) kualitas telur ayam ras petelur fase kedua yang disimpan pada suhu *refrigerator* hingga 8 minggu tergolong baik berdasarkan nilai rata-rata HU.

KEYWORDS:
External and internal quality
Herbal eggs
Second phase layer
Storage time
Refrigerator

ABSTRACT

This study aimed to determine the effect of storage time at refrigerator temperature on the external and internal quality of the second phase layer chicken herbal eggs. This research was conducted on May 21 – September 2021 at the Livestock Production

Laboratory, Department of Animal Husbandry, Faculty of Agriculture, University of Lampung. This research was conducted experimentally using a completely randomized design (CRD) consisting of 9 treatments and 4 replications. Each replication consisted of 3 eggs. The data obtained were analyzed for Analysis of Variance at the 5% level of significance, the results of the variance analysis were significantly different, the Least Significant Difference test was continued. The results of this study showed that the weight of herbal eggs decreased significantly (P<0.05) with increasing storage time, which was for 8 weeks ranging from 0.90% – 5.82%. Albumen index also decreased and the storage of herbal eggs for 0 weeks (0.073) was significantly (P<0.05) higher than storage for 1-8 weeks (0.061-0.036). Likewise, the yolk index in herbal egg storage for 0 – 1 week (0.420 – 0.411) was significantly higher (P<0.05) compared to storage for 2 – 8 weeks (0.388 – 0.358). On the other hand, the size of the air cavity diameter showed that the longer the storage time is increasing, which is for 8 weeks ranging from 1.409 cm – 3.058 cm. The quality of the second phase layer chicken herbal eggs was classified as well based on the average HU value (52.25 – 72.55). Conclusion of this study were 1) the longer storage time at refrigerator temperature could decrease egg weight, albumen index, yolk index, air cavity diameter, and Haugh Unit and could increase the size of the air cavity diameter of second phase layer chicken herbal eggs; and 2) the quality of the second phase layer chicken herbal eggs that were stored at refrigerator temperature for up to 8 weeks was classified as well based on the average HU value.

1. Introduction

Eggs are livestock products that are needed as a relatively inexpensive source of animal protein. Based on Livestock and Animal Health Statistics (2018), it shows that the total egg production in 2017 was 2.1 million tons consisting of 0.2 million tons of native chicken eggs, 1.5 million tons of laying hens, 0.3 million tons of ducks , 0.03 million tons of quail and 0.04 million tons of manila duck.

Consumption of broiler eggs per capita per year in 2016 was 99,796 eggs. There has been an increase of 2.46% from consumption in 2015 of 97,398 eggs (Ministry of Trade, 2018). Consumption of these eggs continues to increase, in 2017 the consumption of layer eggs per capita was 106,418 eggs, an increase of 6.64 percent from the consumption in 2016 of 99,796 eggs (Livestock and Animal Health Statistics, 2018). This data means that eggs are still considered a reliable source of protein to meet people's growth and intelligence.

In the market, currently it is circulating herbal chicken eggs. Herbal eggs are obtained from farms that provide rations with additional feed additives. The feed additives provided include noni, bay leaf, red galangal, and red betel. The use of herbal ingredients

is very useful to replace the work of antibiotics, especially synthetic antibiotics which have many shortcomings such as being harmful to the health of both livestock and humans.

Procurement of broiler eggs at the breeder level that is ready to be marketed takes 2 - 3 days.At the distributor level, broiler eggs are stored for 3-5 days. While at the consumer level, there are chicken eggs that are directly consumed. But some are kept back;so that it can reduce the quality of broiler eggs. Based on research by Wangti et al.(2018) there are findings that at the consumer level, chicken eggs are stored at temperatures above 10-15 ^{o}C, thus accelerating the decline in egg quality.

For this reason, it is important to research the effect of the storage time of herbal eggs on the external and internal quality of eggs in the form of egg weight, air cavity, albumen index, yolk index, and Haugh unit (HU) at the refrigerator temperature. It is hoped that from the results of this study, clearer information will be obtained about the length of storage time of herbal eggs in the refrigerator temperature in the community and gives the importance of storing eggs at refrigerator temperatures.

2. Materials and Method

This research was carried out to observe and collect data on the storage time of herbal egg-laying hens of the second phase for 8 weeks at the Sekuntum Herbal Farm in Dusun 2, Toto Projo Village, Way Bungur District, East Lampung Regency and the Livestock Production Laboratory, Department of Animal Husbandry, Faculty of Agriculture, University of Lampung.

2.1. Materials

The eggs used in this study consisted of 108 herbal eggs from laying hens (Lohmann Brown strain) at the second production phase (age 70--80 weeks) with an average egg weight of 62.24 g ± 4.07 g and the coefficient of variance is 6.53%. The eggs are oval in shape, clean, undamaged, the same color, relatively the same weight and 1 day old from Sekuntum Herbal farm, East Lampung. The Sekuntum Herbal Farm uses rations that are added with natural feed additives derived from noni, bay leaf, laos (red galangal), and red betel.

2.2. Method

This research was conducted experimentally using a completely randomized design (CRD) consisting of 9 treatments and 4 replications. Each replication consisted of 3 eggs. The treatments used were: storage time of herbal eggs for 0 weeks (P0);1 week (P1);2 weeks (P2);3 weeks (P3);4 weeks (P4);5 weeks (P5);6 weeks (P6);7 weeks (P7); and 8 weeks (P8). Egg storage temperature for 28 days ranged from 4.3-10.8˚C and humidity ranged from 15--45%.

The data obtained were analyzed by *Analysis of Variance* (ANOVA) at the 5% level of significance, if the results of the variance were significantly different, the Least Significant Difference test was continued (Steel and Torrie, 1993). The variables that will be observed and measured and calculated in this study were egg weight loss (%), yolk index, albumen index, air cavity diameter (cm), and Haugh unit (HU). Egg weight loss was calculated using initial weight minus weight after storage divided by initial weight multiplied by 100% (Nova et al., 2014). To measure the air cavity of the egg is by observing the egg to see the size of the air cavity.Then marked with a pencil and measured with a calliper (Syamsir, 1993).

The albumen and yolk index values could be calculated using the formula according to the instructions of Kurtini and Riyanti (2014), as follows.

$$\text{Albumen Index} = Ha/Dr \; ; \; \text{Yolk Index} = Ha/Dr$$

Information:
Ha = Height of albumen or yolk (mm)
Dr = Mean longest and shortest thick albumen/yolk (mm)

Haugh Unit (HU) calculation is a measurement of albumen height and egg weight. HU was calculated based on the Raymond Haugh formula (Rasyaf, 2005), namely:

$$HU = 100 \log (H + 7{,}57 - 1{,}7\ W\ 0{,}37)$$

Information:
HU : Haugh unit;
H : Albumen height (mm);
W : Egg weight (g)

3. Result and Discussion

The results of the study of the duration of storage of herbal eggs of laying hens at the second phase in a refrigerator temperature for 8 weeks on the external and internal

quality of eggs in the form of a decrease in egg weight (%), albumen index, yolk index, air cavity diameter (cm) and Haugh unit (HU) are presented in Table 1 and Table 2.

The results of the analysis of variance showed that the duration of storage of herbal eggs of laying hens in the second phase at the refrigerator temperature for 8 weeks had a significant effect (P<0.05) on the external and internal quality of eggs, namely a decrease in egg weight (%), albumen index, yolk index, diameterair cavity (cm) and Haugh unit (HU).

3.1. The Effect of Treatment on Herbal Eggs Weight Loss

The results of the analysis of variance (Table 1 and Table 2) showed that the treatment duration of storage of herbal eggs for laying hens in the second phase at refrigerator temperature for 8 weeks had a significant effect (P<0.05) on the decrease in egg weight (%).

Table 1. The results of the study of the shelf life of herbal eggs for laying hens at the second phase in the refrigerator temperature from week 1 to week 4 on the external and internal quality of eggs

Variable	Treatment				
	P0	**P1**	**P2**	**P3**	**P4**
Egg Weight Loss (%)	--	0.90^{a}	1.37^{ab}	1.92^{b}	2.80^{c}
Albumen Index	0.073^{h}	0.061^{g}	0.052^{defg}	0.049^{cdef}	0.046^{abcde}
Yolk Index	0.420^{g}	0.411^{g}	0.388^{f}	0.382^{def}	0.373^{bcde}
Air Cavity Diameter (cm)	1.409^{a}	1.752^{b}	2.173^{c}	2.324^{d}	2.466^{e}
Haugh unit (HU)	72.55^{h}	68.04^{gh}	61.61^{cdefg}	60.73^{cdef}	59.05^{abcde}

Information: Different superscript letters on the same line indicate significantly different (P<0,05); Storage time of herbal egg for 0 weeks (P0); 1 weeks (P1); 2 weeks (P2); 3 weeks (P3); 4 weeks (P4)

Table 2. The results of the study of the shelf life of herbal eggs for laying hens at the second phasein the refrigerator temperature from week 5 to week 8 on the external and internal quality of eggs

Variable	Treatment			
	P5	**P6**	**P7**	**P8**
Egg Weight Loss (%)	3.17^{cd}	3.68^{d}	4.48^{e}	5.82^{f}
Albumen Index	0.044^{abcd}	0.039^{abc}	0.037^{ab}	0.036^{a}
Yolk Index	0.368^{abcd}	0.361^{abc}	0.359^{ab}	0.358^{a}
Air Cavity Diameter (cm)	2.660^{f}	2.760^{f}	2.873^{g}	3.058^{h}
Haugh unit (HU)	57.55^{abcd}	54.42^{abc}	53.06^{ab}	52.25^{a}

Information: Different superscript letters on the same line indicate significantly different (P<0,05); Storage time of herbal egg for 5 weeks (P5); 6 weeks (P6); 7 weeks (P7); 8 weeks (P8)

The results of the LSD test showed that the herbal eggs had a significant decrease in egg weight with increasing storage time. The data showed that herbal eggs stored for 1 week experienced a decrease in egg weight by 0.90%, while eggs stored for 8 weeks experienced a decrease in egg weight by 5.82%. The longer the storage time, the greater the drop in egg weight. The decrease in egg weight that occurred during storage was caused by the evaporation of water and the release of CO gas from the egg contents through the pores of the shell. Evaporation and release of this gas occurs continuously during storage, so the longer the eggs are stored the egg weight will decrease.

According to Sudaryani (2000) evaporation of water and the release of gases such as CO, NH3, and a little HS as a result of the degradation of egg organic matter occurs since the egg leaves the chicken's body through the pores of the egg shell and continues continuously, causing a decrease in the quality of the egg white, the formation of air cavities, and a decrease in egg weight. The decrease in egg weight is also influenced by storage temperature, relative humidity and eggshell porosity.

This herbal egg weight loss is better when compared to non-herbal chicken eggs.This is due to the different levels of albumen viscosity. Albumen viscosity can occur with the addition of herbs in the ration such as a bay leaf. Wiryawan et al. (2007) added that the essential oil contained in bay leaves has a distinctive aroma that can increase feed consumption. The addition of bay leaf flour will increase ration consumption and with increasing ration consumption, protein consumption by laying hens will increase. The increased protein that enters the chicken's body will be processed and one of them functions as albumen formation, so that the albumen in herbs is thicker. Thicker albumen will help slow down the process of albumen melting in chicken eggs which has an impact on egg weight loss when stored.

3.2. The Effect of Treatment on Herbal Egg Albumen Index

The results of the analysis of variance showed that the treatment duration of the second phase of laying hens' herbal eggs in the refrigerator for 8 weeks had a significant effect ($P<0.05$) on the albumen index. The results of the Least Significant Difference (LSD) test showed that the albumen index in the storage of herbal eggs for 0 weeks (0.073) was significantly ($P<0.05$) higher than storage for 1-8 weeks (0.061-0.036).

This phenomenon is caused by a longer storage time, then gas exchange occurs in the herbal eggs which are getting higher which can cause the diameter of the albumen to widen and the height of the albumen to decrease so that it affects the magnitude of the albumen index. This is following Sudaryani (2006), the albumen index value is a value that describes the thickness of albumen, the smaller the high value of albumen, the more watery the albumen is so that the albumen quality is lower.

The fresh egg white index ranges from 0.050-0.174 according to SNI 01-3926-2008 (BSN, 2008). In the storage of herbal eggs that were stored from 0 to 8 weeks of storage, the average ranged between 0.036 and 0.073. The storage time for 4 weeks had an albumen index of 0.046 which is not far from the albumen index according to SNI. This happens because there are feed additives in the form of herbal ingredients, such as bay leaf flour (TDS) containing bioactive substances such as tannins, flavonoids, and essential oils (Dalimarta, 2000). Wiryawan et al. (2007) added that the essential oil contained in bay leaves has a distinctive aroma that can increase feed consumption. The addition of bay leaf flour will increase ration consumption and with increasing ration consumption, protein consumption by laying hens will increase. The increased consumption of rations means that more protein will be digested. The protein in the ration breaks down based on the need for egg formation. Egg protein based on its solubility will be absorbed by magnum to synthesize albumen proteins in the form of ovomucin, ovalbumin, ovomucoid, ovoglobulin, and ovotransferrin. According to Nesheim et al (1979), the egg white protein associated with the gel structure is ovomucin. Ovomucin is the main ingredient that determines egg white height and the formation of ovomucin depends on protein consumption (Yuwanta, 2004). The higher ovomucin in albumen will affect the albumen index in eggs.

The herbal eggs stored for 5-8 weeks have an albumen index ranging from 0.044 to 0.036 which is lower than the albumen index according to SNI 01-3926-2008 (BSN, 2008).This indicates that the herbal eggs have decreased in quality.

3.3. The Effect of Treatment on Herbal Egg Yolk Index

The results of the analysis of variance showed that the duration of storage of herbal eggs for laying hens in the second phase at refrigerator temperature for 8 weeks had a significant effect ($P<0.05$) on the yolk index. The results of the Least Significant

Difference (BNT) test showed that the yolk index in the storage of herbal eggs for 0 – 1 week (0.420 – 0.411) was significantly higher (P <0.05) compared to storage for 2 – 8 weeks (0.388 – 0.358).

This phenomenon is caused by the longer shelf life. There was a decrease in the value of the yolk/yolk index due to the water content in the albumen surrounding the yolk being absorbed into the yolk; there is a decrease in the permeability of the vitelline membrane causing the yolk to experience flattening. Soeparno et al. (2011) stated that egg storage causes the transfer of water from the egg white to the yolk as much as 10 mg/day at a temperature of 10 ^{o}C. The osmotic pressure of the egg yolk is greater than that of the egg white so that water from the egg white moves to the yolk. Continuous water transfer will cause the yolk viscosity to decrease so that the yolk becomes flat and then it will break because the water transfer process depends on the thickness of the egg white and the yolk index decreases, then the vitelline membrane will be damaged and cause the egg yolk to be damaged.

The average yolk index obtained in the study was good, namely 0.358-0.420 according to the opinion of Purwantini and Roesdiyanto (2002) that a good yolk index ranged from 0.33 to 0.51 with an average of 0.42. This is also the National Standardization Agency, (2008) which states that the index of fresh egg yolks ranges from 0.33-0.52.Furthermore, according to the National Standardization Agency (2008) which states the egg yolk index quality I = 0.458-0.521, quality II = 0.394-0.457, quality III = 0.330-0.393;then the egg yolk index in the results of this study included quality II and III.The longer it is stored, the lower the yolk index, which is of course the lower the quality standard.

3.4. The Effect of Treatment on Herbal EggAir Cavity Diameter

The results of the analysis of variance showed that the treatment of the second phase of the storage period for laying hens in the refrigerator temperature for 8 weeks had a significant effect (P<0.05) on the diameter of the air cavity. The results of the Least Significant Difference (LSD) further test showed that the diameter of the air cavity indicated that the longer the storage time was increasing. This is in accordance with the research conducted by Samli et al. (2005) which also shows that the longer the storage time, the larger the air cavity size. The increase in the size of the air cavity according to

Jazil et al. (2013) is caused by the shrinkage of egg weight caused by evaporation of water and the release of gases that occur during storage. With age, eggs will lose fluid and their contents will shrink, increasing the air cavity. In addition, according to Jazil et al. (2013) the air cavity in the egg is formed shortly after laying due to the difference in room temperature which is lower than the body temperature of the parent, then the contents of the egg become colder and shrivel up to separate the inner and outer shell membranes, this membrane separation is usually occurs on the blunt side of the egg. The longer the egg storage time, the greater the depth of the air cavity.

The diameter of the air cavity of the second phase of herbal chicken eggs at a shelf life of 0 weeks was 1.409 cm lower than the average diameter of the air cavity of fresh chicken eggs, which was 1.5 cm (Mutiara, 2010). The second phase of herbal chicken eggs at storage age above 1 week in the results of this study (1.752 cm – 3.058 cm) was still larger than the average diameter of the air cavity (1.5 cm) of the fresh chicken eggs. It was said that even though using a refrigerator functions to maintain egg quality, it was still not enough to maintain the quality of the air cavity diameter. In other words, it can be stated that the second phase layer chicken herbal eggs were only able to maintain the quality of the air cavity diameter for less than 1 week.

The diameter of the air cavity of purebred chicken eggs at refrigeration temperature with a 2-week shelf life of 2.173 is not much different from that of purebred chicken eggs stored at room temperature for 11 days in Syamsir's (1993) study, which is 2.039 cm. This is caused by the low temperature in the refrigerator, which is around 4.3-10.8 ºC; low temperatures will inhibit the evaporation of gases such as the evaporation of CO2 and H2O in eggs. The inhibition of the evaporation process that occurs in eggs will have an impact on the diameter of the air cavity of the egg, so that eggs stored at refrigerator temperature will be smaller in diameter when compared to eggs stored at room temperature. This is by the National Standardization Agency (2008) which states that the best egg storage temperature is 10 ºC.

The superiority of herbal eggs when viewed from the ratio of 0-week air cavity diameter with the average air cavity diameter of non-herbal fresh chicken eggs is due to the consumption of feed additives in the form of herbs, such as noni. Srinovasahan and Durairaj (2014) stated that noni is a medicinal plant that has the potential to be developed because it contains several useful substances including alkaloids, anthraquinones,

flavonoids, tannins, and saponins so that they can be used for chicken rations and can improve the quality of layer chicken eggs. Sunder et al. (2013) stated that the addition of noni fruit flour (Morindacitrifolia) as much as 4% in poultry food has the potential to increase hen day production with better egg quality and increased mineral content in egg-shells. The increase in mineral content in the shell causes the second phase of the egg-shell to be thicker when compared to purebred chicken eggs that do not consume herbs; so that gas exchange in the egg can be slowed down. The slow evaporation process causes the air cavities in the second phase of herbal eggs to be better than those of chicken eggs that did not consume herbal rations.

3.5. The Effect of Treatment on Haugh unit (HU) of Herbal Egg

The HU value is one of the criteria for determining the quality of the inner egg by measuring egg albumen height and egg weight. A high HU value indicates that the viscosity of the albumen is getting thicker. Albumen contains ovomucin. Ovomucin plays a role in binding water to form albumen gel so that albumen can be thick. Albumen is more viscous if the ovomucin nets are large and strong so that the albumen viscosity becomes high. The higher the HU value, the higher the ovomucin and the better the quality of the egg interior.

The results of the analysis of variance showed that the treatment of the second phase of the storage period for laying hens in the refrigerator temperature for 8 weeks had a significant effect ($P<0.05$) on HU. Furthermore, the results of the Least Significant Difference (LSD) test showed that the value of HU at the storage of herbal eggs for 0 weeks (72.55) was significantly ($P<0.05$) higher than that of storage for 8 weeks (52.25). In addition, there was a tendency for the HU value to decrease with the longer storage time for the herbal eggs. This phenomenon is caused by longer shelf life, then gas exchange occurs in the herbal eggs which are getting higher which can cause the diameter of the albumen to widen and the height of the albumen to decrease so that it affects the HU value. This is by Sudaryani (2006), the albumen index value is a value that describes the thickness of albumen, the smaller the high value of albumen, the more dilute the albumen so that the quality of the albumen is lower which ultimately the HU value of the herbal eggs decreases.

The average HU value obtained in the study was included in the good category, ranging from 52.25 to 72.55.This is in accordance with the opinion of Purwantini and Roesdiyanto (2002) that eggs with the best quality have a HU value above 72 while newly released eggs have a HU value of 100. Further stated by Buckle et al., (1987) that eggs with good quality values HU is 75, while damaged eggs have a HU value below 50.

4. Conclusion and Suggestion

4.1. Conclusion

1) The longer storage time at refrigerator temperature could decrease egg weight, albumen index, yolk index, air cavity diameter, and Haugh unit (HU) and could increase the size of the air cavity diameter of second phase layer chicken herbal eggs .
2) The quality of the second phase layer chicken herbal eggs that were stored at refrigerator temperature for up to 8 weeks was classified as well based on the average HU value.

4.2. Suggestion

1) The second phase layer of chicken herbal eggs which will be stored at refrigerator temperature can be stored for up to 8 weeks.
2) There was a need for further research to observe the microbial content in the second phase layer chicken thick eggs which are stored at refrigerator temperature for up to 8 weeks.

References

Agustina, L., S. Syahrir., S. Purwanti., J. Jillber., A. Asriani., dan Jamilah. 2017. Ramuan herbal pada ayam ras petelur Kabupaten Sidenreng Rappang. *Jurnal Pengabdian pada Masyarakat*. 21: 47--53.

Badan Standarisasi Nasional (BSN). 2008. Telur Ayam. SNI 01-3926-2008. Dewan Standarisasi Nasional.Jakarta.

Buckle, K.A., R. A. Edward, G. H. Fleet danWootton. 2009. Food Science. UI-Press. Jakarta.

Dalimarta, S. 2000. Atlas Tumbuhan Obat di Indonesia Jilid 2. Trubus Agriwidya. Jakarta.

Jazil, N., A. Hintono, dan S. Mulyani. 2013. Penurunan Kualitas Telur Ayam Ras dengan Intensitas Warna Coklat Kerabang Berbeda Selama Penyimpanan. *Jurnal Aplikasi Teknologi Pangan.*1: 43--47.

Kementerian Perdagangan. 2018. Analisis Perkembangan Harga Bahan Pangan Pokok di Pasar Domestik dan Internasional. Pusat Pengkajian Perdagangan Dalam Negeri. Jakarta.

Kurtini, T. dan Riyanti. 2014. Penuntun Praktikum Produksi Ternak Unggas. Laboratorium Produksi dan Fisiologi Ternak. Universitas Lampung. Bandar Lampung.

Mutiara, N. 2010. Pengetahuan Bahan Pangan. Fakultas Teknik. Universitas Negeri Yogyakarta.

Nesheim, M. C., R. E. Austic, dan L. E. Card. 1979. Poultry Production. 12th Edition. Lea and Febiger. Philadelphia.

Nova, I., T. Kurtini, dan V. Wanniatie. 2014. Pengaruh lama penyimpanan terhadap kualitas internal telur ayam ras pada fase produksi pertama. *Jurnal Ilmiah Peternakan Terpadu.* 2: 16--21.

Purwantini dan Roesdiyanto. 2002. Produksi dan Kualitas Itik Lokal di Daerah Sentra Peternakan Itik. Unsoed. Purwokerto

Rasyaf, M. 2005. Pengelolaan Usaha Peternakan Ayam Kampung. Penebar Swadaya. Jakarta.

Roesdiyanto. 2002. Kualitas telur itik tegal yang dipelihara secara intensif dengan berbagai tingkat kombinasi metionin-lancang (*Atlanta sp.*) dalam pakan. *Journal. Animal Production*. 4: 77--82.

Samli, H. E., A. Agma, dan N. Senkoylu. 2005. Effects of storage time and temperature on egg quality in old laying hens. *Journal Poultry.*14:548—553.

Soeparno, R.A., Rihastuti, I., dan S. Triatmojo. 2011. Dasar Teknologi Hasil Ternak. Gadjah Mada University Press, Yogyakarta.

Srinovasahan, V. dan Durairaj, B. 2014. Antimicrobial activities of hydroethanolic extract of morinda citrifolia fruit. International *Journal of Curent Microbiology and Applied Sciences.* 3: 26--33.

Standar Nasional Indonesia. 2008. Pakan Ayam Ras Petelur, SNI 01 – 3926 – 2008. Dewan Standarisasi Nasional. Jakarta.

Statistik Peternakan dan Kesehatan Hewan. 2018. Direktorat Jenderal Peternakan dan Kesehatan Hewan. ISBN : 978-979-628-035-3

Steel, R.G.D. dan J.H. Torrie.1993. Prinsip dan Prosedur Statistika. Gramedia Pustaka Utama. Jakarta.

Sudaryani, T. 2006. Kualitas Telur. PT. Penebar Swadaya. Jakarta.

Sudrajat dan T. M. Wardiny. 2016. Budidaya Ternak Unggas. Edisi 2. Universitas Terbuka. Tangerang Selatan.

Sunder, J., S. Jeyakumar, T. Sujatha, dan A. Kundu. 2013. Effect of feeding of morical (*Morinda citrifolia*) based herbal supplement on production and egg quality in Nicobari fowl. *Journal of Medicinal Plants Research*. 7: 40--48.

Suprapti, L. M. 2002. Pengawetan Telur. Kanisius.Yogyakarta

Suprijatna, E., U. Atmomarsono dan R. Kartasudjana. 2005. Ilmu Dasar Ternak Unggas. Penebar Swadaya. Jakarta.

Suradi, K. 2006. Perubahan kualitas telur ayam ras dengan posisi peletakan berbeda selama penyimpanan suhu refrigerasi. Jurnal Ilmu Ternak. Fakultas Peternakan. Universitas Padjajaran. Bandung. 6: 136--139.

Syamsir, E. 1993. Comparative Study On Quality and Functional Characteristics of Quail And Layer Eggs. Institut Pertanian Bogor. Bogor.

Syamsir, E.,S. Soekartodan, S.S. Mansjoer. 1994. Studi komparatif sifat mutu dan fungsional telur puyuh dan telur ayam ras.*Buletin Teknologi dan Industri Pangan. Bogor*. 5: 5--7.

Wangti, S., H. S. Kusuma, dan Y. N. S. Ulvie. 2018. Pengaruh suhu dan lama penyimpanan telur terhadap kualitas telur ayam ras (Gallus L) di Instalasi Gizi RSUP Dr Kariadi Semarang. Prosiding Seminar Nasional Mahasiswa Unimus Vol. 1. e-ISSN: 2654-766X.

Widiyanto, D. 2003. Pengaruh Bobot Telur dan Lama Penyimpanan terhadap Kualitas Telur Ayam Strain CP 909 yang Ditambahkan Zeolit pada Ransumnya. Skripsi. Fakultas Pertanian. Universitas Lampung, Bandar Lampung.

Winarno, F.G dan S. Koswara. 2002. Telur, Penanganan dan Pengolahannya. M- BRIO Press. Bogor

Wiryawan, K. G., S. Luvianti, W. Hermana, dan S. Suharti. 2007. Peningkatan performa ayam broiler dengan suplementasi daun salam *syzygium polyanthum* (wight) walp sebagai antibakteri escherichia coli. *Media Peternakan.* 30: 55—62.

Yuwanta, T. 2004. Telur dan Produksi Telur. Universitas Gadjah Mada Press, Yogyakarta.

Yuwanta, T. 2010. Telur dan Kualitas Telur. Universitas Gadjah Mada. Yogyakarta.