

(RESEARCH ARTICLE)



The benefits of purple sweet potato waste flour in the ratio of maintaining the quality of Lohmann brown chicken eggs

I Gede Adit Puspa Dantayasa, I Wayan Suarna and Desak Putu Mas Ari Candrawati *

Bachelor of Animal Husbandry Study Program, Faculty of Animal Husbandry, Udayana University, Denpasar, Bali, Indonesia.

World Journal of Biology Pharmacy and Health Sciences, 2024, 17(03), 087–095

Publication history: Received on 20 January 2024; revised on 03 March 2024; accepted on 05 March 2024

Article DOI: <https://doi.org/10.30574/wjbphs.2024.17.3.0098>

Abstract

Lohmann brown chickens are laying hens as a source of egg supply. However, eggs are easily damaged if stored, it is necessary to improve egg quality, one of which can be done by utilizing purple sweet potato waste. This research aims to determine the effect of using purple sweet potato waste flour in rations on the quality of *Lohmann brown* chicken eggs stored for 5 weeks, carried out in Candiksuma Village, Melaya District, Jembrana Regency Bali for 12 weeks. The design used was a completely randomized design (CRD) consisting of 4 treatments and 4 replications. The treatment consisted of rations without purple sweet potato waste flour as a control (A), and rations containing 5% purple sweet potato waste flour (B), 10% (C), and 15% (D). Each experimental unit consisted of 10 chickens aged 65 weeks. After one month of treatment, 96 eggs were taken to be stored. The variables observed were egg weight, egg pH, egg specific gravity, egg yolk color, eggshell thickness, egg white percentage, egg yolk percentage, egg white index, egg yolk index, and haugh units (HU). The research results showed that giving purple sweet potato waste flour did not reduce egg quality in the variables of egg weight, egg pH, egg specific gravity, egg yolk percentage, egg white index, and egg yolk index during 5 weeks of storage. A decrease in egg quality occurs in egg yolk color, eggshell thickness, egg white percentage, and Haugh Units (HU). It can be concluded that providing purple sweet potato waste flour in the ration can maintain the quality of *Lohmann brown* chicken eggs stored for 5 weeks.

Keywords: Lohmann Brown Chicken; Egg Quality; Shelf Life; Purple Sweet Potato Waste Flour

1. Introduction

Lohmann Brown chickens are a type of laying chicken that is popularly kept by breeders. This type of laying chicken has high productivity, low feed conversion, and good growth, and the eggs produced are generally liked by the public. Eggs have quite a complete nutritional value, they are also known as a food source of high-quality animal protein, have a good taste, and are easy to digest [1]. Eggs are easily damaged if stored for a long period. According to [2] stated that fresh eggs, namely eggs newly produced by a hen, have a shelf life of 10–14 days. Once the eggs are older than that, the egg quality will decrease. In general, breeders do not care about the shelf life of eggs, but on the other hand, for several breeders, it is a challenge to find innovations that can improve egg quality by reducing ration costs. Researchers [3] stated that 70% of production costs are determined by ration costs, therefore, an alternative to reducing ration prices is by utilizing purple sweet potato waste. Researchers [4] stated that the carbohydrate content of purple sweet potatoes is 77.89%, the protein content is 8.99%, the fat content is 0.45%, and the ash content is 1.49%, and the highest content of purple sweet potatoes is carbohydrates as an energy source. Researchers [5] stated that purple sweet potatoes can increase the amount of carotenoid pigments so that they can improve the quality of egg yolk color. Researchers [6] stated that the anthocyanin compounds in purple sweet potatoes function as antioxidants. Several studies that have used purple sweet potatoes, including Researchers [5], stated that giving 8% purple sweet potatoes to free-range

* Corresponding author: dan DPMA Candrawati.

chickens did not have a real effect on egg weight, egg white index, egg yolk index, HU value, and eggshell thickness, but did provide a significant effect on egg yolk color. Researchers [7] stated that giving purple sweet potatoes at 15, 20, 25, and 30% resulted in a difference in the average egg yolk color score but did not cause an average difference in the egg yolk index or egg yolk percentage. Based on the description above, research was conducted on the benefits of purple sweet potato waste flour in rations for maintaining the quality of Lohmann Brown chicken eggs.

2. Material and Methods

2.1. Material

The research was carried out in the livestock products technology (THT) laboratory, Faculty of Animal Husbandry, Udayana University, Jimbaran Hill, and in Candiksuma Village, Melaya District, Jembrana Regency, Bali. Using 160 Lohmann Brown laying hens aged 65 weeks, the research was carried out for 12 weeks. The feed given is PL 242, and the concentrate (KLK) is produced by PT. Japfa Comfeed Indonesia. The tools used consist of a caliper and flat glass, a yolk color chart, a thickness measure, a pH meter.

2.2. Methods

This study used 4 treatments, namely Lohmann Brown chickens given a ration without purple sweet potato waste flour (A), a ration containing 5% purple sweet potato waste flour (B), a ration containing 10% purple sweet potato waste flour (C) and a ration containing 15% purple sweet potato waste flour (D). Each treatment consisted of 4 repetitions and each treatment unit consisted of 10 chickens. After one month of treatment, 96 eggs were taken for storage.

2.3. Observed Variables

The variables observed were egg weight, egg pH, egg specific gravity, egg yolk color, eggshell thickness, egg white percentage, egg yolk percentage, egg white index, egg yolk index, and haugh units (HU). The data obtained were analyzed using one-way analysis of variance (ANOVA); if there was a significant difference ($P < 0.05$) between treatments, it was continued with Duncan's multiple range test [8].

3. Results and discussion

The benefits of purple sweet potato waste flour in rations for maintaining the quality of Lohmann Brown chicken eggs stored for 5 weeks are presented in Table 1.

Table 1 Benefits of purple sweet potato waste flour in rations in maintaining the quality of Lohmann Brown chicken eggs stored for 5 weeks

Variable	Treatment ¹⁾			
	A	B	C	D
Egg weight (g/piece)	60,15±1,43 ^{a2)}	59,74±4,65 ^a	58,08±3,53 ^a	61,07±4,98 ^a
pH of eggs	7,79±0,09 ^a	7,79±0,18 ^a	7,90±0,09 ^a	7,88±0,06 ^a
Egg specific gravity	1,04±0,01 ^a	1,04±0,00 ^a	1,04±0,01 ^a	1,05±0,01 ^a
Egg yolk color	9,00±0,00 ^a	10,25±0,50 ^b	9,75±0,50 ^b	10,50±0,58 ^b
Egg shell thickness (mm)	39,75±0,96 ^a	37,75±1,26 ^a	36,50±1,73 ^b	40,00±0,82 ^a
Egg white percentage (%)	51,48±2,93 ^a	45,50±3,09 ^b	45,58±2,52 ^b	44,58±2,09 ^b
Egg yolk percentage (%)	27,96±2,64 ^a	27,25±3,35 ^a	27,25±1,12 ^a	25,67±3,17 ^a
Egg white index	0,015±0,001 ^a	0,015±0,001 ^a	0,017±0,002 ^a	0,016±0,001 ^a
Egg yolk index	0,096±0,02 ^a	0,095±0,02 ^a	0,100±0,03 ^a	0,09±0,02 ^a
Haugh units (HU)	32,8±1,30 ^a	31,2±1,87 ^a	39,0±3,21 ^b	34,5±2,93 ^b

Values with different letters on the same row, i.e., their designations, are significantly different ($P < 0.05$), while values with the same letters on the same row, i.e., their designations, are not significantly different ($P > 0.05$).

Egg weight is directly related to the internal composition of the egg, which includes the percentage of egg white, the percentage of egg yolk, and the specific gravity of the egg. In this study, the egg weight of Lohmann Brown chickens obtained from the treatment with the addition of 5%, 10%, and 15% purple sweet potato waste flour had the same effect as chickens given the control ratio (A). This means that the provision of purple sweet potato waste flour does not affect the weight of Lohmann-Brown chicken eggs stored for 5 weeks. This is because the provision of purple sweet potatoes does not change the nutritional content of the ration, so it does not affect the weight of the eggs. In their opinion, [9] stated that the weight of chicken eggs is influenced by the nutritional content of the ration given, genetic factors, the environment, and the age of the chicken. Meanwhile, according to [10], if the protein content in the ration tends to be the same, there is no difference in the reduction in egg weight produced by chickens. Researchers [11] explain that egg white is one part of a whole egg, which has a percentage of around 58–60% of the weight of the egg. Egg weight is also inseparable from the influence of egg yolk weight. According to [12], the egg yolk is around 30%–32% of the egg weight. The average weight of chicken eggs stored for up to 5 weeks is presented in Figure 1.

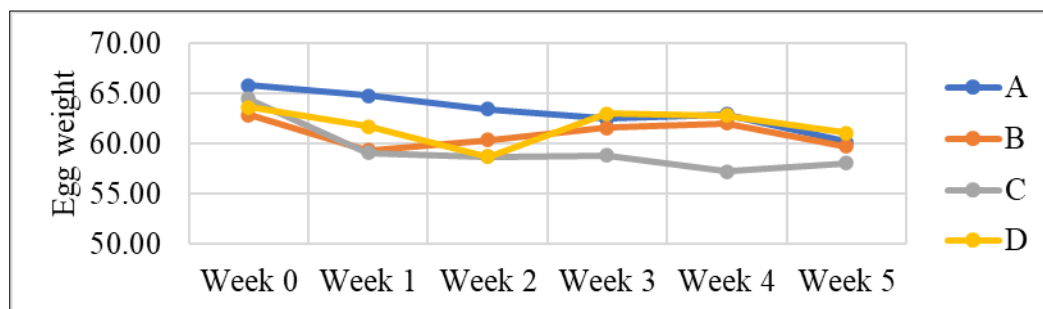


Figure 1 The average weight of chicken eggs stored for up to 5 weeks

The percentage of egg white significantly decreased compared to the control treatment (A), but was still within the normal range. This is in line with [13], who stated that the percentage of fresh chicken egg whites treated with various types of antioxidants was between 47.00% and 52.03%. The longer the storage time, the less the weight and percentage of egg white will be. This is the opinion of [14], who stated that the longer eggs are stored, the more the weight of the egg white will decrease, while the weight of the egg yolk will be more stable. Other factors influence the percentage of egg yolk, namely, according to [15], egg yolk weight is influenced by ovary development, chicken body weight, age at sexual maturity, quality and quantity of feed, disease, environment, and feed consumption. The average percentage of chicken egg whites stored for up to 5 weeks is presented in Figure 2.

The percentage of egg yolk in Lohmann Brown chickens treated with 5%, 10%, and 15% purple sweet potato waste flour obtained relatively similar results to the control treatment (A). The yellow percentage, which was not significantly different, was due to the egg weight produced being relatively the same between treatments. This was also due to the presence of anthocyanin compounds in purple sweet potato waste flour, which act as antioxidants and function to improve the work of the poultry's digestive organs and maintain the health of the poultry's intestines, thereby improving the digestion of ingredients. feed such as carbohydrates, fats, and proteins, so that the nutrients used for the formation of egg yolk will be absorbed properly, causing the percentage of egg yolk to be maintained for 5 weeks of storage. This is supported by the opinion of [16], who states that factors that can influence the percentage of egg yolk are the fat and protein content in the ration because most of the fat and protein are found in egg yolk. The average percentage of chicken egg yolk stored for up to 5 weeks is presented in Figure 3.

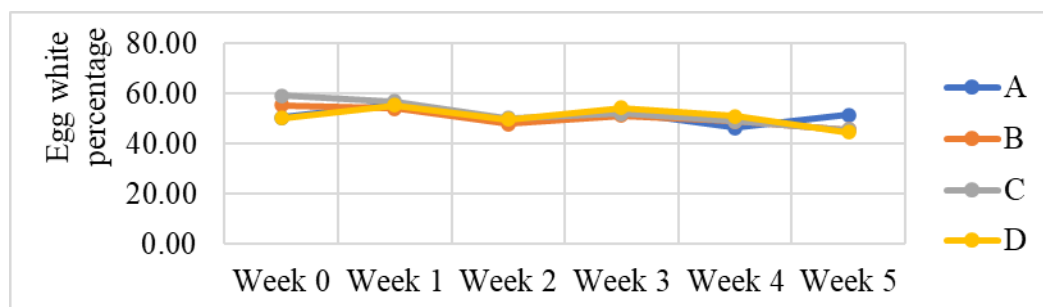


Figure 2 The average percentage of chicken egg whites stored for up to 5 weeks

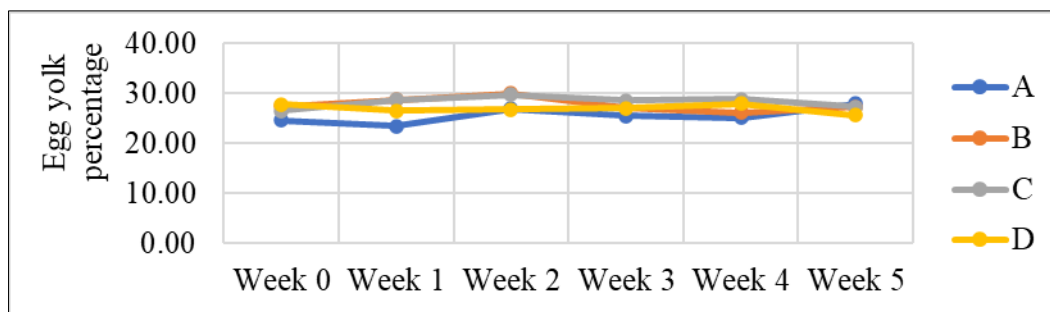


Figure 3 The average percentage of chicken egg yolk stored for up to 5 weeks

The specific gravity of Lohmann Brown chicken eggs treated with 5%, 10%, and 15% purple sweet potato waste flour had the same effect as chickens were given control ratios (A). This is because the average weight of the eggs obtained has the same effect as chickens given the control ratio (A), resulting in the specific weight of the eggs not decreasing or increasing. According to [17], the specific gravity of an egg is almost partly influenced by the weight of the egg and the thickness of the eggshell, and the floating or sinking of the egg is caused by the air sac in the egg. If the air sac is large, the egg will float, but if the air sac is small, the egg will sink. Long storage will cause the air space in the egg to become larger than before; so that the weight of the egg is reduced [18]. In this study, the specific gravity of eggs decreased with storage time. However, it can be seen that the reduction in specific gravity in treatment C (10%), which was stored for up to 5 weeks, was slower than in treatments A, B, and D (Figure 4). This is thought to be because the eggshell pores can suppress egg evaporation and enlarge the air cavity. can be minimized due to the tannin content in purple sweet potato waste. According to [19], tannins will react with food proteins that affect the eggshell so that the pores of the eggshell become impermeable to gas, air, and water evaporation, and the loss of carbon dioxide in the eggshell can be prevented as little as possible. The average specific gravity of chicken eggs stored for up to 5 weeks is presented in Figure 4.

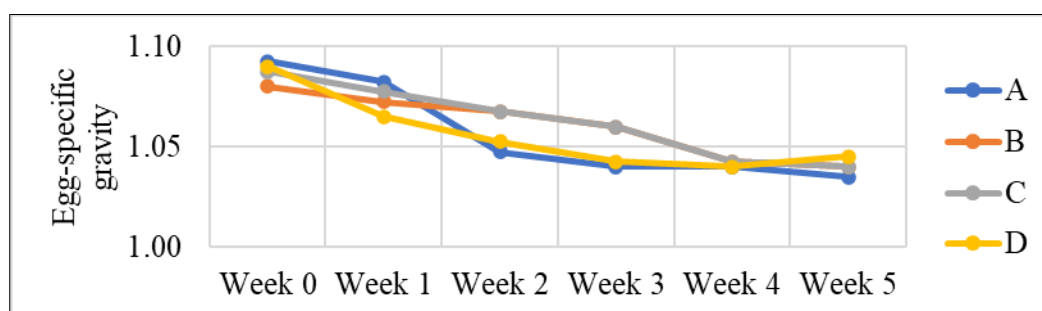


Figure 4 The average specific gravity of chicken eggs stored for up to 5 weeks

The average pH value of the eggs was not significantly different from the control treatment (A). This was due to the presence of anthocyanin, which acts as an antioxidant, thereby inhibiting the loss of CO₂ and water content in the eggs and thereby maintaining the pH value of the eggs during storage for up to 5 weeks. This is in line with [20], who stated that the increase in the pH value of eggs is caused by the loss of CO₂, and the water content in the eggs will be lost due to the long storage time, which accelerates the occurrence of metabolic reactions that will later cause the egg yolk to become runnier, which will affect the pH value. Meanwhile, according to [11], fresh eggs will experience H₂O diffusion from the egg white to the egg yolk. In this study, the pH value of the eggs increased but still showed non-significantly different results, causing the egg whites to become thinner, the height of the viscous egg whites to decrease, and the egg white index value to become smaller; however, the still showed insignificantly different results. This is the opinion of [21], who states that CO₂ is lost through the pores of the eggshell, causing the concentration of bicarbonate ions in the egg white to decrease, causing damage to the buffer system. This causes the pH of the egg to rise and the egg white to become alkaline, which is followed by damage to the ovomucin fibers so that the viscosity of the egg white decreases. In this study, the pH value of the eggs fell within the range of normal egg pH values. According to [22], fresh eggs have a pH value ranging from 7.6-7.93 to a maximum value of 9.7. The average pH of chicken eggs stored for up to 5 weeks is presented in Figure 5.

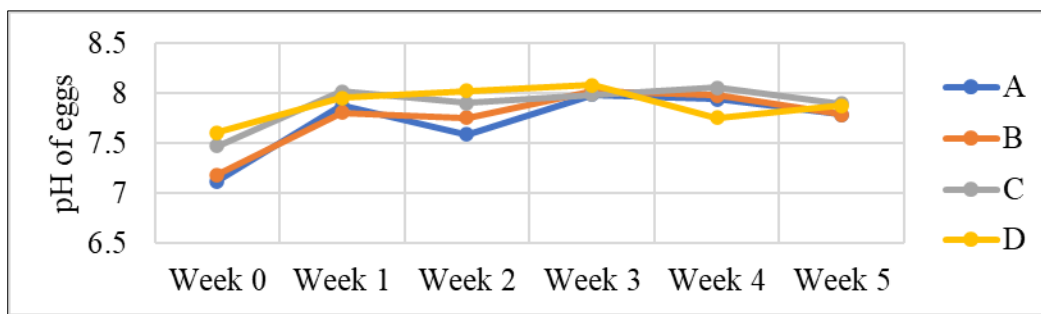


Figure 5 The average pH of chicken eggs stored for up to 5 weeks

The color of the egg yolk was significantly higher than the control treatment (A), this was due to the addition of purple sweet potato waste flour in the ration, which contained anthocyanins, causing the color of the egg yolk to increase (concentrate). This is in line with [5], which states that anthocyanins are a group of pigments that cause a reddish-purple color. This purple sweet potato waste flour given to laying hens can increase the number of carotenoid pigments so that it can improve the quality of the egg yolk color. In the treatment with the addition of 15% purple sweet potato waste flour, it had the highest color score because the ration contained the highest anthocyanin substances seen from the highest level of waste flour, which could later cause the yellow color of the eggs to become more intense (Table 4.1). This statement is the opinion of [23], which states that if the ration contains more beta-carotene and anthocyanin substances, the color of the egg yolk will become reddish yellow (dark). However, in this study, the decrease in egg yolk color in the treatment with the addition of purple sweet potato waste flour did not decrease as much compared to the control treatment (A). According to [24], the migration process of H₂O from egg white to egg yolk is not too large, so the condition of the egg yolk is still good, and there is no significant decrease in the color of the egg yolk. The average color of chicken egg yolks stored for up to 5 weeks is presented in Figure 6.

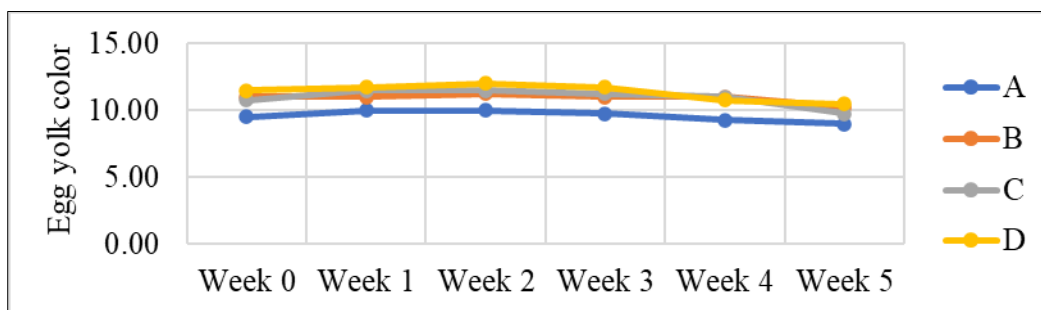


Figure 6 The average color of chicken egg yolk stored for up to 5 weeks

The eggshell thickness of Lohmann Brown chickens that received the 5% and 10% treatments had a significantly lower effect compared to the control treatment (A). In the 15% treatment, the effect was significantly higher than in the control treatment (A). This is related to the white and yolk index because the thickness of the eggshell can affect the freshness of the egg during storage, which can later affect the white and yolk index, as can be seen from the white index value and egg yolk in each treatment had the same effect as chickens are given control rations (A), where the egg shell thickness of Lohmann Brown chickens given the treatment was able to maintain the white and yolk index values during 5 weeks of storage. In this study, the addition of 15% purple sweet potato waste flour resulted in the best eggshell thickness because purple sweet potato waste flour acts as an antioxidant, namely anthocyanin, which can reduce stress in chickens; so the eggshell formation process is better and more optimal. This antioxidant also maintains immunity. epileptic body so that the chicken becomes healthier. This statement is supported by [25], who stated that the thickness or thinness of the eggshell is influenced by the strain of the chicken, the age of the parent, feed, stress, and disease in the parent. Meanwhile, [24] argues that the factor that can influence the thickness of the eggshell is the age of the chicken. This is caused by the reduced ability to absorb and metabolize calcium in old chickens because the older the chicken, the bigger the egg, while the amount of calcium deposited in the egg remains constant so that the eggshell becomes thinner. The average shell thickness of chicken eggs stored for up to 5 weeks is presented in Figure 7.

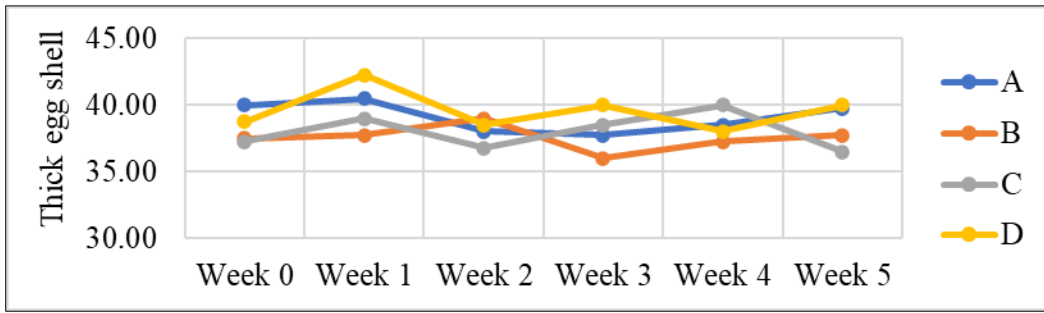


Figure 7 The average thickness of chicken egg shells that are stored for up to 5 weeks

The egg white index can be influenced by the protein content in the ration, which in turn affects the egg white index. This statement is supported by the opinion of [26], who states that the shape of the egg is an expression of the protein content of the ration, where the more protein content in the ration, the thicker the egg white will be, causing the thicker the egg white to be, the higher the egg white index value. so that it will be able to maintain the quality of the egg whites during the storage period. According to [27], the longer the egg white is stored, the higher the egg white will decrease, and the egg white will become thinner. Meanwhile, according to [28], the longer the storage, the more the thick egg white layer will decrease quickly, and ultimately, the decrease will be slower. The average white index of chicken eggs stored for up to 5 weeks is presented in Figure 8.

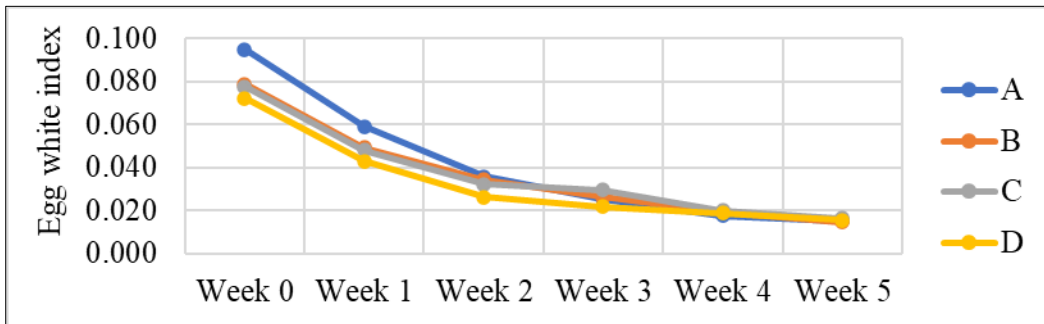


Figure 8 The average white index of chicken eggs stored for up to 5 weeks

The yolk index will experience a decrease in quality if stored for a long time, causing damage to the egg yolk, where the egg white will enter the egg yolk, causing the air pockets in the egg to widen, as seen by the percentage of egg white that decreases with each treatment (Table 3). This has resulted in a dilution of the egg white so that the egg white and yolk become thinner, thus affecting the egg white and yolk index. This statement is the opinion of [29], who stated that the egg yolk index will decrease along with a decrease in egg white quality, which is indicated by the diffusion of water from the yolk albumin. Meanwhile, according to [29], the decrease in the egg yolk index value was caused by the entry of egg white water into the egg yolk as a result of the difference in osmotic pressure between the egg white and the egg yolk, causing the egg yolk to become runny. The average yolk index for chicken eggs stored for up to 5 weeks is presented in Figure 9.

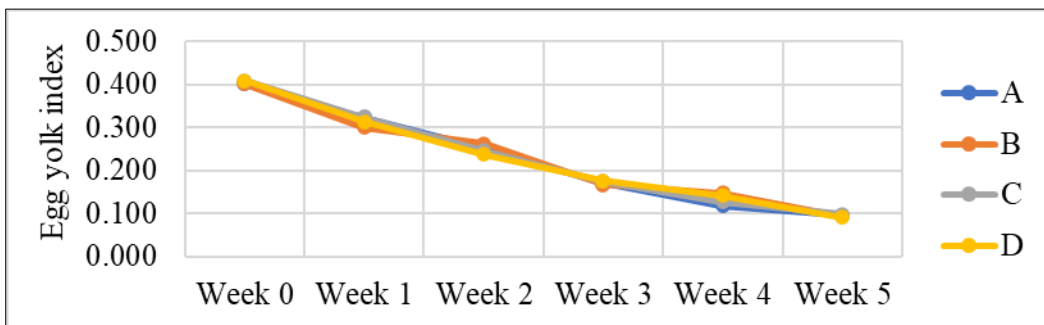


Figure 9 The average yolk index of chicken eggs stored for up to 5 weeks

Haugh Unit (HU) eggs from Lohmann Brown chickens treated with 5%, 10%, and 15% purple sweet potato waste flour had a significant effect on chickens given control rations (A). This is related to a high egg white index, which usually indicates egg fresh, which is in line with the high Haugh Unit (HU) value. This can be seen in the highest white and yolk index, namely in treatment D (addition of 10% purple sweet potato waste flour), which is also in line with the high Haugh Unit (HU) value, namely 39.0 (Table 3). The average Haugh Unit (HU) of chicken eggs stored for up to 5 weeks is presented in Figure 10.

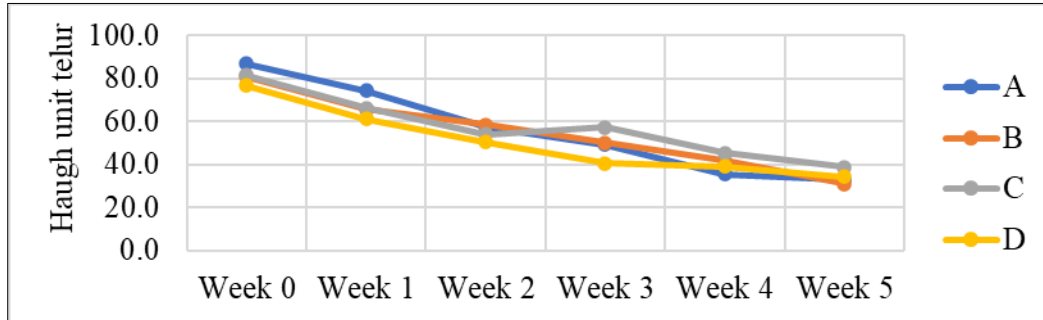


Figure 10 The average haugh unit (HU) of chicken eggs stored for up to 5 weeks

The provision of purple sweet potato waste flour affected the Haugh Unit (HU) of Lohmann-Brown chicken eggs stored for 5 weeks. This was thought to be caused by a decrease in the protein content in the ration, which contained the addition of purple sweet potato waste flour, but the protein content of the ration was still within the standard level, which caused The decrease in the haugh unit (HU) value of eggs due to the protein in the feed will affect the protein content in the egg white so that it will affect the viscosity of the egg white. This statement is the opinion of [30], which states that adequate protein intake in the ration is one of the factors that can influence the quality of egg whites (mucin and lysozyme) so that it can provide good results on the haugh unit (HU) value. This is also supported by the opinion of [31], who stated that factors that can influence the haugh unit (HU) value are albumin height, feed nutrition, protein intake, and egg weight. According to the [32], the results of research on the Haugh Unit (HU) value of eggs are included in the AA to B quality groups.

4. Conclusion

Based on the research results, it can be concluded that the provision of purple sweet potato waste flour in the ration can maintain the quality of Lohmann Brown chicken eggs stored for 5 weeks. It is recommended for laying hen breeders to provide 15% purple sweet potato waste flour in the ration to maintain egg quality, increase the color of the egg yolk to a more intense color, and increase the thickness of the egg shell.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

- [1] Thohari, I. Egg Preservation and Processing Technology. Malang: UB Press. ISBN: 9786024326814. 2018.
- [2] Wedana, I. P. C., Wiyana, I. K. A., and Wirapartha, M. The Effect of Storage Time on the Physical Quality of Eggs of Chicken Breeds Raised Intensively. Journal of Tropical Animal Science. Faculty of Animal Husbandry. Universitas Udayana. Jl. P. B. Sudirman, Denpasar. 2017.
- [3] Kurniawan, S.A., Oktovianus, R. Nahak, T. B., Dethan, A. A. Comparison of the Use of Two Types of Rations on Daily Body Weight Gain (PBBH), Ration Consumption and Ration Conversion for Broiler Chickens. Journal of Animal Science (JAS). 2015; 1 (1): 1-3.
- [4] Muhammad R., Nur A. N., Idrus, S. Analysis of Nutrient Content in Purple Sweet Potato Flour (Ipomoea Batatas Var Ayamurasaki) Using Sun and Oven Drying. Jurnal Biotek. Jln. H. M. Yasin Limpo No. 36 Romang Polong, Samata, Kabupaten Gowa, Sulawesi Selatan. 2019; Vol 7. No1.

- [5] Kalsum, Umi. 2018. The Effect of Adding Sweet Potatoes to the Ration on the Physical Quality of Free-Range Chicken Eggs. Faculty of Animal Husbandry. Universitas Mataram. 2018.
- [6] Husna, Nida E. I., Melly N., dan Syarifah R., Anthocyanin Content and Antioxidant Activity of Fresh Purple Sweet Potatoes and Their Processed Products. Department of Agricultural Products Technology. Faculty of Agriculture. Universitas Syiah Kuala. Jl Tgk. Hasan Krueng Kalee No.3 Darussalam, Banda Aceh. 2013; Vol. 33. No. 3.
- [7] Setyono, H. Rizqiati, Isroli, A., S. Susanti, dan T. Adisarjana. Effect of Supplementation of Sweet Potato Flour (Ipomoea Batatas) in the Ration on the Quality of Local Duck Eggs. Faculty of Animal Husbandry UNDIP. 2010.
- [8] Steel, R. G. D. dan J. H. Torrie. Statistical Principles and Procedures. Translation: B. Sumantri. Edisi Ke-2. Gramedia Pustaka Utama, Jakarta. 1993.
- [9] Moreki, J. C., Gabanagosi, K. Potential Use of Moringa Oleifera in Poultry Diets. Global Journal of Animal Scientific Research. 2014; Vol 2 (2): 109–115.
- [10] Witantri, H., Suprijatna, E., & Sarengat, W. The Effect of Adding Red Ginger Flour (Zingiber Officinale Var. Rubrum) in Feed on the Quality of Village Chicken Eggs in the Layer Period. Animal Agriculture Journal. 2013; 2 (1): 478–488.
- [11] Kurtini, T., Nova, K. dan Septinova, D., Poultry Production. Universitas Lampung. Bandar Lampung. 2014.
- [12] Dirgahayu, F. I., Septinova, D., and Nova, K. Comparison of the External Quality of Isa Brown and Lohmann Brown Strain Chicken Eggs. Animal Husbandry Scientific Journal. 2016; 4(1): 1-5.
- [13] Ridwan N. L., Hassan R. A., Qota E. M., and Fayek H. M. Effect Of Natural Antioxidant on Oxidative Stability Of Eggs And Productive and Reproductive Performance of Laying Hens. International Journal of Poultry Science. 2008; 7 (2): 134–150.
- [14] Ronald S. R., Jose S. C., and Luis S. F. Egg Quality during Storage of Eggs from Hens Fed Diets with Crude Palm Oil. Journal MVZ Cordoba. 2019; 24 (3): 7297–73.
- [15] Tugiyanti, E., and Iriyanti, N. External Quality of Eggs of Laying Hens Receiving Rations with the Addition of Fermented Fish Meal Using Anti-Histamine Procedure Isolate. Jurnal Aplikasi Teknologi Pangan. 2012; Vol. 1 No. 2.
- [16] Priyono, S. N. The Effect of Length of Exposure and Energy Levels of the Same Feed on the Quality of Quail Eggs. Thesis. Faculty of Animal Husbandry Universitas Diponegoro. Semarang. 1992.
- [17] Purnomo, H. Water Activity and Its Role in Food Preservation. Universitas Indonesia Press. Jakarta. 2011.
- [18] Sastrawan, I. P., Astawa, I.P., and Mahardika, I. G. The Effect of Supplementation (Amino Acids, Minerals and Vitamins) Through Drinking Water on the Quality of Eggs Stored for Up to 21 Days. Faculty of Animal Husbandry. Universitas Udayana. Denpasar, Bali. Jurnal Peternakan Tropika. 2020; 8 (1): 189-201.
- [19] Karmila. M., Maryati, and Jusmawati. Utilization of Guava Leaves (Psidium Guajava L.) as an Alternative for Preserving Purebred Chicken Eggs. FMIPA. UNM. Makassar. 2008
- [20] Hajrawati and Aswar, M. Interior Quality of Purebred Chicken Eggs using Betel Leaf Solution (Piper Betle L.) as a Preservative. National Seminar on Animal Husbandry and Veterinary Technology. Makassar. 2011.
- [21] Jazil, N., Hintono, A., and Mulyani, S. Decrease in the quality of breed chicken eggs with different shell brown color intensity during storage. Journal of Food Technology Applications. 2013; 1 (2): 43-47.
- [22] Saraswati, T. R., Dewi P., and Anwar, M. D. Quality of Purebred Chicken Eggs After Applying Aloe Vera and Different Storage Times. Faculty of Science and Mathematics, Universitas Diponegoro. 2016; Vol 24. No 1: 13-20.
- [23] Yamamoto, T. L. Juneja, R., Hatta, H., and Hen, M. K. Eggs: Basic and Applied Science. University of Alberta, Canada. 2007.
- [24] Kurtini, T., Veronica W., and Nova, I. The Effect of Storage Time on the Internal Quality of Purebred Chicken Eggs in the First Production Phase. Lampung University. Soemantri Brojonegoro No.1. Gedung Meneng Bandar Lampung. Halm. 2011; 16-21.
- [25] Hargitai, R., R. Mateo, J. Torok. Shell Thickness and Pore Density in Relation to Shell Colouration Female Characteristic, and Enviromental Factors in the Collared Flycatcher Ficedula Albicolis. J. Ornithol. 2011; 152: 579-588.

- [26] Agro, L. B., Tristiarti, and Mangisah, I. Quality of Phase 1 Laying Arabian Chickens with Various Levels of Azolla Microphylla. *Animal Agricultural Journal*. 2013; Vol. 2 (1): 445-447.
- [27] Azizah, N., Djaelani. M. A., dan Mardiaty, S. M. Protein Content, Egg White Index (IPT) And Hough Unit (HU) of Soaking Duck Eggs After using a Solution of Guava Leaves (*Psidium Guajava*) Stored at Room Temperature. *Buletin Anatomi dan Fisiologi*. 2018; 3(1):46-55.
- [28] Saraswati, T. R. Optimization of Quail Reproductive Function and Chemical Biosynthesis of Egg-Forming Materials. Leskonfi, Jakarta. 2015.
- [29] Wulandari E., Rachmawan, O., Tafik, A. T., Suwarno, N., and Faisal, A. The Effect of Betel Leaf Extract (*Piper Betle* L.) as a Soak for Consumable Chicken Eggs on Durability at Room Temperature Storage. *Jurnal Iptek*. 2013; 7 (2): 163-174.
- [30] Sumadja, W. A., Resmi, M. and Atthenan. Use of Kepayang Cake (*Pangium Edule Reinw*) in Rations on the Quality of Quail (*Coturnix Coturnix Japonica*) Eggs. Faculty of Animal Husbandry. Universitas Jambi. ISSN (P): 2615 – 2584. ISSN (E): 2615 – 3343. 2019.
- [31] Amin, N. S., Anggraeni, and Dihansih, E. The Effect of Adding Turmeric (*Curcuma Domestica*) Extract Solution to Drinking Water on the Quality of Quail Eggs. *Indonesian Animal Husbandry Journal*. 2015; 1: 115-125.
- [32] USDA No. 75. Egg Grading Manual. U. S. Washington DC. 1964.