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Physical Quality of Quail Eggs Fed with Added Snail Flour

M. Akramullah*, R. R. Dapawole, and N. A. D. Tiya

Universitas Pertahanan, Trans Timor National Road, Fatuketi Village, Kakuluk Mesak District, Belu Regency, East Nusa Tenggara, Indonesia, 85752.
*Corresponding Author: muh.akramullah@idu.ac.id

ABSTRACT

This study aimed to see the physical quality of quail eggs (*Coturnix-coturnix japonica*) fed with snail flour (*Achatina fulica*). The quail used were 72 tails, averaging 42 days of age. The maintenance of quail in this study was carried out intensively (caged). During the research, quail was given feed treatment at 07:00 WITA and 16:00 WITA, while drinking water was given in a libitum. The parameters observed in this study were egg weight, Haugh unit, yolk weight, yolk index, yolk color, albumen weight, albumen index, shell weight, and thickness of the shells. This research used a completely randomized design (CRD) with three treatments and four replications. The research treatments are as follows: P0 (feed + snail flour 0%), P1 (feed + snail flour 5%), and P2 (feed + snail flour 10%). Giving snail flour into the feed significantly gave a significant effect on the weight of eggs, yolk weight, yolk color, albumen index, shell weight, and thickness of quail shells (P <0.05), while Haugh units (P> 0.05). The results of this study can be concluded that adding snail flour up to 5-10% could produce a higher physical quality of the eggs compared to the treatment without the addition of snail flour into the feed.

Keywords: egg weight, quail, snail flour, yolk color

INTRODUCTION

Quail (*Coturnix-coturnix* japonica) is one of the commodities of laying poultry. Quail can reproduce relatively fast, which is 42 days, with an amount of egg production of 250-300 scales/year (Akramullah et al., 2023). Quail eggs are one of the high food sources of protein, which is 13.20% (Lokapirnasari, 2017). Based on the physical composition, quail eggs consist of 31.90% yolk, 47.40% egg albumen, and 20.70% eggshells (Satria et al., 2021).

Feed is one of the factors that can affect livestock productivity (Badaruddin et al., 2021) because 60-70% of expenses are only for feed purchases. It is because the cost of poultry feed has relatively high and unstable price. One of the causes of the high price of animal feed is that Indonesia still imports some of the raw materials for feeding from abroad. Thus, there is a need for alternative feed raw materials that can reduce production to production but have good nutritional content, low prices, and raw materials are always available.

Snail flour (*Achatina fulica*) is one of the alternative feed ingredients that can be used as a source of cheap and easy protein. Snail is a type of land snail that comes from East Africa and spreads almost throughout the world. It is estimated that it has entered Indonesia since 1922. Snail is often considered a pest for farmers. The use of snails as a source of animal protein feed is still limited. This is due to the limited information on using snails in animal feed ingredients, especially for quail livestock. The utilization of snails into additional feed that is processed into snail flour is expected to reduce the cost of feed production.

Jehemat and Koni's research (2013) showed that broiler chickens have an increase in body weight of 25.71 g/day by giving snail flour by 30% in feed, as a substitute for fish meal. Snails can be processed into flour or silage snails, each with a protein content of 44-62% and 18.70% (Sinurat, 1999). Snail flour in feed significantly affects fat carcass content and duck body weight (Rasno and Sulistyoningsih, 2014). Snail flour reportedly has a good lysine content of 8.98% (Jehemat and Koni, 2013). Sahid et al. (2012), reported that snail flour contains high minerals and amino acids: serine tyrosine acid, phenylalanine acid, histidine, threonine, aspartate, alanine, proline, tryptophane, valine, lysine, leucine, cysteine, methionine, arginine, glycine, glutamine, and isoleucine.

Genetic and environmental factors influence the production of quail eggs. Quail has high egg production genetically, but it does not produce optimally if it is not balanced with good environmental conditions. One important environmental factor is feeding. The addition of snail flour in feed is expected to produce eggs of good quality. Observing the physical quality of the quail eggs is the weight of eggs, Haugh units, yolk weight, yolk index, yolk color, albumen weight, albumen index, shell weight, and thickness of shells. This study aimed to see the physical quality of quail eggs (*Coturnix-coturnix* japonica) fed with snail flour.

MATERIALS AND METHODS

Research material

The research material is as many as 72 quail birds, averaging 42 days of age. The feed is made by yourself with ingredients consisting of vaccines, vita chicks, snail flour, tofu praise flour, bran, ground corn, concentrate, label sticker, and plastic bag. The tools used in research are litter cages, feed sites, drinking water, digital feed scales, pens to record research results, and cameras for documentation.

Cage and feed preparation

The maintenance of quail is done intensively using a battery cage; the size of each cage is 60 x 30 x 30 cm per cage filled with six quails. Before being used first, the cage, sanitation, and given lime, then the cage is silent for one week before the quail is put into the cage.

The nutritional content of each research ingredient, namely corn, rice bran, RK 24 (concentrate), tofu pulp flour, and snail flour, is presented in Table 1.

Snail flour

The first snail flour is prepared is ingredients and tools for making snail flour. Still-alive snails are stored in a bucket for 2-3 days to reduce dirt and mucus. Next, the snail is washed thoroughly. Then the snail is sprinkled with salt so that the mucus can be thoroughly washed. Clean snails are boiled for 20 minutes or until boiling. The cooked snail is separated from the shell and dirt. Then washed thoroughly so that clean snails were obtained. The snail meat is boiled for 20 minutes, drained, and cut thinly. Pieces of snail meat are dried in the sun to dry. Then blend until smooth, resulting in snail flour. Snail flour is ready to use.

The formulation of the formulation feeds itself as a treatment feed in this study is presented in Table 2.

Table 1. The nutritional content of feed ingredients

Nutritional Substance	Corn[1)]	Rice Bran[1)]	RK 24[1)]	TPF[2)]	SF[3)]
Crude protein (%)	9.00	12.00	36.59	22.64	57.20
Crude fat (%)	3.80	7.90	3.00	6.12	3.34
Crude fibre (%)	2.50	8.20	8.00	22.65	2.05
Calcium (Ca) (%)	0.02	0.12	10.00	0.04	2.00[4)]
Phosphorus (P) (%)	0.10	0.50	1.10	0.06	0.80[4)]
ME (Kkal/g)	3,430	1,630	3,974	4,010	1,420

Information: TPF = Tofu Pulp Flour, SF= Snail Flour, ME= Metabolic Energy
(1) = Herni et al. (2022)
(2) = Akbarillah et al. (2017)
(3) = Jehemat dan Koni (2013)
(4) = Rasno dan Sulistyoningsih (2014)

Table 2. The composition of the research formulation feed

Feed Ingredients	Treatment		
	P0 (%)	P1 (%)	P2 (%)
Corn	40	40	45
Rice bran	30	25	25
Concentrate	30	25	15
Tofu pulp flour	-	5	5
Snail flour	-	5	10
Total	100	100	100
Feed Nutritional Content			
Crude protein (%)	18.18	19.74	19.39
Crude fat (%)	4.79	4.72	4.78
Crude fibre (%)	5.86	6.29	5.71
Calcium (Ca) (%)	3.04	2.64	1.74
Phosphorus (P) (%)	0.52	0.48	0.42
ME (Kkal/g)	3,053.2	3,044.5	2,889.6

Note: Microsoft Excel calculation results based on proximate analysis

Method of mixing feed ingredients

Mixing feed ingredients is carried out daily by the percentage of feed ingredients used in each treatment. Feed acceleration begins with mixing snail flour with corn because corn has a higher oil content than concentrate with bran, making blending with the snail flour easier. Furthermore, other feed ingredients are mixed, namely concentrate, bran, and tofu pulp flour, into feed ingredients and stirred to become homogeneous and ready to be given to quail cattle.

Maintenance

The maintenance of quail in this study was carried out intensively (caged). During the study, quail was given feed for treatment in the morning at 07:00 WITA and 16:00 WITA, while the administration of drinking water ad libitum.
The research eggs were collected every morning and evening, given identity and weighed.

Research design

This research design uses a complete random design (CRD) with three treatments and four replications; each test consists of 6 samples. The treatment given is the addition of snail flour with a different level to the feed. The treatment of the addition of snail flour in quail feed is as follows:
P0: Feed + Snail Flour 0%.
P1: Feed + Snail Flour 5%.
P2: Feed + Snail Flour 10%.

Research variable and data analysis

The parameters observed in this study were egg weight, Haugh unit, yolk weight, yolk index, yolk color, albumen weight, albumen index, shell weight, and thickness of shells.

Research data were analyzed statistically using a Complete Randomized Design (CRD) (Steel and Torry, 1995), and differences were interpreted with the Duncan Multiple Test.

RESULTS AND DISCUSSION

Egg weight

The weight of the egg is the weight of the egg, which includes eggshell, albumen, and yolk. The average weight of eggs during the study of each treatment were P0 (9.79 g/grain), P1 (11.47 g/grain), and P2 (11.17 g/grain). The egg produced is still at the average level, according to the standard of 6-16 g/grain (Jumadin et al., 2017). According to Rahmasari et al. (2021), quail eggs weigh 10-11 g/grain (8% of the parent body weight).

Snail flour put into feed significantly affected the weight of quail eggs ($p < 0.05$). The use of snail flour up to a level of 10% at feed tends increased the weight of quail eggs compared to without giving snail flour (P0). Different weight of eggs is thought to be caused by the nutritional content in the feed. Anwari et al. (2018) reported that the difference in the weight of eggs produced can be influenced by age, livestock size, environmental temperature, and nutritional content in the feed.

Table 3. The results of observations of the physical quality of quail eggs that are treated with the addition of snail flour

Parameter	Treatment		
	P0	P1	P2
Egg weight (g/grain)	9.79±0.52^{b}	11.47±0.98^{a}	11.17±0.51^{a}
Haugh unit	93.26±3.10	91.28±4.82	95.28±2.69
Yolk			
Yolk weight (g)	3.15±0.30^{b}	3.83±0.58^{a}	3.77±0.13^{a}
Yolk index (%)	45.40±5.40	45.88±4.04	47.27±4.19
Yolk color	5.33±0.82^{b}	7.50±1.05^{a}	8.17±0.98^{a}
Albumen			
Albumen weight (g)	5.37±0.30	6.01±0.78	5.86±0.65
Albumen index (%)	12.98±2.36^{b}	13.54±2.59^{ab}	15.89±1.65^{a}
Egg shell			
Shell weight (g)	1.27±0.31^{b}	1.63±0,13^{a}	1.54±0.10^{a}
Shell thickness (mm)	16.17±1.47^{b}	16.83±0.75^{ab}	17.67±0.82^{a}

Note: Different superscripts in a row, different significantly ($p < 0.05$).
P0 = Feed + Snail Flour 0%
P1 = Feed + Snail Flour 5%
P2 = Feed + Snail Flour 10%

The addition of snail flour in feed increases egg weight, this is due to amino acids found in snail flour. Amino acids are part of a protein that has a vital role in egg formation (Maknun et al., 2015), mainly the type of amino acid lysine and methionine (Lisnahan et al., 2018).

Lysin amino acids and methionine function to launch metabolic processes and are essential amino acids that are very influential on egg weight (Maknun et al., 2015). Santoso (1989) reports that snail flour has complete amino acids, 1 g methionine, and 4.35 g of lysine (in 100 g of snail flour weight material). According to Widnyani et al. (2021) that the administration of micro-nutrients, namely lysine amino acids, and methionine, has a significant effect on the physical quality of eggs, namely the weight of eggs, egg density, yolk color, and Haugh unit of eggs.

In addition, fatty acids can also affect the weight of eggs. It is to Rahman et al.'s statement. (2018) that linoleic acid controls lipids and proteins needed for the development of follicles in the ovaries and directly controls egg size.

Haugh unit

Haugh unit is a value that expresses egg quality which is determined based on the correlation of egg weight and albumen height (Jazil et al., 2013). The Haugh average of egg units during the study for each treatment was P0 (93.26), P1 (91.28), and P2 (95.28). Haugh egg units produced are classified as very good (AA), according to the standards of the United States Department of Agriculture (2009); egg quality values <31 quality C, 31-60 quality B, 60-72 quality A, and >72 quality AA.

Snail flour in the feed did not significantly affect the quail egg unit (P> 0.05). Snail egg flour for all treatments was of >72 AA quality; this indicated that the albumen quality of each treatment was classified as very good based on the Haugh unit value obtained. The addition of snail flour in the feed did not directly impact the process of albumen formation, resulting in a Haugh unit tilapia which was not much different. The correlation between the weight of the egg and the albumen height influences the size of the Haugh unit value. High and low egg albumen is determined by ovomucin. Ovomucin is an albumen protein that plays a role in binding water and forming an albumen gel (Kusumastuti et al., 2013). Long egg storage will cause the binding capacity of ovomucin to decrease due to the evaporation of CO2 and H2O, so albumen decreases its viscosity (Sihombing et al., 2014) and produces low Haugh units. It is to the statement of Jazil et al. (2013) that the longer the storage, the lower the Haugh unit.

Yolk

The egg yolk is the first part of the egg formed in the ovaries of the female quail. Yolk has a round shape and is stored in the centre of the egg. Yolk is a fat emulsion in water with a dry ingredient of up to 50%.

a. Yolk weight

Snail flour in feed significantly affects the weight of quail egg yolk (p <0.05). Snail flour in feed with a level of 5% to 10% produces a higher yolk weight than without the provision of snail flour (P0). It is because the fat content influences the weight of the Yolk in the feed. Argo et al. (2013) state that egg yolk is influenced by fat in feed because most fat deposits are in yolk eggs. Types of fatty acids that can increase yolk weight are Omega 3, 6 (Indi et al., 2014), and 9 (Kanbur et al., 2022) because the three types of fatty acids are widely found in Yolk (Oğuz et al ., 2012). Snail flour contains omega 3 fatty acids, omega 6, and omega 9 (Pa et al., 2020), so when added to feed with 5% and 10% produces higher yolk weight. Based on the research of Haryadi and Triono (2006), snails contain omega three fatty acids (30.4%), omega 6 (31.2%), and omega 9 (7.3%).

b. Yolk index

The Yolk index is one of the parameters used to see the quality of egg freshness. The Yolk index value is one indicator to see the viscosity of Yolk obtained from the results of the height ratio and Yolk diameter (Kusumastuti et al., 2013). The Yolk Index research results ranged from 45.40 - 47.27%, which is still relatively good. Sartika et al. (2018) stated that a good Yolk index ranges from 0.33-0.50%.

Snail flour in the feed does not significantly affect the yolk index of quail eggs (P> 0.05). It shows that the provision of snail flours up to 10% does not significantly affect the Yolk index. The quality of the Yolk index obtained in all treatments is still within usual standards, allegedly because the research eggs used are still fresh. The statement of Indrawan et al. (2012) that the Yolk index value will decrease if the storage is getting longer. The decrease in the yolk index value is caused by the entry of water from the albumen diffused into Yolk, because the vitelline yolk membrane is not strong enough to hold it, causing the size of the yolk to get more oversized and softer (Kamaruddin et al., 2020). Rondonuwu et al. (2017) state that eggs aged one day have a Yolk index value of 0.52%.

c. Yolk color

Snail flour in feed significantly affected the color of the quail egg yolk ($p < 0.05$). The research results show that the provision of snail flour up to 10% at feed has a better yolk color score than feed without treatment. The higher the level of additional flour increases, the yolk color score value. The increase in yolk color scores in the treatment of snail flour is affected by linolenic acid content (Darmawan, 2016). Linolenate fatty acids are included in groups of omega-3 fatty acids (Nurasmi and Susanti, 2019) and are most commonly found in snail flour (Rebhung and Luke, 2020). Giving snail flour to quail is one way to meet the needs of saturated teak fatty acids, especially omega-3 fatty acids. According to Pa et al. (2020), snails are rich in omega-3 content, reaching 30.4% (Haryadi and Triono, 2006), making them suitable for laying poultry feed ingredients.

Amino acids of lysine and methionine found in snail flour can affect egg yolk colour. Widnyani et al. (2021) stated that administering micro-nutrients in the form of lysine amino acids and methionine gives color changes to egg yolk.

Albumen

Egg white (albumen) is divided into four parts, the first is the outer albumen dilute layer, the second is the outside of the thick albumen layer, the third is the inside of the dilute albumen layer, and the fourth is the inside of the Calazaferous layer (Sulistina et al., 2017).

a. Albumen weight

The average weights of the albumen during the study of each treatment were P0 (5.37 g), P1 (6.01 g), and P2 (5.86 g). By the results obtained by Sahid et al. (2020), the weight of the quail egg albumen ranges from 5.64-6.37 g. Hanapis et al. (2020), 5.00-5.25. Snailing flour in feed does not significantly affect the weight of quail egg albumen ($P > 0.05$). Snail flour at a 5% and 10% level does not provide a significant difference, but statistically, the treatment of P1 (snail flour 5%) produces a higher weight average. It is suspected of having a relationship between the weight of the albumen and the weight of the egg produced, which also has a significant weight in the P1 treatment. Saputra et al. (2019) believes eggs that have a larger size and weight will produce sizes and weight in more significant parts of eggs, one of which is albumen. Campbell et al. (2009) report that the difference in the weight of eggs produced can be influenced by age, livestock size, environmental temperature, and nutritional content in the feed.

a. Albumen index

The egg indexes obtained during the study were P0 (12.98%), P1 (13.54%), and P2 (15.89%). This result is not much different from the opinion of Buckle et al. (1987) state that the new albumen index ranges from 5.00-15.00%, while the Indonesian National Standard (2008) is 5.00-17.40%. Snailing flour into feed significantly affects the quail egg albumen index ($P > 0.05$). It is alleged because the nutritional content contained in snail flour can meet the needs of the albumen process. Jehamet and Koni (2013) state that snail flour containing protein reaches 62%, fat, amino acids that are quite complete, and minerals. Accepting Purnamasari et al. (2015) and Harmayanda et al. (2016), the value of the albumen index in eggs is influenced by the nutritional content in the feed. Purwati et al. (2015) state that a high egg albumen index is influenced by high protein consumption, so the formation of ovomucin is also more significant. Ovomucin is an albumen protein that binds water and forms an albumen gel (Kusumastuti et al., 2013).

Kurtini et al. (2014) stated that storing eggs for 30 days can reduce the albumen index due to physicochemical damage to the ovomucin fibres, this causes the water-holding capacity to decrease, and the albumen gel structure to change, and water in the egg can enter the egg yolk through egg membrane.

Eggshell

Eggshells are the outer layers of eggs that are hard, contain lime, have a smooth texture, and serve to protect eggs from physical damage or microbial contamination. Zhang et al. (2016) state that eggshells contain many minerals and are very low in protein. Schaafasma et al. (2000) state that the minerals of eggshells are high and other minerals such as Zn, Cr, SE, P, Fe, Mg, F, Na, Zn, and a little protein. Feeds containing minerals can affect the thickness of the eggshell (Sakroni et al. 2015).

a. *Shell weight*

The average weight of the shell during the study of each treatment is P0 (1.27 g), P1 (1.63 g), and P2 (1.54 g). Snailing flour into feed significantly affects the weight of quail eggs ($p < 0.05$). It means that the provision of snail flour is 5% to 10%, producing a higher furniture weight than without snail flour (P0). The weight of the eggshell is higher in the P1 treatment, and the possibility of having a relationship with the weight of the eggs is also higher. The results of this study were by the statement of Harmayanda et al. (2016) that quantitatively, the weight of the eggshell is obtained from the total weight of eggs multiplied by 10%. Nurjannah et al. (2017), the suggested weight affected the egg shoot weights.

b. *Shell thickness*

The average thickness of the shells during the study of each treatment were P0 (16.17 mm), P1 (16.83 mm), and P2 (17.67 mm). Snail flour in feed significantly affects the thickness of the quail eggshell ($p < 0.05$). It is due to the addition of 5% tofu pulp flour in the treatment of P1 and P2, thus affecting the shells' thickness. Tofu pulp flour contains minerals and vitamins needed by quail in egg formation.

Mainly vitamins C and E have an essential role in forming eggshells. Tofu is rich in protein and a source of vitamins, minerals, and antioxidants such as polyphenols, isoflavones, vitamin C, and vitamin E (Poysa and Woodrow, 2002). Vitamin C supplementation in the feed will stimulate calcium mobilisation from bones so that calcium can be used more for forming eggshells. Research Results Sahin et al. (2003) show that the supplementation of vitamins C and E in feed can produce the thickest eggshells and the heaviest weight. Vitamins C and E added to broiler chicken feed can prevent a decrease in the quality of eggshells (Chung et al., 2005).

CONCLUSION

Based on the results of the study, it can be concluded that the provision of snail flour into the feed up to a level of 5-10% has a significant effect on the weight of the eggs, yolk weight, yolk color, albumen index, shell weigth and thickness of the shell Unit, and weight albumen. So, the provision of snail flour 5-10% into feed could improve the physical quality of quail eggs.

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