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Addition of Moringa Leaf Flour (*Moringa oleifera L*) in Rations on the Quality of Quail (*Coturnix coturnix japonica*) Eggs

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ABSTRACT

This study aims to evaluate the use of moringa leaf flour (*Moringa oleifera* L) in rations on the quality of quail eggs. The researchers designed four treatments and five replications: P0, a ration without the use of Moringa leaf flour (control); P1, a ration containing 5% Moringa leaf flour; P2, a ration containing 10% Moringa leaf flour; and P3, a diet containing 15% Moringa leaf meal. These were analysed using ANOVA. The results showed that the use of *Moringa leaf* flour up to 15% had a significant effect ($P<0.05$) on yolk color but had no significant impact ($P>0.05$) on egg weight, yolk index, albumen index, haugh unit, shell weight, and thick shell. Based on the research results, incorporating Moringa leaf flour into rations up to 15% can enhance yolk colour without reducing egg weight, yolk index, albumen index, Haugh units, shell weight, and shell thickness.

Keywords: Moringa leaf flour, quail egg quality

INTRODUCTION

Nutrition is essential for society. Quail is one of the poultry commodities with high nutritional value, making it a suitable source of animal protein. There are several types of quail, one of which is the *Coturnix coturnix japonica* type of quail. This quail is the most popular type of quail raised by the community for both egg production and meat (Subekti & Hastuti, 2013).

Eggs are a rich source of animal protein, providing the body with essential nutrients, including protein, fat, vitamins, and minerals. The nutrient content in quail eggs is 13.2% protein and 11.1% fat (Lokapirnasari, 2017). In determining the quality of eggs, there are two things, namely, exterior and interior quality. External quality consists of egg weight and shell thickness, while defining internal quality includes egg yolk color, egg yolk index, and egg white index (Putri, 2020). According to Yuwanta (2010), yolk color, yolk index, and Haugh unit egg value are determined by the β-carotene and protein content in the egg yolk. Sources of egg yolk pigmentation can be obtained from feed ingredients such as yellow corn, vegetable fats (such as oil palm), and forage legume leaves. One of the legume leaf greens that can be used is Moringa leaves.

Moringa leaves are a plant with high nutritional content and antioxidant properties. Moringa leaves also have a high β-carotene content, which can help produce eggs of good quality. Kasadi (2015) reported that Moringa is rich in β-carotene, protein, vitamin C, calcium, and potassium, and is a good food source due to its natural antioxidant properties, which are attributed to the presence of various types of antioxidant compounds, including ascorbic acid, flavonoids, phenolics, and carotenoids.

The use of Moringa leaf flour in rations as a substitute for commercial feed supplements up to a level of 2.5% cannot increase egg weight, egg yolk index, egg white index, shell thickness, or high units, but can improve egg yolk colour (Pritisa, 2021). Based on this explanation, Moringa leaf flour, as a feed supplement, remains ineffective; therefore, its level is increased and used as a protein source feed ingredient.

Several studies used legumes as poultry feed ingredients, showing the following results. According to Dominga *et al*. (2022), incorporating Moringa leaf flour into the ration at levels ranging from 0% to 15% can enhance the intensity of egg yolk colour in free-range chickens. Utilising 5% to 10% Moringa leaf flour in the diet can increase the egg protein content in free-range chickens. Another study by Badri (2022) using Indigofera leaf flour (*Indigofera area*) at a level of 10% to 12.5% can increase the colour of the yolk without reducing the quality of the albumen index, yolk index, shell thickness, and Haugh unit.

Based on the description above and several previous studies, research was conducted to evaluate the use of Moringa leaf flour at 5%,

10%, and 15% to maintain the quality of quail eggs.

MATERIALS AND METHODS

The tools used in this research were cages, egg carpets, buckets, digital scales, callipers, rulers, feed containers, drink containers, glass plates, micrometre screws, yolk color fans, tripods, and grinding machines. The materials used in this research were 160 30-day-old quail, Moringa leaf flour, feed, and water.

Methods

This research employed a CRD (Completely Randomised Design) with four treatments and five replications, each replication consisting of eight quails.

P0: Rations without the use of Moringa leaf flour (control)
P1: The ration contains 5% Moringa leaf flour
P2: The ration contains 10% Moringa leaf flour
P3: The ration contains 15% Moringa leaf flour

The cage preparation is by sanitising the cage. The feeders and drinkers were cleaned, and curtains were installed. Sanitation, disinfection, and preparation of all necessary items for the research were conducted.

The process of making Moringa Leaf Flour (*Moringa oleifera* L)

The picked Moringa leaves are dried on a tarp in an open room until they are completely dry. Drying is not done in direct sunlight because it can damage the nutritional content of Moringa leaves. After that, the Moringa leaves are ground to obtain Moringa leaf flour.

Maintenance

This research used quail aged 30 days. Quails are reared until they lay eggs; after laying eggs, all samples are taken for each replication. Feed and water are given twice daily, at 6:00 AM and 5:00 PM. The drinking place is cleaned every day.

Sampling

Egg sampling was carried out every two weeks during the study. The number of eggs used was two eggs per repetition.

Ration Formulation

The nutritional content of the ration ingredients is presented in Table 1.

Table 1. Nutrient content of feed ingredients that make up the ration

Ration Materials	CP (%)	ME (Kkal/kg)	CF (%)	Fat (%)	Ca (%)	P (%)
Bran[a)]	8.5	1810	12	4.2	0.2	1
Ground Corn[a)]	8.9	3321	2.2	4	0.02	0.23
KLK[b)]	33	2700	9.83	6.3	10.8	1.28
Mineral Mix[c)]					32	10
TDK[d)]	27.67	2303	5.31	3.70	2.09	0.67

Source: a.) Hartadi *et al*. (2005), b.) Label KLK, c.) Label Mineral Mix, d.) Sari (2017).

The formulation of ration content and nutrition is presented in Table 2:

Table 2. Diet formulations used and their nutritional content

Ration Materials (%)	P0	P1	P2	P3
Bran	5	5	5	5
Ground Corn	39	39	39	39
KLK	55	50	45	40
Mineral mix	1	1	1	1
TDK	0	5	10	15
Total	100	100	100	100
Crude protein (%)	22.05	21.78	21.51	21.25
ME (Kkal/kg)	2870,69	2850,84	2830,99	2811,14
Fat (%)	5.24	5.11	4.98	4.85
Fibre (%)	6.86	6.64	6.41	6.19
Ca (%)	6.28	5.84	5.41	4.97
P (%)	0.94	0.91	0.88	0.85

Observed variables

Egg weight

Egg weight was obtained by weighing the eggs with a digital scale in grams.

Egg yolk color

Egg yolk color is measured using a yolk color fan; standard color with a score of 1-16 from pale to dark orange (dark).

Egg yolk index

The egg yolk index value is the ratio between the egg yolk's height and the egg yolk's diameter. It can be measured with a calliper and calculated using the following formula.

The egg white index value is the ratio between the height of the thick egg white and the egg white's diameter. It can be measured with a calliper and calculated using the following formula.

$$\text{Egghite index} = \frac{\text{High viscous egg white}}{\text{egg white diameter}}$$

Haugh Unit (HU)

The Haugh unit measurement is used to determine the viscosity of eggs. Haugh units can be measured using the formula:

$$HU = 100 \log (H + 7.57 - 1.7.\ W^{0.37})$$

Information:
HU = Haugh Unit
H = Egg white height (mm)
W = Egg weight (g)

Eggshell Weight

Shell weight was obtained by weighing the egg shells with a digital scale in grams.

Shell Thickness

Eggshell thickness was measured using a screw micrometre. Eggshell thickness is measured using the following formula:

$$\text{Shell Thickness} = \frac{t1 + t2 + t3}{3}$$

Explanation:
t1 = The thickness of the eggshell is blunt at the end (mm)
t2 = The thickness of the egg's middle shell (mm)
t3 = The thickness of the eggshell has a pointed tip (mm)

Data Analysis

Egg quality data were analysed using ANOVA. If the results of the analysis have a significant effect ($P < 0.05$), a further test is carried out using DMRT (Duncan's Multiple Range Test) to examine the effect between treatments.

RESULT AND DISCUSSION

The use of moringa leaf flour *(Moringa oleifera L)* in rations on the quality of quail eggs can be seen in Table 3. Analysis of variance showed that the use of Moringa leaf flour in the ration had no significant effect ($P>0.05$) on egg weight. The average weight of the eggs produced ranged from 10.91 to 11.39 g/g/piece. The results obtained were better than those in Sobur's (2022) research; the importance of quail eggs added with Moringa leaf tempeh flour, at a concentration of up to 4%, averaged between 10.64 and 11.07 g/item. Pritisa (2021) reported that the importance of quail eggs given up to 2.5% Moringa leaf flour averaged 10.32-11.11 g/item. From the two studies above, it can be seen that the results of this study have a higher egg weight.

Table 3. Use of Moringa leaf flour in rations on quail egg quality

Variable	P0	P1	P2	P3	P
Egg weight	11.15±0.60	11.39±0.46	10.97±0.63	10.91±0.90	0.38
Egg Yolk Color	5.4±0.58	6.8±0.39	7.0±0.61	7.6±0.81	0
Index yolk	0.450±0.02	0.459±0.02	0.451±0.02	0.444±0.02	0.49
Index albumen	0.114±0.016	0.126±0.021	0.119±0.017	0.117±0.012	0.41
Haugh unit	88.19±2.99	91.39±3.98	88.27±2.76	89.18±2.70	0.1
Eggshell Weight	1.33±0.11	1.31±0.10	1.30±0.08	1.34±0.08	0.67
Eggshell Thickness	0.19±0.005	0.19±0.007	0.19±0.005	0.19±0.008	0.75

Note: P0: Rations without the use of Moringa leaf flour/control, P1: The allocation contains 5% Moringa leaf flour, P2: The ration contains 10% Moringa leaf flour, P3: The allocation includes 15%. P>0,05): no significant, P<0,05): highly significant.

Factors influencing egg weight include the type of quail, type of feed, and environment (Rahmasari et al., 2021). Lesson and Summers (2005) stated that the food substances that play the most role in controlling egg size are protein and amino acids. Moringa leaves contain various types

of amino acids, including aspartic acid, glutamic acid, alanine, valine, leucine, isoleucine, histidine, lysine, arginine, phenylalanine, tryptophan, cysteine, and methionine (Aminah et al., 2015). The absence of a natural effect in this study is attributed to the use of the same type of quail, feed, and environment, as well as the nearly identical protein content in the ration, which does not significantly impact the weight of the eggs produced.

Egg Yolk Color

The analysis of variance showed that the use of Moringa leaf flour in the ration had a significant effect ($P<0.05$) on yolk color. Based on further tests, P0 significantly differed from P1, P2, and P3 in the second week, but P1 was not substantially different from P2 and P3. In the fourth week, P0 was not significantly different from P1, but it was substantially different from P2 and P3. In the sixth week, P0 significantly differed from P1, P2, and P3, but P1 was not substantially different from P2 and P3. In the eighth week, P0 significantly differed from P1, P2, and P3, but P1 was not substantially different from P2 and P3. On average, during the study, P0 was significantly different from P1, P2, and P3, but P1 was not substantially different from P2. This result shows that 5-15% Moringa leaf flour can improve yolk color.

The more Moringa leaf flour used in the ration, the better the yolk color. The color of the yolk is influenced by the content of carotenoid compounds, which are found in many plants. Sujana et al. (2006) reported that food containing carotenoid pigments, especially β-carotene and xanthophyll pigments, can affect egg yolk color. The β-carotene content in 100 g of Moringa leaf flour is 16.3 mg (Gopalakrishnan et al., 2016).

In this study, the average color of the yolk produced ranged from 5.4 to 7.6. The results were better than those of Pritisa (2021); the colour of the yolk treated with Moringa leaf flour, up to 2.5%, averaged between 5.7 and 6.3. SNI (2008) defines quail egg yolk color scores as quality 1 (score > 5), quality II (score 4-5), and quality III (score < 4). The average yolk color score from this study is included in quality I.

Yolk Index

The analysis of variance showed that the use of Moringa leaf flour in the ration had no significant effect ($P>0.05$) on the yolk index. The average yolk index produced ranged from 0.444 to 0.459. According to SNI (2008), the egg yolk index comprises three quality levels: quality I (0.458-0.521), quality II (0.394-0.457), and quality III (0.330-0.393). According to SNI (2008), the results of this research are categorised in Grade I. The results are better than those of Pritisa's (2021) study; the yolk index, as given by Moringa leaf flour, averaged between 0.39 and 0.41 at concentrations of up to 2.5%.

Factors that influence the egg yolk index are the availability of protein and amino acids in the feed, which can affect the egg yolk index because protein and amino acids are components that form the vitelline membrane, which functions to hold the egg yolk so that the egg yolk index depends on the protein intake consumed by livestock (Satria et al., 2021). This study does not have a natural effect because the protein content in the rations is almost the same, so it does not affect the yolk index produced.

Albumen Index

The analysis of variance revealed that the inclusion of Moringa leaf flour in the ration had no significant effect ($P > 0.05$) on the albumen index. The resulting average albumen index ranged from 0.114 to 0.126. Sobur (2022) reported that the albumen index for quail eggs supplemented with Moringa leaf tempeh flour at up to 4% averaged between 0.11 and 0.12. According to SNI (2008), the egg white index is classified into three categories: quality I (0.134-0.175), quality II (0.092-0.133), and quality III (0.091-0.050). According to SNI (2008), the results of this research fall within quality level II.

Argo *et al.* (2013) reported that factors influencing the egg white index value include storage time, temperature, and feed nutrition. The higher the protein content in the feed, the thicker the egg white will be, which in turn affects the albumen index, determined by the height of the thick egg white and its diameter. The absence of a natural effect in this study is because the storage time and temperature used were the same, and the protein content in the ration was nearly identical, so it did not affect the resulting albumen index.

Haugh Unit (HU)

The analysis of variance showed that the use of Moringa leaf flour in the ration had no significant effect ($P > 0.05$) on the Haugh unit. The average Haugh unit produced ranged from 88.19 to 91.39. According to Jaelani and Zakir (2016), AA-quality eggs have a value of (HU>72), A-quality eggs have a value of (HU 60-72), and B-quality eggs have a value of (HU 31-60). Based on Jaelani and Zakir (2016), the results of this research are included in AA quality. The results

were better than those of Pritisa (2021); the average HU given Moringa leaf flour at concentrations up to 2.5% ranged from 80.51 to 82.74. HU is a unit that correlates albumen height and egg weight. The higher the HU, the better the egg quality.

Amin *et al*. (2015) stated that the factors influencing the high unit value are albumen height, feed nutrition, protein intake, and egg weight. Other factors that affect the immense unit value include the age of the quail and the length of egg storage (Satria et al., 2021). The absence of a natural effect in this study is thought to be because the age of the quail and the storage time for the eggs used were the same, and the results of the ANOVA on egg weight had no discernible effect, so the same thing with the haugh unit did not show significantly different results.

Eggshell Weight

The analysis of variance showed that the use of Moringa leaf flour in the ration had no significant effect (P>0.05) on shell weight. The average weight of the shells produced ranged from 1.30 to 1.34 g/g/piece. Suseno (2014) reported that the average weight of quail egg shells treated with moringa leaf flour and *Saccharomyces cerevisiae* (yeast) went from 0.95-0.99 g/item. Zuhri et al. (2017) reported that the average weight of quail eggshells treated with up to 1% garlic flour ranged from 0.85-0.89 g/piece. According to Amrullah (2003), the quantitative importance of the shell is 10-13% of the egg's total weight.

Shell weight is greatly influenced by the feed consumed, egg weight, and quail age (Amrullah, 2003). The calcium and phosphorus content in feed plays a significant role in determining the quality of eggshells, including their thickness, weight, and eggshell structure (Wahju, 2004). The calcium content in the diet ranged from 4.97% to 5.84% and was lower than that of the control treatment. However, with a calcium source of more than 4%, it still contributed to good shell formation. This study had no discernible effect because the calcium and phosphorus content in the ration was almost the same, so it did not affect the weight of the shells produced.

Eggshell Thickness

The analysis of variance showed that the use of Moringa leaf flour in the ration had no significant effect (P>0.05) on shell thickness. The average thickness of the shells produced was 0.19 mm. The results obtained were higher than those of Pritisa's (2021) research; the average thickness of surfaces treated with Moringa leaf flour at up to 2.5% ranged from 0.16 to 0.17 mm.

Factors that influence shell formation include the bird's age, high environmental temperature, food, and disease. The age of the bird affects the formation of the eggshell. The older the bird, the thinner the eggshell will be because the reproductive function of the bird decreases due to the increasing age of the bird (Fitriani et al., 2016). Yuwanta (2010) states that the most critical factors influencing shell thickness are calcium, phosphorus, and vitamin D, although calcium and phosphorus play an essential role in eggshell formation in small amounts. The absence of a natural effect in this study is due to the fact that the calcium and phosphorus content in the ration is almost the same, so it does not affect the thickness of the shells produced.

CONCLUSION

Based on the results of this research, using Moringa leaf flour in rations can increase yolk colour without reducing egg weight, yolk index, albumen index, Haugh units, shell weight, or shell thickness.

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