Effect of Indigofera leaves as a substitute for soybean meal in laying quail (Coturnix-coturnix japonica) ration on egg production, feed conversion ratio, and yolk color score

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Abstract. Indigofera leaves is one of alternative feed that can be used in quail rations. This study aims to determine the effectiveness of Indigofera leaves a substitute for soybean meal in quail rations. The material used were 100 female quails aged 56 weeks, yellow corn, rice bran, laying hens concentrate, soybean meal, and Indigofera leaves. This research used a completely randomized design with four treatments and five replications. The treatments applied were T0 (control), T1 (rations containing 4% Indigofera leaves), T2 (rations containing 6% Indigofera leaves), and T3 (rations containing 8% indigofera leaves). The variables observed were feed consumption, egg production, egg weight, feed conversion ratio (FCR) and yolk color score. The data obtained were analyzed using analysis of variance and continued using Duncan Multiple Range Test through SPSS program. The results showed that the use of Indigofera leaves significantly affect (P <0.05) the FCR and egg yolk color score, but did not affect feed consumption, egg production and egg weight. Indigofera zollingeriana leaves meal could be used in laying quail (Coturnix coturnix Japonica) ration up to 8% as a substitute for soybean meal and did not gave a negative effect on its performance. Moreover, Indigofera leaves meal increased egg yolk color value.

1. Introduction
Poultry is one of the livestock that gave the largest contribution in the animal protein needs of the Indonesian people. One type of poultry that has the potential to be developed as an alternative to fulfill the needs of animal protein is quail (Coturnix coturnix japonica). These birds have high reproductive and production cycles. Like most other high-producing poultry species, quails are highly dependent on the continuity and quality of the feed. This causes quails to be very vulnerable to fluctuations in feed prices, therefore it is necessary to use alternative feed that has good quality but are easily obtained, low prices and high availability.

One of the alternative feed that can be used for quail is Indigofera leaves. Indigofera zollingeriana has high enough forage productivity and good nutrient content, especially its high protein content. The use of Indigofera leaves in rations can reduce ration costs and increase income [1]. According to [2], the crude protein content found in Indigofera leaves reaches 29.16%, crude fiber reaches 14.02%, and crude fat reaches 3.62%. Beside protein, Indigofera leaves are also reported to contain beta-carotene which can increase the vitamin A content of quail eggs.

Palupi et al. [3] stated that Indigofera contains beta carotene which soybean meal does not have. Jiang et al. [4] stated that beta carotene can improve egg quality, especially yolk color. This is due to the fatty acids and protein of Indigofera sp. shoots can replace the proportion of fatty acids and protein from soybean meal in forming egg yolk. This is due to the ration without shoots of Indigofera sp. does not contain β-carotene, whereas the rations containing shoots of Indigofera sp. there is β-carotene which increases the color pigment of the egg yolk produced. The carotenoid concentration in egg yolk is a...
reflection of the food consumed by the chicken. The brighter the egg yolk intensity will have a higher physical quality, so it is preferred by consumers. If the feed contains more carotene, namely xanthophyll, the egg yolk color will be more reddish-orange [5].

2. Materials and method
One hundred of 56 weeks laying Japanese quails were housed and raised for 6 weeks of the experiment. These quails were divided into 4 groups of treatments and each treatment was replicated 5 times. The treatments used in this experiment were 4 levels of Indigofera i.e., control (ration without ILM, T0), ration containing Indigofera 4% (T1), 6% (T2), and 8% (T3), respectively. The basal feed ingredients consisted of yellow corn, rice bran, and laying hens concentrate which formulated to fulfill the requirements for laying hen quail.

Indigofera leaves were harvested from Halu Oleo University Plantations Education and Research. Indigofera leaves were transformed into Indigofera leaves meal (ILM) through sun dry process for 2 days. The sun-dried Indigofera leaves then grounded into a meal.

During the experiment, feed consumption, egg weight, egg production, feed conversion ratio and yolk colour score were recorded. Feed consumption was measured every day by calculating the difference between the given and leftover feed. Quail eggs were collected daily to calculated egg production and egg weight. Egg production was expressed as a percentage of the number of eggs produced by the number of quails reared. Moreover, the feed conversion ratio was calculated by comparing the amount of consumed feed with weights of eggs produced at a certain time. Yolk color was determined using the La Roche color yolk fan scale from 1-15.

The data obtained were analyzed using analysis of variance (ANOVA) based on completely randomized design. Data were analyzed by using the Statistical Package for Social Sciences (IBM®SPSS® version 16.0). The mean value differences were considered significant at the level of P<0.05, the data were further analyzed by using Duncan multiple range test [6].

3. Results and discussion
The productive performance of laying hen quails fed Indigofera leaf meal is presented in table 1.

| Parameters                  | T0                  | T1                  | T2                  | T3                  |
|-----------------------------|---------------------|---------------------|---------------------|---------------------|
| Feed consumption (g/bird/d) | 22.24±1.2           | 19.2±2.7            | 20.88±1.3           | 22.34±2.0           |
| Egg production (%)          | 51.64±6             | 51.28±1.4           | 52.82±7             | 53.84±1.1           |
| FCR                         | 5.1a±0.6            | 4.6b±0.7            | 4.6b±0.7            | 5.1a±0.1            |
| Egg weight (g)              | 10.9±0.5            | 10.9±0.5            | 11±0.1              | 10.9±0.8            |
| Yolk colour score           | 5.0a±0.2            | 5.3ab±0.1           | 5.1a±0.1            | 5.5b±0.1            |

*Different superscripts within a row show a significantly different (P<0.05) T0: without ILM, T1: 4% ILM; T2: 6% ILM and T3: 8% ILM.

3.1. Feed consumption
The results showed that the use of Indigofera leaves to substitute soybean meal had no significant effect on the feed consumption of the quails. This indicated that the inclusion of Indigofera leaf meal in the ration up to 8% shows that Indigofera flour does not affect consumption like other fibrous feed ingredients. This is not in line with the statement of Has et al [7] that crude fiber can increase feed consumption in poultry. The feed consumption of quail is influenced by the energy content of rations, therefore, poultry fed rations with low energy content consuming feed more compared to those fed rations with higher energy content [8]. Palupi et al [9] reported that the addition of Indigofera in quail rations did not affect consumption. The beta carotenoid content of eggs has increased along with the increase in Indigofera leaves in the ration.

3.2. Egg production.
Egg production in this study was not affected by the use of Indigofera leaves meal in the ration (P>0.05). This showed that the inclusion of Indigofera leaf meal up to a level of 8% in the ration did not
shown a negative impact on egg production. Akbarillah et al. [10] reported that the use of Indigofera leaves below 10% did not affect egg production and FCR. Siagutla et al. [11] reported that the use of Indigofera leaves in rations to replace corn did not affect the production performance in laying hens. Egg production in this study was relatively low compared to that reported by Napirah et al [12], which ranged from 68-77% for 12 weeks old quail, and 80% for 20 weeks old quail eggs [13]. This is presumably because of the older age of the quail used in this study (80 weeks). Nhan et al [14] reported that there was an increase in egg weight, a decrease in production, and a decrease in egg color as the quail grew older. The fact that a higher level of Indigofera inclusion in the ration did not lower the egg production indicated that the use of Indigofera leaves in rations can replace soybean meal in rations. The role of Indigofera in maintaining the egg production in different levels of inclusion might be attributed to the higher level of its carotenoid content. Bortolotti et al [15] stated that carotenoids function as pigments and play a role in physiological processes for egg production and embryo development.

3.3. Egg weight
The egg weight in this study was relatively lower than that reported by [12, 14]. The nutrient content of Indigofera leaves is thought to replace the nutrients in soybean meal, especially fatty acids and proteins. Palupi et al [3] reported that Indigofera shoot leaves contain essential amino acids that can be used by livestock for production, but at a lower level than the index of essential amino acids of soybean meal. This study also revealed that there were no differences in the size of the eggs produced from quails fed different levels of Indigofera. This is indicated that there is no negative impact of the Indigofera on egg weight parameters. The egg weight in this study is following the report by Has et al [13] that the weight of quail eggs ranges from 9-10 g. The lower value of the egg weight in this study was thought to be due to the relatively low protein content of the diet offered to the quails during the study (18%).

3.4. Feed Conversion Ratio (FCR)
The result of variance analysis showed that the treatments gave a significant effect (P<0.05) on quail feed conversion ratio. FCR value of quail hens fed Indigofera at 4 and 6% level in the ration were significantly lower than that of in either control or fed 8% groups. The lower value of FCR indicated that quail hens showed a higher level of efficiency in converting feed to produce eggs. The fact that egg weight and production was similar among treatment groups, the improvement on FCR value in T1 (4%) and T2 (6%) was presumably due to the feed absorption in the gut of hens. The use of 4 and 6% of Indigofera leaves in hens rations produced a lower feed conversion than hens in control and fed 8% of Indigofera leaves. This was due to the nutrient content of T1 and T2 can maximize absorption, while T3 tends to cause an increase in crude fiber ration, thereby reducing its effectiveness. The use of Indigofera leaves meal at levels above 10% in rations can reduce FCR in laying birds [16]. Has et al. [7] reported that increasing the crude fiber of the ration can reduce the digestibility of dry matter and organic matter. Akbarillah et al. [10] also reported an increase in FCR with the use of Indigofera leaves above 10% in laying ducks.

3.5. Yolk color score
The use of Indigofera leaves 8% in hens ration significantly increased the yolk color score than the hens in the control group. This is indicated that the β-carotene content in Indigofera leaves can affect the yellow color of the eggs. Palupi et al [3] stated that Indigofera contains types of β-carotene differently compared to soybean. Moreover, previous studies reported the positive effect of β-carotene from different sources on egg quality, yolk color in particular, in some egg-producing poultry [4, 10, 17]. The carotenoid concentration in egg yolk is a reflection of the food consumed by the hen. If hens consumed feed contains more carotene, i.e., xanthophyll, the egg yolk color appeared more reddish-orange [5]. The deposition of beta-carotene in the yolk depends on the efficiency of transferring carotene from the intestine into the ovum [18]. The color score in this study was relatively low but was still in line with that reported by Nhan et al [14] that the score of quail egg yolks over the age of 38 weeks was 4.69 with an egg weight of 11.56 g. On the other study, Widiyanto and Indrawan [19] revealed that the color score for the yolk of 9 weeks of quail eggs was 6.5-7.
4. Conclusion

*Indigofera zollingeriana* leaves meal could be used in laying quail (*Coturnix coturnix Japonica*) ration up to 8% as a substitute for soybean meal and did not give a negative effect on its performance. Moreover, *Indigofera* leaves meal increased egg yolk color value.

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