The effects of graded levels of fermented duckweed in quail diets on egg production and yolk cholesterol

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Abstract. This study aims to examine the effect of feeding graded levels of fermented duckweed meal (FDM) in quail diets on production performances, egg internal quality and yolk cholesterol. A total of 100 two-months-old quail layers (Coturnix coturnix japonica) were randomly allocated into four dietary treatments, in which each treatment consisted of five replications with five birds each according to a completely randomized design. The FDM used in each treatment were 0, 5, 10, and 15%, complementing other feed ingredients. Observations were conducted for 6 weeks following a week of adaptation to diets and environment. On the last two days, six eggs from each replication were collected for determination of internal qualities and yolk cholesterol. Result shows that daily egg production varied from 66–76%. Egg production of birds received diet with 10% FDM was not different (P>0.05) from those of control, but those fed on diet with 15% FDM was significantly lower (P<0.05). Egg weight and yolk weight decreased when level of FDM increased, but eggshell and egg yolk cholesterol were not affected (P>0.05) by dietary levels of FDM. The results suggest that fermented duckweed meal using mixed culture probiotics can be fed up to 10%.

1. Introduction
Eggs consumed by the community are chicken eggs, free-range chicken, duck and quail eggs. Quail eggs are foods with a fairly complete nutritional content, and are favored by all ages because of their small size and good taste [1]. The quail eggs are mostly produced by small breeders. A common problem faced by small farmers are in providing feed. High price of conventional feed sources and quail competing with other poultry and other monogastric animals for feed items suggest that alternative, nonconventional, and locally available feed sources be used. Therefore, a continuous effort is needed to obtain alternative feed ingredients to replace partly or totally of the conventional feed ingredients.

Besides, among eggs of chicken, duck and quail, quail egg contains higher cholesterol content [2] which may limit their consumption. To produce food that is safe for consumption, efforts are needed to reduce the cholesterol levels of quail eggs. Duckweeds (Lemma sp) is one of the water plants that has the potential to be used as feed ingredients for poultry, especially in developing countries [3] where the prices of commercial feeds is relatively high. This plant contains a fairly high protein (20-40% DM) and its fiber content is relatively low (10-18%) and rich in macro and micro minerals such as calcium and chlorine. The use of duckweed as quail feed ingredients is expected to be an alternative supply of affordable feed ingredients which may reduce cholesterol levels in their eggs.
Studies regarding the use of this plant as a replacement of conventional source of protein in poultry diets showed variable results. Haustain [4] recommended the contribution of protein from duckweed in feed by 5%. Meanwhile O’Neill [5] found that feed intakes and production characteristics were not affected by the inclusion of 13% duckweed (S. punctata) in the diet of laying hens. Variation in recommendation might be related to variation in its chemical composition, and reduction performance when the birds fed on high level of duckweed might be associated with higher dietary fiber content.

Fermentation technology aimed to improve the quality of poultry feed by increasing protein and reducing fiber contents [6-7]. The objective of this experiment was to evaluate the effects of feeding graded level of fermented duckweed on the production performances and yolk cholesterol of quail (Coturnix coturnix japonica).

2. Materials and methods
This research was conducted in Gopala Farm, at Kuranji Village, Labuapi District, West Lombok Regency. Samples preparation were conducted at the Laboratory of Nutrition and Feed Science, Faculty of Animal Husbandry, University of Mataram. The analysis of cholesterol levels of yolk was done in the Integrated Department of INTP-Faculty of Animal Science IPB.

2.1. Preparation of fermented duckweed
Fresh duckweed (Lemna sp.) was collected in rice field around the city of Mataram, then sun dried for two days (up to constant weight with water content of 10-12%). Mixed culture probiotics in liquid form containing lactobacillus sp, Bacillus sp, Pshydomonas sp, Azobacter sp, Sacharomyces sp, Aspergillus oryzae, Rhidopus oryzae, and Pshydomonas sp. was used as fermenter. The fermenter was sprayed into dried duckweed so that the moisture content was approximately 50%, then loaded into plastic container. The container was sealed to allow an aerobic environment for the process of fermentation. The fermentation was terminated at day 14. The fermented duckweed was then sun dried for two days, then ground to pass 2mm screen. Fermented duckweed meal (FDM) was analyzed for its chemical composition according to standard procedure [8].

2.2. Dietary treatment and experimental design
Four dietary treatments, i.e., control diet and diets containing 5, 10 and 15% FDM were formulated. The ingredients used in formulating the diets in this study were yellow corn, rice bran, concentrate, crude palm oil (CPO), premix, and FDM. The proportion of each ingredient in diets and their chemical composition are present in Table 1.

One hundred two-month- old quails layer were randomly allocated into four dietary treatments according to completely randomized design. Each treatment had five replicates consisted of 5 birds each which were placed in a 50 x 40 x 30 cm galvanized wire boxes. Feed was provided ad libitum in mash form and drinking water was always available. Feed intake and egg production were noted daily. At the last two days of experimental period, egg samples were collected for measuring levels of yolk cholesterol.

The differences in feed intake, egg production, feed conversion ratio (FCR), and levels of yolk cholesterol were subjected to analysis of variance using General Linear Model (GLM) procedures of SAS software [9]. When the model was significant, Duncan Multiple Range Test was run for post hoc analysis.
Table 1. The proportion of each ingredient and chemical composition of dietary treatments

| Ingredients          | Levels of FDM* | Requirement |
|----------------------|----------------|-------------|
|                      | Control       | 5%          | 10%         | 15%         |                |
| Yellow corn (%)      | 30            | 34          | 34          | 30          | -             |
| Concentrate (%)      | 35            | 29          | 27          | 25          | -             |
| Rice bran (%)        | 31            | 28          | 25          | 25          | -             |
| FDM (%)              | 0             | 5           | 10          | 15          | -             |
| Premix (%)**         | 1             | 1           | 1           | 1           | -             |
| Crude palm oil (%)   | 3             | 3           | 3           | 4           | -             |

Chemical composition

| Parameters          | Control (g/kg) | 5% (g/kg) | 10% (g/kg) | 15% (g/kg) | Requirement |
|---------------------|----------------|-----------|------------|------------|-------------|
| Crude protein       | 175.6          | 174.0     | 174.8      | 175.4      | 170-190     |
| ME (MJ/kg)          | 11.58          | 11.57     | 11.37      | 11.40      | 11.29       |
| Ca (g/kg)           | 38.7           | 33.3      | 35.0       | 31.2       | 32.5        |
| P (g/kg)            | 9.7            | 8.7       | 9.3        | 9.2        | 6.0         |
| Crude fiber (g/kg)  | 62.2           | 64.1      | 65.0       | 68.5       | 50          |
| Crude fat (g/kg)    | 69.4           | 70.7      | 70.4       | 80.2       | 40          |

*FDM = Fermented duckweed meal.

** Each 1 kg contained: vitamin A 12,000,000 IU, vitamin D; 2,000,000 IU, vitamin E 8,000 IU, vitamin K2 2,000 mg, vitamin B1 2,000 mg, vitamin B2 5,000 mg, vitamin B6 500 mg, vitamin B12 12,000 µg, vitamin C 25,000 mg, Ca-D-pantothenate 6,000 mg, Niacin 40,000 mg, Cholin chloride 10,000 mg, Methionine 30,000 mg, Lysine 30,000 mg, Manganese 120,000 mg, Iron 20,000 mg, Iodine 200 mg, Zinc 100,000 mg, Cobalt 200 mg, Copper 4,000 mg, Santoquin (antioxidant) 10,000 mg, Zinc bacitracin 21,000 mg.

3. Results and discussion

3.1. Production performances

The production performances of quails (Coturnix coturnix javonica) given diets containing different levels of FDM are presented in Table 2. Feed consumption was not affected (P>0.05) by levels of FDM in diets. Each bird consumed around 25g feed daily. The amount of feed consumed by birds is affected by factors such as types of feed and quality, production period, body weight of the bird and environmental temperature [10]. Non-significant differences observed in this study might be due to similar age and production period of the birds, relatively similar feed composition, and similar environmental temperature.

Daily feed consumption of quail in this study is in the vicinity to those reported by Arbiatur and Sopandi [11] but higher than those reported by Amo [12]. The Indonesian feeding standard (SNI) for laying quail recommends the diet to contain 20% protein, while the protein content of dietary treatments in this study were only 17 – 18%. Therefore, the birds consumed more feed to meet their protein need to maintain high level of egg production.

Table 2. Production performances of quail given diet containing different levels of FDM

| Parameters          | Control (g/bird/d) | 5% (g/bird/d) | 10% (g/bird/d) | 15% (g/bird/d) | SEM | P-value |
|---------------------|--------------------|---------------|----------------|----------------|-----|---------|
| Feed consumption   | 24.49              | 25.45         | 24.71          | 25.43          | 0.54| 0.394   |
| Hen day egg production (%) | 76.80           | 75.60         | 70.20          | 66.6           | 2.19| 0.015   |
| Feed conversion ratio (g feed/g egg) | 2.64               | 2.77          | 2.94           | 3.13           | 0.67| 0.006   |
| Egg weight (g/egg)  | 11.54              | 10.96         | 10.58          | 10.25          | 0.14| 0.001   |
| Yolk cholesterol (mg/g) | 19.82             | 19.12         | 18.49          | 18.92          | 1.58| 0.756   |

Note: Different superscripts in the same row were significantly different (P<0.05); SEM = pooled standard error; FDM = fermented duckweed meal.
Table 2 shows that the average egg production of quail given diet containing up to 10% FDM was not significantly different from those received control diet. However, egg production of quail received diet with 15% FDM was about 10% lower than control. This trend was also observed in egg weight. Quail given diet with 15% FDM produced lighter egg (10.25g vs 11.54g) compared to those offered control diet. However, the weight of eggs produced in this study is still in the normal range as reported by previous researchers. Quail egg weight ranges from 8-10 g [13] and Wiryawan et al. [14] reported that quail eggs given feed containing crab waste were no different from quail fed control feed, ranging from 10.17 - 10.61g.

Feed conversion ratio (FCR) increased along with increasing levels FDM in diets. Table 2 shows that feed conversion increased from 2.64 for quail fed control diet to 3.13 for quail received diet with 15% FDM. This indicates that feed efficiencies decreased along with increasing levels of FDM in diets. Lower feed efficiencies for quail given diet with 15% FDM is likely due to the gradual increase of fiber content of FDM containing diet (Table 1), because dietary fiber is poorly digested by poultry. It decreased digesta transit time [15]. This is supported by the studies in broiler chicken by Jorgensen [16] and Pinheiro [17] who showed a significant reduction in nutrient digestibility as levels of dietary fiber increased.

3.2. Yolk cholesterol
The concentration of cholesterol in egg yolk may vary dependent upon a number of factors such as the age of the birds, genotype, rearing system and diet [18]. It is concluded that the cholesterol content in yolk can be changed ± 25% by cholesterol from feed and fat. This indicates that level of yolk cholesterol may be reduced by environmental and nutritional manipulations. Fenita and Suteky [19] observed a significant reduction in cholesterol levels in quail serum after quail received feed containing niacin. The showed that total cholesterol level in serum blood decreases in line with the increasing use of niacin in feed.

The average total cholesterol level of quail egg yolk in this study ranged from 16.97 - 21.09 mg/g (Table 2). Although the statistical analyses showed no significant different (P> 0.05) on the cholesterol levels of eggs produced by quail which received feed containing 5-15% fermented duckweed, quails fed on diet with 10% fermented duckweed produced eggs whose cholesterol levels were around 13.90% lower than controls. The level of dietary crude fiber in this study might not high enough to inhibit fat digestibility. Besides, the duckweed used has been fermented so that certain amount of fiber contained in it was digested properly and did not provide significant inhibition to the digestibility of nutrients including fat as a source of cholesterol. Similar result was reported by Avianti [20] who concluded that administration of turmeric flour with a level of 54 mg / head / day did not affect feed consumption and level of cholesterol in quail eggs.

4. Conclusion
This study concluded that, egg production of birds received diet with 10% duckweed was not different (P>0.05) from those of control, but those fed diet with 15% was significantly lower. According to hte egg weight, it is decreased when level of fermented duckweed meal increased, but egg yolk cholesterol was not affected (P>0.05) by dietary levels of FDM. All in all, the results suggest that fermented duckweed meal using mixed culture probiotics can be included in quail diet up to 10%.

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