Infertile egg powder as a potential feedstuff for starter broilers

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Abstract. Infertile egg powder (IEP) contains a high nutrient content, particularly protein, thus it is potential to be utilized as a feedstuff. The objective of this study was to investigate the utilization of IEP as a feedstuff for starter broilers. This study used 196 one-day-old male broilers which were randomly allocated to four treatments in a completely randomized design with 7 replicates of 7 birds. The four dietary treatments included: basal diet (T0), 96% basal diet + 4% IEP (T1), 94% basal diet + 6% IEP (T2), and 92% basal diet + 8% IEP (T3). The diets were provided ad libitum. The variables were the feed intake, growth performances and feed cost. The data were subjected to analysis of variance and continued with Duncan’s Multiple Range Test. Feeding with T1, T2 and T3 did not affect the feed intake. However, T2 showed higher protein intake, while T2 and T3 showed higher energy intake than T0 (P<0.05). The IEP increased birds’ average daily gain and feed efficiency (P<0.01). The T1, T2 and T3 treatments yielded lower feed cost. It can be concluded that IEP can be utilized as feedstuff for starter broilers as indicated by improvement in growth performances.

1. Introduction
Feeding with sufficient nutrient content to young chicks is important for their performance due to the incapability and immature of digestive tract. Besides, the young broiler chickens required a high level of nutrient for growth of digestive tract and other organs [1]. The well-developed digestive tract will support the growth in all parts of the body such as muscles, skeleton and immune system [1,2].

Protein sources for poultry diet are commonly dominated by fish meal, meat bone meal and soybean meal. Other alternative of protein sources, for example hatchery by product, is needed to reduce the utilization of conventional protein sources. The incubation process in the chicken hatchery results about 10-15% infertile eggs which is rich in protein, fat, and other bioactive nutrients such as lysozyme, avidin and phosvitin [1,3]. Thus, it has a potential to be utilized as animal feedstuff, for example in the form of dried egg powder. Egg powder has a high level of nutrient bioavailability. Processing of infertile eggs as infertile eggs powder (IEP) also offers an interesting economic potential since it utilized the hatchery by product as a feedstuff.

Previous studies showed the beneficial effects of feeding with egg powder on the performances and immunity in poultry [2,3]. Inclusion of egg powder in broiler diet increased the feed intake, body weight and decreased the feed conversion ratio [1]. Similarly, utilization of egg powder in the diet
improved immune status of starter broilers [2]. Therefore, the objective of this study was to investigate the utilization of IEP as a feedstuff on the performances of starter broilers.

2. Materials and Methods

2.1. Experimental Design and Diet Formulation
In total, 196 one-day-old male Lohman MB 202 were allotted into four dietary treatments and seven replicates each with seven individuals. The four treatments were 100% basal diet (T0), 96% basal diet + 4% IEP (T1), 94% basal diet + 6% IEP (T2), and 92% basal diet + 8% IEP (T3). The basal diet was formulated based on corn and soybean meal. The infertile eggs were cracked and the eggshells were removed. The egg contents were then mixed homogenously with 10% wheat flour (w/w) and 10% palm oil (w/w). The mixture was then dried in the oven at 70 °C for 60 minutes, followed by sundrying, and ground to obtain the IEP. Nutrient content of the IEP is presented in Table 1 while nutrient content of the basal and experimental diets was presented in Table 2.

| Nutrients                        | Content     |
|----------------------------------|-------------|
| Metabolizable energy (kcal/kg)*   | 5454.9      |
| Crude protein (%)                | 31.47       |
| Crude fat (%)                    | 30.10       |
| Crude fiber (%)                  | 0.59        |
| Ash (%)                          | 1.99        |
| Calcium (%)                      | 0.05        |
| Phosphorus (%)                   | 0.18        |

*Calculated according to Sibbald et al. [4]:

\[ \text{ME}=3951 + (54.4 \times \text{crude fat}) - (88.7 \times \text{crude fiber}) - (40.8 \times \text{ash}) \]

| Component                   | T0  | T1   | T2   | T3  |
|-----------------------------|-----|------|------|-----|
| Basal diet (%)              | 100 | 96   | 94   | 92  |
| Infertile egg powder (%)    | 0   | 4    | 6    | 8   |
| Metabolizable energy (kcal/kg) | 3112.50  | 3202.59 | 3245.09 | 3286.01 |
| Crude protein (%)           | 21.47 | 21.85 | 22.03 | 22.21 |
| Crude fat (%)               | 6.86  | 7.76  | 8.18  | 8.59 |
| Crude fiber (%)             | 3.46  | 3.35  | 3.30  | 3.25 |
| Ash (%)                     | 3.69  | 3.63  | 3.60  | 3.57 |
| Calcium (%)                 | 1.09  | 1.05  | 1.04  | 1.02 |
| Phosphorus (%)              | 0.43  | 0.42  | 0.42  | 0.41 |

2.2. Data Collection and Analysis
Prior to the treatment, the birds were raised in a brooder from day 1 to 10 and fed a commercial diet. Then they were allotted randomly to the experimental unit according to aforementioned design. At day 11, the birds were weighed and provided the experimental diets. During the experiment, water and feed were provided ad libitum. The starter period data were collected until day 25. The variables that were observed included feed intake, protein and energy intake, average daily gain, feed efficiency and feed cost:gain ratio. Feed intake was measured daily while body weight was measured weekly. Protein energy intake were obtained by multiplying the feed intake with protein and energy content of the diet. Feed efficiency (as percentage) were calculated by dividing the bodyweight gain with feed intake while feed cost (gain is the feed cost to obtain one kg gain weight) [5].

The feed, protein, and metabolizable energy intakes, average daily gain and feed efficiency data were analyzed with analysis of variance to determine the effect of the treatments. If the treatments
showed significant effect, it was continued with Duncan’s test at α=0.05 [6]. Feed cost and gain ratio data was presented descriptively.

3. Results and Discussion

3.1. Feed Intake and Gain

The inclusion of IEP in the diet did not affect feed intake (P>0.05), but increased protein and energy intakes and average daily gain (P<0.05), as presented in Table 3. Feed intake during starter period ranged between 72.55 and 75.27 g/day. Apparently, alteration in metabolizable energy and crude protein content in the experimental diets did not affect feed intake. This finding was in line with previous observation where inclusion of egg powder in the diet did not affect feed intake of broilers [1]. However, inclusion of IEP in the diet yielded the higher (P<0.05) protein intake (T2) and energy intake (T2 and T3) compared with basal diet (T0). Inclusion of IEP in the diet increased protein and energy contents leading to improvement in protein and energy intake [7].

In poultry, feed intake is determined by protein and energy content in the diet, in which the higher protein and energy may decrease the feed intake [8]. However, increasing the protein and energy content due to inclusion of IEP in this study did not alter the feed intake, probably the nutrients were still required to obtain a higher growth rate as indicated by improvement of ADG (P<0.01). Inclusion of IEP in the diet provides more nutrients which support the optimal growth rate of the birds during starter period. Moreover, protein in IEP has a high biological value and digestibility as well as a good amino acid balance, leading to an enhance in growth rate [9]. Previous observation revealed that inclusion of dried egg powder improved bodyweight and feed conversion ratio in broilers during starter period (24 days). Similarly, increasing the hatchery waste meal in the diet improved the performance of broiler chickens [10]. In addition, feeding with hatchery waste meal increased the performance of male ducks [11].

| Treatments | Feed Intake (g/day) | Protein Intake (g/day) | Energy Intake (kcal/day) | Average Daily Gain (g/day) |
|------------|---------------------|------------------------|--------------------------|---------------------------|
| T0         | 72.69 ± 5.16        | 15.61 ± 1.11b          | 226.24 ± 16.05c          | 39.32 ± 2.00b             |
| T1         | 72.55 ± 5.48        | 15.85 ± 1.20b          | 232.35 ± 17.56bc         | 43.27 ± 2.93a             |
| T2         | 75.27 ± 2.35        | 16.59 ± 0.52a          | 244.25 ± 7.63a           | 44.18 ± 1.75a             |
| T3         | 74.22 ± 2.34        | 16.48 ± 0.52ab         | 243.89 ± 7.70ab          | 44.82 ± 1.94a             |
| P value    | 0.296               | 0.035                  | 0.007                    | <0.001                    |

\(^{a,b}\) Different superscript in the same column indicated significant difference (P<0.05).

3.2. Feed Efficiency and Feed Cost: Gain Ratio

Feed efficiency was ranging from 54.54% to 60.79% (Table 4) and was significantly influenced by addition of IEP (P<0.01). This result indicated that broiler diets with IEP were more efficient in improving bodyweight gain during starter period compared with that without IEP. The IEP contains substantial amount of nutrient, such as protein and fat, which increased the nutritional value of the diet. Growth and development of digestive tract of the birds during starter period could be warranted by providing required nutrients [2]. Previous study showed that utilization of egg powder in the diet increase villus height and villus crypt ratio in broilers, leading to a higher capacity of nutrient absorption [1]. Consequently, a more efficient in the utilization of nutrient in improving growth rate was obtained as indicated in this research.

Utilization of IEP in the diet reduced the feed cost/gain ratio, indicated that lower cost was required to yield one kg bodyweight gain of starter broilers. This result was consistent with higher average daily gain (Table 3) and feed efficiency (Table 4) following dietary inclusion of IEP in this study. Although increasing level of IEP increased the feed price, the birds fed diet with IEP generated higher
growth rate and feed efficiency, leading to reduced feed cost per kg bodyweight gain during starter period. This finding suggests that IEP is economically efficient to be utilized as animal feedstuff. In agreement with this finding, Esmailzadeh et al. [1] showed that feeding broiler chickens with egg powder resulted higher efficiency index than feeding without egg powder.

| Treatments | Feed Efficiency (%) | Feed Cost:Gain Ratio (IDR) |
|------------|---------------------|-----------------------------|
| T0         | 54.54 ± 2.51<sup>b</sup> | 14,440.85 ± 676.55           |
| T1         | 59.96 ± 2.45<sup>a</sup> | 13,306.32 ± 548.09           |
| T2         | 57.92 ± 3.14<sup>a</sup> | 13,880.84 ± 779.97           |
| T3         | 60.79 ± 2.65<sup>a</sup> | 13,299.52 ± 590.98           |
| P value    | <0.001              | -                           |

<sup>a,b</sup> Different superscript in the same column indicated significant difference (P<0.01).

4. Conclusion
Inclusion of infertile egg powder in the diet improved the performances of starter broilers, as indicated by improvement in bodyweight gain and feed efficiency, associated with improvement in protein and energy intakes. Feeding with infertile egg powder yielded lower feed cost per kg bodyweight gain of starter broilers. Thus, infertile egg can be utilized as an animal feedstuff.

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