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Utilization of infertile egg powder in ration improves the digestive tract development of broiler chickens

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Abstract. Infertile egg powder (IEP) is a potential feedstuff with high nutrient content. This experiment investigated the effect of IEP utilization in the ration on digestive tract development of broiler chickens. In total, 196 one-day-old male broilers were distributed into four dietary treatments with 7 replicates of 7 birds each. The treatments comprised a basal diet (T0), 96% basal diet + 4% IEP (T1), 94% basal diet + 6% IEP (T2), and 92% basal diet + 8% IEP (T3). The weight and length of the digestive tract were measured at the end of feeding trial to observe their development. Analysis of variance was applied to analyze the effect of treatments, while Duncan's Multiple Range Test was applied to compare the mean of each treatment. The results indicated that feeding with IEP (T1, T2, and T3 groups) generated the longer duodenum, jejunum, ileum and whole small intestine compared with feeding without IEP (T0, $P < 0.05$), with the highest magnitude was observed for T3. Accordingly, IEP improved the weight of small intestine ($P < 0.05$). In line with this, the IEP groups had heavier gizzard and liver than non-IEP groups. It can be concluded that IEP improves the development of digestive tract of broiler chickens.

1. Introduction

A large quantity of poultry by-product, such as infertile eggs from hatchery processing, is commonly produced in a vast growth poultry industry. About 10-15% infertile eggs are resulted from the hatchery industry [1,2]. The infertile eggs could be used as a good alternative feedstuff for chickens considering that the egg reserves are used as single source to supply the nutritional requirements during embryonic development [3]. Furthermore, the eggs have natural balance of essential nutrients [4] and contain a high level of nutrients such as protein, fat, maternal antibodies, and bioactive nutrients [5].

The digestive tract in newly hatched broiler chickens is not fully developed, thus, feeding them with sufficient nutrient content is important for supporting their digestive tract development and growth performance [2]. Digestible ingredient is needed to support the optimal digestive system development, lead to a fast growth of other organs, such as muscles, skeleton and also to enhance immune system [2,3]. The infertile eggs could be processed as dried infertile egg powder (IEP) which further could be applied as feed ingredient without any negative impacts on growth performance [1,3]. For example, there exist studies which showed that egg powder inclusion in ration enhanced the growth performance and immune status in chickens [1,3]. An improvement in body weight and feed conversion was also observed in a study using broiler chickens fed dried egg powder [2]. However,



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there is a lack information on the effect of egg powder on digestive tract development. Thus, this study aimed to investigate the effect of IEP utilization in the ration on digestive tract development of broiler chickens.

2. Materials and methods

2.1. Experimental design and ration

The experiment was run in experimental farm, Department of Animal Science, Universitas Sebelas Maret. The study used 196 one-day-old male Lohman MB 202 broiler chickens. They were distributed into four ration treatments with seven replicates of seven birds. The four treatments comprised the 100% basal ration (T0), 96% basal ration + 4% IEP (T1), 94% basal ration + 6% IEP (T2), and 92% basal ration + 8% IEP (T3). The IEP was prepared by cracking the eggs, then mixing 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, and sun-dried thereafter. The dried infertile egg was then ground to obtain the IEP. Nutrient content of the IEP and experimental diets are presented in Table 1 and Table 2, respectively.

Table 1. Nutrient content of the infertile egg powder

Nutrients	Content
Metabolizable energy (kcal/kg)*	5454.9
Crude protein (%)	31.47
Crude fat (%)	30.10
Calcium (%)	0.05
Phosphorus (%)	0.18

*Calculated according to Sibbald et al. [6]:

$$ME = 3951 + (54,4 \times \text{crude fat}) - (88,7 \times \text{crude fiber}) - (40,8 \times \text{ash})$$

Table 2. Nutrient content of the experimental diets

Component	T0	T1	T2	T3
Basal diet (%)	100	96	94	92
Infertile egg powder (%)	0	4	6	8
Nutrient content				
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
Calcium (%)	1.09	1.05	1.04	1.02
Phosphorus (%)	0.43	0.42	0.42	0.41

2.2. Feeding trial and sample collection

During adaptation period from day 1 to 10, the birds were kept in a brooder room and offered a commercial ration. The birds were then individually weighed at day 11, and randomly distributed to the pens according to previously explained design. Each pen consisted of seven birds. During the treatment period, the birds were fed one of the four experimental rations. Standar management in broiler raising was applied with ad libitum water and ration supply. At the end of feeding trial on day 35, two birds per replicate in average weight were selected to digestive tract measurement, resulting in total 98 birds. The birds were slaughtered after 12 hours feed removal to empty the digestive tract, then the intestine and liver were removed.

The variables that were observed included the weight of digestive organs, including liver, gizzard, and small intestine as well was the length of small intestine. The digestive organ weights were measured using digital scale (600×0.01 g). The intestinal length was measured using ruler for each part of small intestine [7].

2.3. Data analyses

The collected data were pooled and averaged in each replicate. The 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 $\alpha=0.05$ [8].

3. Results and discussion

The inclusion of IEP in the ration increased digestive organs weight including liver, gizzard, small intestine, and parts of small intestine ($P<0.05$; **Table 3**), although only the relative weight of liver and gizzard in T3 was affected by IEP (**Table 4**). Accordingly, the length of small intestine and its parts were also enhanced by addition of IEP in the ration ($P<0.05$; **Table 5**). Similar trends were observed for the improvements in digestive organ weight and length, in which all variables indicated that the highest magnitudes of these improvements were observed in T3 group followed by T2 or T1. Furthermore, the lower relative weight of liver and gizzard in T3 group indicated that the growth of the body was achieved in higher magnitude, compared with the other treatments. This finding indicated that utilization of IEP at 8% generated the best response in term of digestive tract development and growth performance. In this case, IEP provided a good nutrition content to support digestive tract development, as has been observed previously, that digestible nutrients are needed to support digestive tract development as well as growth of broiler chickens [2].

Table 3. Digestive organs weight of broilers fed infertile egg powder (gram)

Treatments	Liver	Gizzard	Duodenum	Jejunum	Ileum	Small Intestine
T0	25.82 ^b	14.75 ^b	11.01 ^c	13.63 ^c	10.59 ^b	35.22 ^c
T1	30.99 ^a	15.75 ^{ab}	12.51 ^{bc}	17.49 ^{bc}	11.96 ^{ab}	41.96 ^b
T2	29.64 ^a	16.89 ^{ab}	12.71 ^b	15.85 ^{ab}	12.44 ^a	41.00 ^b
T3	30.34 ^a	17.15 ^a	14.55 ^a	19.14 ^a	13.75 ^a	47.44 ^a
P value	0.04	0.02	<0.01	<0.01	<0.01	<0.01

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

Table 4. Relative digestive organs weight to body weight of broilers fed infertile egg powder (%)

Treatments	Liver	Gizzard	Duodenum	Jejunum	Ileum	Small Intestine
T0	2.47 ^a	1.41 ^a	1.05	1.31	1.01	3.37
T1	2.38 ^{ab}	1.20 ^b	0.96	1.34	0.92	3.22
T2	2.24 ^{ab}	1.27 ^{ab}	0.96	1.20	0.94	3.10
T3	1.98 ^b	1.12 ^b	0.95	1.25	0.90	3.10
P value	0.02	<0.01	0.14	0.36	0.12	0.13

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

Table 5. Small intestine length of broilers fed infertile egg powder (mm)

Treatments	Duodenum	Jejunum	Ileum	Small Intestine
T0	22.07 ^b	50.57 ^b	49.36 ^b	122.00 ^b
T1	23.50 ^a	63.21 ^a	57.29 ^a	144.00 ^a
T2	23.14 ^{ab}	59.93 ^a	58.79 ^a	141.86 ^a
T3	24.00 ^a	62.86 ^a	60.64 ^a	147.50 ^a
P value	<0.01	<0.01	<0.01	<0.01

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

In broiler chickens, development of digestive tract plays a pivotal role in supporting birds' growth since the broiler chickens only raised in a relatively short time. In Indonesia, broiler chickens are commonly harvested at about 35 days. Improvement in digestive tract development due to IEP inclusion in the ration may indicate a better nutrient digestion and absorption, which lead to provision

of more nutrients to support the optimal growth rate of the birds. The longer the small intestine also indicate the more nutrient can be absorbed and utilized by the birds. It is well known that providing adequate nutrient in the ration, both during starter and finisher periods, is one of the best ways to generate an optimal performance. Egg products contain high quality of protein, particularly albumin, bioactive components and lysozyme. It also contains lipids and antioxidants [4]. The high availability of nutrients in IEP assist the digestive tract development of broiler chickens [2].

In support to this study, feeding with 40 g egg powder per kg ration produced longer intestine, higher villus, and lower crypt depth in broiler chickens, indicating an improvement in small intestine development due to feeding egg powder [2]. This finding indicated that the high nutrient levels in IEP has positive impact on intestinal morphometry. A well-developed digestive tract supports the growth rate of broiler chickens, as observed in previous study that inclusion of dried egg powder improved body weight and feed conversion ratio in broilers. Similarly, increasing the hatchery waste meal in the diet improved the performance of broiler chickens [9] and male ducks [10]. In growing layer chicks, inclusion of dried eggs by-product in ration improved body weight and feed conversion at 8 weeks of age [1], which partly, can be attributed to bioactive egg components such as essential fatty acids, balanced amino acids, antibody and bactericidal enzyme [4,11].

4. Conclusion

Utilization of infertile egg powder in the ration enhances the digestive tract development as indicated by the heavier liver, gizzard organs, duodenum, jejunum, ileum and whole small intestine as well as longer duodenum, jejunum, ileum and whole small intestine. This improvement might be addressed to the high nutritional value and high availability of nutrients in the egg powder, which are required for supporting the high growth rate of digestive tract and body of the chickens.

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