Effect of chitosan oligosaccharide (COS) and L-arginine supplementation on broiler performance

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Abstract. Usage of antibiotic growth promoter is eliminated for the poultry production starting from January 2018. This policy may affect animal performance and health status in tropical countries like Indonesia. A study of Chitosan Oligosaccharide (COS) and L-arginine supplementation was carried out to evaluate the growth performance of broiler. A total of 300 DOCs (day old chickens) broilers with an initial average body weight of 46 g, were randomly treated into 5 treatments with 6 replications (10 unsexed birds in each pen) for 35 days. Dietary treatments were (P0) basal diet (BD) without supplement, (P1) BD + Antibiotic growth promoter (Zinc Bacitracine 200 mg kg⁻¹) of diet, (P2) BD + COS 100 mg kg⁻¹ of diet, (P3) BD + L-arginine 1.9% of diet, (P4) BD + COS mg kg⁻¹ + L-arginine 1.9% of diet. The results showed that treatments with COS and L-arginine significantly (P <0.05) increased feed intake, body weight, weight gain and reduce feed conversion ratio at starter period compared with fed P0. Furthermore, feed conversion ratio and mortality were significantly (P <0.05) decreases at all treatments and body weight and weight gain significantly (P <0.05) increased only at COS treatment compared with fed P0, at the overall experimental periods. In conclusion, dietary addition of COS 100 mg kg⁻¹ is able to use as alternative for antibiotic growth promotor replacement without giving effect on broiler performance

1. Introduction

Prohibition of using Antibiotic Growth Promoters (AGP) in Indonesia makes probiotics, prebiotics and enzymes as an alternative to potential AGP substitutes. Chitosan is one of the prebiotics that can be used as an alternative to AGP. Wang et al [1] reported that supplementation with 0.1% (w/w) chitosan reduced the amount of E. Coli in the chicken's digestive tract, also increased microvilli density of the small intestine, serum titer antibody to fight Newcastle disease virus, and growth performance. Chitosan in the form of Oligochitosan or called Chitosan Oligosaccharide (COS) has a smaller molecular weight of 1000-5000 Da. This makes COS is easier absorbed in the digestive tract of chicken so that it can optimize its function as a prebiotic. Huang et al [2] reported that administration of Oligochitosan supplementation (COS) can increase nutrient digestibility in ileal and improve broiler performance. Other Oligosaccharide such as Fructooligofructose (FOS) and Manna-oligosaccharide (MOS) are also currently accepted for use in livestock as an alternative to antibiotics. This substance works through many mechanisms, including by inhibiting pathogenic enteric adsorption, modulating immune function, and regulating nutrient metabolism (for example: the use of arginine in the intestine) [3-4].

One of the mechanisms of Oligosaccharide in improving livestock performance is by regulating nutrient metabolism (for example: the use of arginine in the intestine). Arginine acts to synthesize NO
and polyamine, which are involved in inflammatory modulation and wound healing [5]. When there is a chicken coccidia infection requires more Arg to produce NO which has an important role in the process of killing directly or indirectly parasites (peroxynitrite, ONOO⁻) [6]. This shows that Arg works more specifically to increase the immune system in livestock. Research on pigs and chickens shows that Arg supplementation can increase the function of the chicken immune system when in a state of immune stress [7]. Tan et al [8] reported that supplementation of L-Arginine 1.9% increase the body weight gain and decrease the feed conversion ratio in the starter phase. L-arginine supplementation can reduce inflammation in chickens induced by lipopolysaccharide (LPS). The hypothesis of the present study was supplementation of COS, L-arginine and combination of them could replace the usage of AGP. The objective of this study was to identify the effect of oligochitosan and L-arginine supplementation on broiler performance.

2. Material and method

2.1. Experimental design, diets, and management

Three hundred unsexed DOCs (day old chickens) broilers with initial average body weight of 46 g assigned randomly to 5 dietary treatment groups (10 birds per pen with 6 pens per treatment). Five diets prepared for study. Dietary treatments were (P0) basal diet (BD) without supplement (Table 1), (P1) BD + Antibiotic growth promoter (Zinc Bacitracine 200 mg kg⁻¹) of diet, (P2) BD + COS 100 mg kg⁻¹ of diet, (P3) BD + L-arginine 1.9% of diet, (P4) BD + COS 100 mg kg⁻¹ + L-arginine 1.9% of diet. The COS used in this study was a mixture of oligosaccharides with molecular weights between 1000 and 5000 Da. The diets were fed in a crumble form for starter phase and pellet form for finisher phase. All groups of broiler had free access to feed and drinking water. The broiler were raised on a brooder during day 1 to 14 and then transferred into floor pens during day 15 to 35.

| Feed ingredients | Starter (1-21 days) | Finisher (22-35 days) |
|------------------|---------------------|-----------------------|
| Corn             | 60.92               | 65.66                 |
| Soybean meal     | 24.82               | 17.89                 |
| Palm oil         | 1.58                | 2.25                  |
| Meat Bone Meal   | 7.00                | 7.00                  |
| CGM              | 3.45                | 4.95                  |
| CaCO3            | 0.64                | 0.70                  |
| Salt             | 0.15                | 0.15                  |
| Methionine       | 0.24                | 0.19                  |
| Lysin            | 0.21                | 0.20                  |
| Premix           | 1.00                | 1.00                  |
| Amount (%)       | 100                 | 100                   |

Feed Nutrient Content:
- Crude Protein (%): 22.50, 20.59
- ME (kcal kg⁻¹): 3100, 3200
- Calcium (%): 0.95, 0.95
- Available phosphorus (%): 0.42, 0.41
- Methionine (%): 0.55, 0.49
- Methionine + cystine (%): 0.86, 0.78
- Lysine (%): 1.40, 1.20

The composition of kg⁻¹ premix: Vitamin A 11 500 000 IU, Vitamin D3 4 500 000 IU, Vitamin E 75 g, Vitamin K3 3.5 g, Vitamin B1 3 g, Vitamin B2 8 g, Vitamin B6 5.5 g, Vitamin B12 30 mg, Niacin 65 g, Panthothenic Acid 15 g, Folic Acid 1.5 g, Biotin 250 mg, Choline chloride 1.5 mg, Vitamin C 50 g, Phytase 700 000 000 FYT, Antioxidant 0.5 g, and carrier added to 1 kg.
2.2. Broiler Chicken Performance
Chickens reared for 35-day trial (5 weeks), the amount of feed intake and body weight were weighed every week.

2.2.1 Feed intake (g head⁻¹)
Average feed intake is calculated from the difference between the rations given and the rest of the ration divided by the number of chickens in one plot. Measurement of residual feed is done once a week in the morning.

2.2.2 Final Body Weight (g head⁻¹)
The final body weight is obtained by weighing all chickens at each treatment at the end of maintenance then averaged.

2.2.3 Body Weight Gain (g head⁻¹)
Body weight gain is obtained from the calculation of the final body weight minus the initial body weight. Body weight is measured once a week.

2.2.4 Feed conversion ratio
Ration conversion is calculated from the ratio between the average feed intake and the average body weight gain.

2.2.5 Mortality (%)
Mortality is calculated from the ration between the dead chicken and the life chicken during the maintenance.

2.2.6 Statistical analysis
The experimental design used in this study was Completely Randomized Design (CRD) 5 treatments and 6 replications. The data was analyzed by analysis of variance (ANOVA), followed by Duncan’s multiple range test [9], using SPSS software (SPSS® version 16.0) with α 5%.

3. Result and discussion
COS and L-arginine supplementation and their combinations to the broilers have a significant effect (P <0.05) increasing on feed intake, body weight, body weight gain and decreasing feed conversion ratio in the starter phase (Table 2). In the finisher phase the all treatments only had a significant effect (P <0.05) on body weight. Giving Chitosan Oligosaccharide 100 mg kg⁻¹ in feed rations improved the performance of broilers with the highest yield compared to other treatments.

The addition of 100 mg kg⁻¹ of Chitosan Oligosaccharide had a positive effect on increasing feed intake, BW, BWG, and significantly reduced FCR (P <0.05) in starter phase and had a positive effect on increasing feed intake, BW, BWG, and decreasing FCR until end of maintenance. These results are consistent with the observations of Huang et al. [2] reported that supplementation of 100 mg kg⁻¹ of COS in broilers was able to increase nutrient digestibility in the ileum and daily body weight gain which was as effective as the addition of AGP. Moreover, COS can stimulate the secretion of digestive enzymes derived from the stomach, pancreas, and intestinal mucosa [10]. In order to, this effect is expected to reduce local inflammation in the intestinal mucosa, facilitate modification of complex molecules to be simpler, and improve the integrity of enterocytes, thereby supporting nutrient digestibility and absorption [11].

The administration of L-arginine supplementation up to 1.9% gave a positive effect on feed intake BW, BWG, and significantly reduced FCR (P <0.05) in the starter phase. But it has no effect on the finisher and cumulative phases. These results are consistent with the observations of Tan et al. [8] reported that administration of L-arginine in feed with a percentage above the requirement of the 1994 NRC standard was able to increase the body weight gain and decrease the feed conversion ratio in the Starter phase. L-arginine supplementation can reduce inflammation in chickens induced by lipopolysaccharide (LPS).
The combination treatment between COS 100 mg kg\(^{-1}\) and L-arginine to 1.9% (P4) gave a significant effect (P <0.05) to increase BW, BWG, and reduce FCR in the starter phase and reduce FCR in the cumulative phase compared to control feed (P0). These results indicate that giving COS 100 mg kg\(^{-1}\) effectively improves performance both in the starter, finisher and cumulative phases, while giving L-arginine to 1.9% is only effective in the starter phase.

### Table 2. Performance of broiler chickens in maintenance of various growth phases

| Variable                        | Treatment     | P0       | P1       | P2       | P3       | P4       |
|---------------------------------|---------------|----------|----------|----------|----------|----------|
| **Starter (1-21 days)**         |               |          |          |          |          |          |
| Feed intake (g head\(^{-1}\))   | 1003.80\(^a\) | 1036.26\(^b\) | 1063.39\(^ab\) | 1041.42\(^bc\) |          |          |
| Body weight (g head\(^{-1}\))   | 763.34\(^c\)  | 815.33\(^b\)  | 850.91\(^ab\)  | 817.67\(^b\)  |          |          |
| Body weight gain (g head\(^{-1}\)) | 717.08\(^c\) | 769.20\(^b\) | 803.99\(^ab\) | 769.98\(^b\) |          |          |
| FCR (FI / BWG)                  | 1.4\(^a\)     | 1.35\(^b\) | 1.32\(^b\) | 1.35\(^b\) |          |          |
| **Finisher (22-35 days)**       |               |          |          |          |          |          |
| Feed intake (g head\(^{-1}\))   | 1710.29\(^b\) | 1741.59\(^ab\) | 1811.33\(^a\) | 1740.23\(^ab\) |          |          |
| Body weight (g head\(^{-1}\))   | 1647.28\(^b\) | 1752.75\(^ab\) | 1633.73\(^b\) | 922.56\(^ab\) |          |          |
| Body weight gain (g head\(^{-1}\)) | 883.94\(^b\) | 937.42\(^ab\) | 864.38\(^a\) |          |          |          |
| FCR (FI / BWG)                  | 1.93\(^b\)    | 1.86\(^b\) | 1.90\(^b\) |          |          |          |
| **Cumulative (0-35 days)**      |               |          |          |          |          |          |
| Feed intake (g head\(^{-1}\))   | 2714.09\(^b\) | 2777.85\(^ab\) | 2901.67\(^a\) | 2697.12\(^b\) |          |          |
| Body weight (g head\(^{-1}\))   | 1647.28\(^b\) | 1752.75\(^ab\) | 2111.33\(^a\) | 1740.23\(^ab\) |          |          |
| Body weight gain (g head\(^{-1}\)) | 1601.01\(^b\) | 1706.62\(^ab\) | 1668.37\(^ab\) | 1692.54\(^ab\) |          |          |
| FCR (FI / BWG)                  | 1.70\(^b\)    | 1.63\(^b\) | 1.62\(^b\) |          |          |          |
| Carcass weight (g head\(^{-1}\)) | 1151.33\(^b\) | 1333.67\(^a\) | 1323.67\(^a\) | 1231.00\(^ab\) |          |          |
| Mortality (%)                   | 12            | 0        | 0        | 3        | 6        |          |

Fl, feed intake; BWG, body weight gain; FCR, feed conversion ratio.

\(^{a,b,c}\) superscripts in the same row are significantly different at P < 0.05.

4. **Conclusion**

Dietary addition of COS 100 mg kg\(^{-1}\) is able to use as alternative for antibiotic growth promotor replacement without giving effect on broiler performance.

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6. **Reference**

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