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The growth performances and the gut health parameters of Sentul chickens supplemented with various dosage of turmeric powder

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Abstract. *Asmara IY, Widjastuti T, Setiawan I, Abun, Partasasmita P. 2018. The growth performances and the gut health parameters of Sentul chickens supplemented with various dosage of turmeric powder. Nusantara Bioscience 10: 121-125.* The aim of this study was to investigate the effect of different levels of turmeric powder (0, 1, 2, 3 g/kg) on production performance and the number of *Escherichia coli* and *Staphylococcus aureus* bacteria in the intestine of Sentul chickens. The results showed that addition of 3 g/kg of turmeric powder to diet significantly reduced feed intake (FI) and improved feed conversion ratio (FCR) of Sentul Chickens aged 9-16 weeks. The birds fed with control diet had the highest number of *S. aureus* and *E. coli*, while the birds fed with the diets added with 2 and 3 g/kg turmeric powder had the lowest number of bacteria. The study reveals that increasing levels of turmeric powder in diets had positive effects on bird's performance and the number of intestinal bacteria. It can be concluded that a level of 3 g/kg turmeric powder in diets gave the best result due to significantly improved FCR.

Keywords: *Curcuma domestica*, intestinal bacteria, performance, Sentul chickens, turmeric powder

INTRODUCTION

Indonesia is one of country, which the number of chicken domestication centers is largest in the world. The diversity of chickens in Indonesia is high and differ from other countries in Asia and in the world (Sulandari et al. 2008). It was reported that more than 30 distinct groups of local chickens are located in Indonesia (Nataamijaya 2000; Partasasmita et al. 2016). Some of them have specific plumage color and are regarded as an indigenous species i.e Sentul chickens (Diwyanto and Iskandar 1999),

Sentul Chicken is a local chicken from Ciamis region, West Java Province, Indonesia. Ciamis people also call Sentul chicken as 'Kulawu Chickens', kulawu means grey since the plumage colors of Sentul chickens are dominated by grey (Universitas Padjadjaran 2012). Sentul chickens had many advantages to be farmed because they are able to adapt to harsh environment and remain productive in low quality of diets (Widjastuti 1996). They produce 120-140 eggs per year (Universitas Padjadjaran 2012). The weight of adult male chickens can reach 1300-3500 g, whereas the weight of female adults is 800-2200 g (Sulandari et al. 2007). Nowadays, Sentul chickens are raised for meat industry. They are sold when their weights are about 750 g and the age of 2.5 months (Asmara 2014). However, like other local chickens such as Pelung and Kedu chickens, the population of Sentul chickens is declined and the status is in danger (Asmara 2014).

Sentul chickens are potential to be developed as organic poultry farms. One of characteristics of organic poultry farms is the use of natural feed additives and the prohibition of synthetic feed additives such as growth promoter antibiotics being used in chicken feeds. The natural feed additives derived from turmeric (*Curcuma domestica Val*) have been used as one of alternatives of growth promoter antibiotics in poultry rations due to their safety for consumers. Turmeric is an essential component used in the Asian cuisines (Ganpati et al. 2011) as well as in Asian indigenous medicine as an antimicrobial agent (Lee et al. 2010; Moghadamtousi et al. 2014).

In animal farming, the use of turmeric and other herbs have positive effects on the feed intake, the secretion of digestive secretions and as anti-bacterial agents (Wenk 2003). Curcumin is identified as the main phytochemical in turmeric, which is responsible for biological effects (Teow et al. 2016). Tyagi et al. (2015) reported that curcumin, especially curcumin I is a significant component in commercial curcumin. It is effective against Gram-positive bacteria such as *Staphylococcus aureus* and Gram-negative bacteria such *as Escherichia coli*. Both bacteria are commonly found in gastrointestinal of mammals and birds. Some strains of *E. coli* may be pathogenic (Vidotto et al. 1990) and cause of negative impact in commercial poultry farms (Blanco et al. 1997), while *S. aureus* has ability to produce entero-toxins which may cause food poisoning in human (Mamza et al. 2010).

It has been reported that turmeric influences growth performances of poultry. Turmeric may possess an antibacterial effect in chickens (Samarasinghe et al. 2003; Lawhavinit et al. 2010; Akbarian et al. 2011; Ürüşan and Bölükbaş 2017), may depress abdominal fat (Samarasinghe et al. 2003), improve FCR in broilers (Ürüşan and

Bölükbaş 2017), increase health status in local ducks (Nova and Yellita 2015) and increase egg production in local chickens (Widjastuti 2017). However, studies on turmeric powder in local chicken rations are rarely explored; thus, investigations of beneficial effects of turmeric powder in local chickens are required. The purpose of this study was to test effects of turmeric powder supplemented in local chicken diets from 0 to 3 g/kg on the growth performances of chicken, i.e., feed intake (FI), weight gain (WG), feed conversion ratio (FCR) and intestinal bacteria of local chicken.

MATERIALS AND METHODS

Experimental design

This study was designed in Completely Randomized Design (CRD). A total of 100 day-old chicks (unsexed) of Grey Sentul Chickens was randomly distributed into 4 groups. The groups consisted of control and 3 treatment groups in which each group contained 5 sub-groups of five birds. In control group, the birds were fed with basal feed, while in treatment groups the birds were fed with the basal diet with different levels of turmeric powder (1, 2, 3 g/kg, respectively). The feed and water were provided ad-libitum. FI and WG were recorded weekly, while FCR was measured by dividing FI by WG.

The study was divided in two different phases and the diet compositions for each phase was shown in Table 1. The local ingredients used to produce the diets and the energy metabolism and protein needs were formulated based on Widjastuti (1996) diet formulation for Sentul chicken. At the end of the study, five birds were randomly selected from each treatment group and were slaughtered. A total of 20 carcasses were opened to collect samples of small intestine tracts of bird. All samples were proceeded at the same day for enumerating bacterial populations using methods reported by Safitri et al. (2008).

Table1. Feed ingredients and nutrient composition

Feed ingredients	Age	
	1-8 weeks	9-16 weeks
Yellow corn (%)	56.00	58.00
Soybean meal (%)	12.00	4.75
Rice bran meal (%)	21.50	28.00
Fish meal (%)	9.25	8.00
$CaCo_3$ (%)	0.50	0.50
Bone meal (%)	0.75	0.75
Nutrient composition:		
Metabolism energy (kcal/kg)	2,850	2,755
Crude protein (%)	17.00	15.08
Crude fat (%)	5.92	6.66
Crude fiber (%)	4.51	4.89
Calcium (%)	1.16	1.05
Phosphorus (%)	0.63	0.58
Lysine (%)	1.21	0.97
Methionine (%)	0.40	0.35
Methionine + lysine (%)	0.75	0.67

Note: Proximate analysis conducted at Nutrition and Feed Laboratory, Faculty of Animal Husbandry, Universitas Padjadjaran, Sumedang, Indonesia

Data analyses

Analysis of variance was applied to the data using statistical package program of SPSS version 19. Significantly different means were separated by a Duncan's multiple comparison test at 0.05 and 0.01 levels, respectively.

RESULTS AND DISCUSSION

Growth responses of local chickens on different dietary treatments were presented in Table 2. During week 1 until week 8 of study, dietary supplementation of 1, 2 or 3 g/kg had no significant effect on the growth parameters of birds, i.e., FI, WG, and FCR. the supplementation of turmeric in the diets significantly ($P<0.05$) changed the value of FI and FCR in week 9 until week 16, whereas the diets had no significant effect on WG.

FCR values were significantly influenced by dietary turmeric ($P<0.05$) during week 9 to week 16 (Table 2). FI values of the groups with supplemented by 2 and 3 g/kg turmeric powder were significantly lower than those in 0 (control group) and 1 g/kg turmeric powder, respectively. The lowest FCR was observed in the group with 3 g/kg turmeric powder in diets, while the highest FCR was observed in the control group. It was found that the differences of FCR were significant between the groups ($P<0.05$). The best FCR occurred in the group with addition of 3 g/kg turmeric powder in diet (5.19).

The highest dry matter digestibility occurred in the group supplemented with 3 g/kg turmeric powder; while the lowest one was found in the group with the addition of 2 g/kg turmeric powder (Table 3). It was observed that the highest crude protein digestibility occurred in the diets with the addition of 3 g/kg turmeric powder.

Table 2. The effect of supplementation turmeric powder on performance of local chickens

Variable	Groups			
	Control	1 g/kg	2 g/kg	3 g/kg
Aged 1-8 weeks				
Feed intake (g)	1,802.60	1,871.93	1,757.93	1,586.27
Weight gain (g)	436.27	391.47	407.93	459.87
Feed conversion ratio	4.21	4.86	4.31	3.59
Aged 9-16 weeks				
Feed intake (g)	2,4012.39^{a}	23,698.12^{a}	22,250.04^{b}	21,429.36^{b}
Weight gain (g)	774.95	740.99	775.73	834.25
Feed conversion ratio	6.23^{a}	6.41^{a}	5.74^{a}	5.19^{b}

Note: a, b, c, d: means within a row with no common superscript differ significantly ($p<0.05$)

Table 3. Nutrient digestibility of diets

Variable	Groups			
	Control	1 g/kg	2 g/kg	3 g/kg
Dry matter (%)	59,86^{a}	55,75^{b}	53,86^{c}	66,05^{d}
Crude protein (%)	75,67^{a}	72,79^{b}	75,78^{ac}	76,80^{c}

Note: a, b, c, d: means within a row with no common superscript differ significantly ($p<0.05$)

Table 4. The number of *Staphylococcus aureus* and *Escherichia coli* in small intestine

Variable	Groups			
	Control	1 g/kg	2 g/kg	3 g/kg
S. aureus (CFU/g) ($x10^5$)	1.49^a	1.17^b	1.11^b	1.07^b
E. coli (CFU/g) ($x10^5$)	1.47^a	1.15^b	1.00^c	0.96^c

a, b, c, d: means within a row with no common superscript differ significantly ($p<0.05$)

Table 4 shows the total number of bacteria observed in small intestine of samples supplemented with different concentration of turmeric powder. It shows that the number of bacteria decreased in line with the increase of turmeric powder addition in the diet. The highest bacteria were observed in the control group. The lowest number of *S. aureus* was obtained in all groups supplemented with different concentration of turmeric powder. While the lowest number of *E. coli* was found in the group with the addition of 2 and 3 g/kg turmeric powder, respectively.

Discussion

The results of present study indicated that turmeric response depends on chicken age and usage dosage. The turmeric powder has no effects on FI, WG and FCR for local chickens aged 1 until 8 weeks, whereas it has significant effect on FI and FCR for chickens aged 9 to 16 weeks. From week 1 to week 8, Sentul chickens are considered in early young period. Wenk (2003) stated that in the early age, metabolism and nutrient digestion of animals are not yet functioned optimally while in the later age the digestion processes can be optimized and adapted to the available feedstuffs. At the time of hatching, bacterial starts to colonize gastro-intestinal tracts of chickens. However, the bacterial colonialization seems to be stable at older age (Rehman et al. 2007). The composition of the bacterial community in intestinal is influenced by many factors such as diet and age (Lu et al. 2003). As a result, the response of turmeric addition in rations in the present study can be observed in age period of 9 to 16 weeks).

At age of 9-16 weeks, the turmeric powder reduced FI significantly especially in the group with the addition of 2 and 3 g/kg turmeric powder, respectively. These results were found to be similar with the results on broiler chickens reported by Ürüşan and Bölükbaş (2017) and local chickens reported by Wang et al. (2015). Ürüşan and Bölükbaş (2017) and Wang et al. (2015) stated that the decrease of FI in their studies may be because of the effects of turmeric aroma on the birds' appetites. Wenk (2003) reported that addition of seven different herbs or herb mixtures in basal diet result in a significant effect on feed intake due to anthraquinone derivatives. Aromatic taste and smell of turmeric are derived from its essential oils (Gupta et al. 2013). Aromatic oily liquids which are extracted by distillation from plant samples such as seeds and flowers are known as essential oils (Adaszyńska-Skwirzyńska and Szczerbińska 2017). In general, dried turmeric rhizomes contain 1.5-5% essential oils (Gupta et al. 2013). The negative effect of turmeric to feed intake of chickens should be further investigated. This is because the results of studies on feed flavoring and taste research for poultry are still debatable (Damron 2003).

Even though FI reduced significantly in present study, WGs were similar in each treatment. In the present study, supplementation of turmeric powder to rations significantly improved the nutrient digestibility. As a result, it has increased feed digestion and nutrient utilization. These results may indicate some beneficial effects of turmeric powder in intestinal tract as it was found in broiler reported by Al-Sultan (2003), Samarasinghe et al. (2003), Durrani et al. (2006), and Ürüşan & Bölükbaş (2017) as well as in local chickens reported by Wang et al. (2015). These previous studies stated similar argumentation that turmeric may stimulate protein synthesis particularly increased the secretion of digestive juices and improved the gastrointestinal condition. The improvement of bird performance by dietary supplementation of turmeric, may be due to mechanisms which were proposed by Platel and Shrinivasan (1996; 2004).

Platel and Shrinivasan (1996) reported that curcumin promote pancreatic digestive enzymes of rats such as amylase, lipase, and proteases. Curcumin supplementation also stimulates the liver to secrete more bile enriched in bile acids (Platel and Srinivasan 2004). Liver and pancreas are the main secretive organs in poultry digestive system (Dibner and Richards 2004). The avian liver provides exocrine secretions called bile to emulsify fats and raise the pH of the duodenal digest, while pancreas provides digestive enzymes and electrolytes, as well as endocrine secretions, consist of insulin and glucagon. The electrolytes resulted from pancreas is important in reducing the acidity of the chime. Higher pH in intestinal is required for the activity of the digestive enzymes produced by pancreas (Dibner and Richards 2004). Digestive enzymes produced by pancreas break down different types of nutrient. Amylase acts on starch, while lipase breakdown fats. Proteases are essential in protein digestion; however, they also have role in solubilization of fiber (Romero 2014).

The present study showed that the supplementation of turmeric improved FCR of local chickens at aged more than 8 weeks. In particular, supplementation of 3 g/kg turmeric powder to diet significantly produced optimum FCR. This result was mainly due to the decreased trend of FI was in line with the increase of turmeric powder in rations while BW was similar among treatments. FCR improvements were found in some studies such as Al-Sultan (2003), Samarasinghe et al. (2003), Durrani et al. (2006), Wang et al. (2015) and Ürüşan and Bölükbaş (2017). The low FCR in birds fed diets supplemented with turmeric powder indicates the impact of phytogenic products of turmeric that influence nutrient efficiency. Optimization of pancreatic, as well as liver secretions due to turmeric supplementation, may reduce time passage and viscosity of diets. Acceleration of digestive process as a result of increased availability of digestive enzymes and bile acids causes the time reduction of feed transit. Nutrient

absorption in the small intestine is more optimal in this situation (Platel and Shrinivasan 2004).

The increased availability of digestive secretions may also reduce viscosity of diets in gastrointestinal of chicken. For example, increased proteases in intestinal are able to optimize disruption of proteins with starch and fiber in the diets. Diet with high fiber increases viscosity of feed. The digestion rate would be expected to decrease, as intestinal viscosity increases. In this situation, chicken would perceive a lower nutrient density diet (Bedford 1995). In addition to previous mechanism, Rajput et al. (2013) stated that improved feed efficiency in chicken supplemented with turmeric powder might be due to the larger villus area, which resulted in the improvement of nutrients absorption. The villi are long folds of epithelial cells which is important for enzyme secretion and nutrient absorption (Dibner and Richards 2004).

The *S. aureus* and *E. coli* amount were less in the groups where the dosage of turmeric powder was increased in the ration. The dose level of 2 and 3 g/kg turmeric powder groups added in chicken diets resulted in the lowest number of bacteria. The finding is in agreement with the findings of Samarasinghe et al. (2003) and Lawhavinit et al. (2010). Samaringhe et al. (2003) reported that dietary turmeric powder reduced *E. coli* bacteria in duodenum of the broilers, while Lawhavinit et al. (2010) stated that turmeric could inhibit *S. aureus* of shrimp and chicken. The lower number of bacteria in chickens fed with diet supplemented with turmeric powder may be because of direct and indirect mechanism. Indirect mechanism is that turmeric supplementation may increase digestive secretions. The diet of chickens, as well as interaction between bacteria and intestinal secretions such as mucin and bile acids, influence the bacterial community in the gastrointestinal tract (Rehman et al. 2007). Bedford (1995) argued that the ingested feed can significantly influence the intestinal bacterial populations by increasing viscosity. Increasing viscosity is known to reduce mixing feed and passage rate by which luminal oxygenation may decrease and the bacterial reproduction may increase. The activity of bacteria may reduce the function of bile acids in emulsifying fat resulted in the growth of depression of chickens (Rahman et al. 2007). The present study showed that antimicrobial effect of turmeric increasing nutrient utilization of local chickens. Based on the previous mechanism, increased digestive juices of pancreatic may result in lower viscosity. The reduced viscosity is essential for advantage of microbiota in the intestine of chickens (Romero 2015).

The direct acts of curcumin to reduce or kills the bacteria have several explanations. Wang et al (2003) stated that FtsZ, a prokaryotic homolog of eukaryotic cytoskeletal protein tubulin, acts importantly in cell division by forming a Z-ring. Natural compounds and chemical agents may inhibit of FtsZ to polymerize cause of cell death (Rai et al. 2008). In addition, Rai et al. (2008) provided evidence suggesting that curcumin inhibits FtsZ assembly which leads to disturbance of the Z-ring formation and inhabitation of bacterial cytokinesis. This mechanism is believed as the main instruments of curcumin to inhibit bacterial cell proliferation (Teow et al. 2016). However, a study reported different mechanism of curcumin as anti-bacterial agent. Tyagi et al. (2015) reported that Curcumin I, a commercial curcumin, inhibits both *S. aureus* and *E. coli*. mainly by damaging the bacterial membrane integrity. Fluorescent probes namely propidium iodide and calcein are used to examine the bacterial membranes, while membrane leakage upon exposure to curcumin was also evaluated by fluorescence and scanning electron microscopes.

The present study suggests that chicken with diets of turmeric powder utilized feed more efficiently; therefore, resulting in a better feed conversion ratio. In addition, the turmeric powder may decrease the activities of some pathogenic bacteria for a better absorption of nutrients. In particular, the level of 3 g/kg turmeric powder was found to be beneficial to local chickens since the chickens improved FCR due to positively affected gut bacteria.

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