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Growth Performance and Blood Profile of Broiler Chicken Fed Black Garlic and Curcuma in the Ration

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ABSTRACT

This study aims to determine the effect of feeding black garlic and curcuma in the ration on the growth performance and blood profile of broiler chickens. This research was conducted in the Faculty Farm and Integrated Laboratory of the Faculty of Animal Science, Universitas Jambi and Health Laboratory, Jambi Province. The research used 200 day old chicken broiler (DOC) with strains of New Lohman MB 202. The experiment was carried out using a Completely Randomized Design (CRD) with 5 treatments and 4 replications, 10 chickens each. The treatments were: P0 = 100% commercial feed (control), P1 = P0 + 3.0% black garlic + 0% curcuma, P2 = P0 + 2.0% black garlic + 1.0% curcuma, P3 = P0 + 1.0% black garlic + 2.0 % curcuma and P4 = P0 + 0% black garlic + 3.0% curcuma. Parameters measured were bodyweight gain, feed consumption and conversion ratio, and blood cholesterol profile (total cholesterol, triglycerides, LDL and HDL). The data were analyzed according to the design used, and highly significant effect on parameter would be tested by Duncan's multiple range test. The results of this study showed that the treatment had a significant effect ($P<0.05$) on feed consumption, bodyweight gain, feed conversion ratio dan blood cholesterol properties. Duncan's test showed that feeding 2% of black garlic and 1% curcuma significantly ($P<0.05$) increased feed consumption as well as bodyweight gain and HDL whereas cholesterol, triglycerides and LDL decreased significantly ($P<0.05$). It is concluded that combination of 2% black garlic and 1% curcuma can improve growth performance up to 5% and blood profile of broilers (total cholesterol, Triglyceride and LDL decreased 8.62%, 36.59% and 28.43% respectively, HDL increased 9.15% approximately).

Keywords: Black garlic, Blood cholesterol, Broiler growth, Curcuma

Introduction

The barrier in consuming broiler meat even though the price is lower than other meat is the cholesterol content inside. According to Tana and Djaelani (2015), broiler chicken meat contained cholesterol approximately 86.68 mg/dL. Meat cholesterol has a positive correlation with blood cholesterol and meat fat (Rahmat and Wiradimadja, 2011). Therefore it can be stated that if blood cholesterol is high, the meat cholesterol is also high and vice versa. Based on this phenomenon, an alternative solution is needed to reduce blood cholesterol without disturbing broiler' performance (growth) such as using natural growth promoter as feed additive. Broiler chicken farming in Indonesia is still fed chicken by commercial feed that has consisted antibiotic growth promoter (AGP) and the residue of AGP was detected in poultry products (Etikaningrum and Iwantoro, 2017; Maya and Widiasih, 2018; Aniza *et al*., 2019; Masrianto *et al*., 2019). Therefore alternative natural growth promoter might be used not only to reduce blood cholesterol but also has positive effect to broiler performance such as black garlic and curcuma. Black garlic is heated garlic in certain time and temperature to produce better pharmacological effect than garlic because the active compounds in black garlic higher than garlic and heating process could produce black garlic with a new formulation, more properties and without the aroma of garlic (Wang *et al*., 2010 and Bae *et al*., 2012). Moulia *et al*. (2018) reported that garlic contains various organosulfur complex compounds, and the two most important ones namely the nonvolatile amino acid γ-glutamyl-Salk (en) il-L-cysteine and oil volatile S-alk (en) il cysteine sulfoxide (ACSOs) or alliin. The other active compounds such as thiosulfinate dan S-allil cistein (SAC), allicin, allil sulfide, dithiin, ajoene and other sulfur compounds. Lisiswanti and Haryanto (2017) reported that garlic has a pharmacological potential as an antibacterial agent, antihypertensive and antithrombotic with 65% water, 28% carbohydrate especially fructose,

2.3% organosulfur materials especially allinase and ajoene, 2% protein which was1,2% of free amino acids mainly arginine. The pharmacological effects of garlic comes from allicin and derivatives, namely diallyl disulfide (DADS), diallyl sulfide (DAS), diallyl trisulfide (DTS) and sulfur dioxide. Allicin in active form acts as an antibiotic and antidiabetic in the human body. However, garlic also has limitations such as a very strong aroma and untasty and heated garlic will reduce the aroma and make it tasty. This is due to the number of active compounds *S*-allylcysteine and sulfur amino acids increased 5-7 times higher in black garlic than garlic (Bae *et al*., 2014). Black garlic contains an organosulfur compound in the form of allicin higher than garlic (Wang *et al*., 2010) and contains very high amino acids methionine and arginine. Methionine is a sulfur-containing amino acid that plays a role in protein synthesis. The content of methionine in the black garlic was 78.11 mg/100 g, while garlic was only 31.56 mg/100 g (Choi *et al*., 2014). L-arginine can inhibit lipogenesis and increase the activity of the lipase enzyme so that it can increase lipolysis in the body which results in reduced body fat deposition (Wu *et al*., 2011; Fouad *et al*., 2013). Due to black garlic can also increase villi height and small intestine crypt depth (Lee *et al*., 2016), it means that it also can increase the surface area of the intestine which results in a wider absorption area so that absorption capacity also increases, because intestinal villi are the main key of nutrients absorption. However, Putra (2019) found that adding black garlic until 5% into the ration tended to decrease feed and protein consumption, thus, had not been able to improve protein utilization in the broiler chicken. Similar result was reported by Kurniawan (2019) who stated that using until 5% of black garlic flour in the ration of broiler chicken had not been able to increase broiler growth and the authors suggested to combine black garlic with other herbs those can increase feed consumption and broiler performance. One of the natural herbs that contains active compound to stimulate an appetite and to get a better nutrients absorption ability is curcuma.

Curcuma (Curcuma xanthorrhiza Roxb) contains the main active compounds, namely essential oils and curcuminoids (Dermawaty, 2015). Next, the author stated that curcuma was widely used as an antimicrobial agent due to its ability to prevent the growth of microbes because of this compounds. The curcuminoid content was 1-2% and the essential oil was 3-12%. Hasimun *et al*. (2011) stated that curcuminoids can increase total cholesterol levels in feces 3.5 times higher than controls. This data showed that curcuminoids have a mechanism to increase the conversion of cholesterol into feces. According to Rahmat and Wiradimadja (2011), lower blood cholesterol levels could be done by reducing endogenous cholesterol synthesis and increasing bile secretion. Therefore, combination of black garlic and curcuma were expected to be able to produce better performance of broiler with low blood cholesterol so meat is produced with low cholesterol but still high protein content.

The purpose of this study was to determine the effect of feeding black garlic and Curcuma into the ration on growth performance and blood cholesterol profile in broiler chicken.

Materials and Methods

This study was conducted in the Farm of Faculty of Animal Science, Universitas Jambi from 10 May until 25 July 2020. The feeding trial was conducted for 5 weeks at Faculty Farm. Nutrients composition of feed was analyzed in the Integrated Laboratory, Faculty of Animal Science, Universitas Jambi. Blood cholesterol was analyzed at the Health Laboratory, Jambi Province.

Two hundred day old chicken in strain of *New Lohman MB 202* were used in ths study and divided into 5 treatment groups of feeding and 4 replications, 10 chickens each. Each chicken group offered feed commercial for starter and finisher phase produced from Japfa Comfeed Indonesia, Tbk and treated according to the treatment diet.

Chicken were kept for 5 weeks under colony cage with a size of 100 x 75 x 50 cm for 10 chickens. Each cage was equipped by lighting lamp with a power of 5 watts, feeder and drinker. The main cage was equipped by lighting lamp with a power of 40 watts. The housed temperature was maintained at 27-30^{o}C.

Black garlic meal was produced by following Nelwida *et al*. (2019) whereas curcuma meal was following the instruction of Dono (2010). Garlic was heated under 60-70^{o}C for 17 days. Curcuma was sliced thinly, air dried for 2-3 days before milling into flour. Commercial feed, black garlic and Curcuma were milled with a size 20 mesh then black garlic and curcuma were added into the commercial feed according to the treatment, mixed thoroughly and offered to the chicken from the starter period (DOC). During the experiment, chickens were not vaccinated and offered additional vitamin due to the current study using black garlic and curcuma which have pharmacological effect. Chickens and rations were weighed every week. Diets and drinking water were offered ad libitum.

The treatment diets were;
P0 = 100% commercial ration (control),
P1 = P0 + 3.0% black garlic + 0% curcuma,
P2 = P0 + 2.0% black garlic + 1.0% curcuma,
P3 = P0 + 1.0% black garlic + 2.0% curcuma, and
P4 = P0 + 0% black garlic + 3.0% curcuma.

The nutrient composition of black garlic, curcuma, commercial feed and treatment diets for starter and finisher periods were shown in Table 1, 2 and 3.

Table 1. Nutrients composition of black garlic, curcuma, and commercial feed (%)

Nutrients Content (%)	Black Garlic	Curcuma	Starter Commercial Feed	Finisher Commercial Feed
Dry matter	91.86	82.10	91.13	88.92
Organic matter	88.25	76.60	84.82	83.40
Ether Extract	1.31	5.55	8.83	5.19
Crude Fibre	1.16	4.54	5.40	3.19
Crude Protein	12.31	6.59	21.07	19.63
Nitrogen Free Extract	73.49	59.92	49.53	55.40
ME (kcal/kg)	3127.78	2708.65	3048.23	2980.78

Source : Integrated Laboratory Faculty of Animal Science, Universitas Jambi (2020). Active compound of Curcuma was curcumin 2%, essential oil 5.97% (Rukmana, 1995).

Table 2. Nutrients composition of treatment diet at starter phase (%)

Nutrients Content (%)	P0	P1	P2	P3	P4
Dry matter	91.13	91.15	91.06	90.96	90.87
Organic matter	84.82	84.92	84.81	84.69	84.58
Ether Extract	8.83	8.61	8.65	8.69	8.73
Crude Fibre	5.40	5.27	5.30	5.34	5.37
Crude Protein	21.07	20.81	20.75	20.70	20.64
Nitrogen Free Extract	49.53	50.23	50.10	49.96	49.83
ME (kcal/kg)	3.048.23	3050.55	3046.48	3042.41	3038.34

P0 = 100% commercial ration (control), P1 = P0 + 3.0% black garlic + 0% curcuma, P2 = P0 + 2.0% black garlic + 1.0% curcuma, P3 = P0 + 1.0% black garlic + 2.0% curcuma, and P4 = P0 + 0% black garlic + 3.0% curcuma.

Table 3. Nutrients composition of treatment diet at finisher phase (%)

Nutrients Content (%)	P0	P1	P2	P3	P4
Dry matter	88.92	89.01	88.91	88.82	88.72
Organic matter	83.40	83.54	83.43	83.32	83.20
Ether Extract	5.19	5.08	5.12	5.16	5.20
Crude Fibre	3.19	3.13	3.16	3.19	3.22
Crude Protein	19.63	19.41	19.36	19.30	19.25
Nitrogen free extract	55.40	55.93	55.80	55.66	55.53
ME (kcal/kg)	2980.78	2985.07	2981.00	2976.93	2972.86

P0 = 100% commercial ration (control), P1 = P0 + 3.0% black garlic + 0% curcuma, P2 = P0 + 2.0% black garlic + 1.0% curcuma, P3 = P0 + 1.0% black garlic + 2.0 % curcuma, and P4 = P0 + 0% black garlic + 3.0% curcuma.

The measured parameter

Parameter measured in this study were bodyweight gain, feed consumption and conversion ratio, and blood cholesterol profile (total cholesterol, triglycerides, LDL and HDL).

At the end of the experiment (5 weeks of age), two chickens whose weight approached the average bodyweight in each treatment were slaughtered for blood collection for the measurement of blood cholesterol profile. Before being slaughtered, the chickens were fasted for 8 hours.

Feed consumption was obtained by calculating the difference between offered and remaining ration, and expressed by g/head/day. Bodyweight gain was obtained by calculating the difference between the final and initial bodyweight, and expressed by g/head/day. Feed conversion ratio was obtained by dividing feed consumption and bodyweight gain. Total cholesterol, LDL and HDL were determined using cholesterol oxidase - para amino antipyrine (CHOD-PAP) method described by Valtek Diagnostics (1997).

Statistical analysis

Collected data were statistically analyzed by using One way ANOVA procedures of Analyse-it that is integrated in Microsoft Excel 2010 for Windows and identification of any significant effect on the parameter were tested by Duncan's Multiple Range Test with Confidence level 95% ($\alpha = 0.05$).

Results and Discussion

Effect of treatment diets on broiler growth performance for 5 weeks feeding trial is shown on Table 4.

Feed consumption

Analysis of variance showed that the treatment diet had significant effect ($P<0.05$) on feed consumption for starter phase (age 1-21 days), finisher phase (age 22-35 days) and whole periods (age 1-35 days). Duncan multiple range test showed that feed consumption of chicken group fed control diet significantly ($P<0.05$) lower than that of other chicken groups. It indicated that offered black garlic and curcuma meal into the ration might be responded better and more effective to increase poultry feed consumption than control group. This present study was in line with to Kurniawan (2019) and Putra (2019) suggestion who found that feed consumption of broiler fed black garlic might be increased to improve their performance by offering another herb which has increasing appetite. The results of this study indicated that the use of herbs either as natural feed additive or therapeutic agents should not be used single but combined with other herbs in accordance with their properties so that therapeutic goals can be achieved.

Result of Duncan Multiple Range test for feed consumption for chicken groups fed either black garlic, curcuma or combination black garlic

Table 4. Average of broiler growth performance fed treatment diet

Parameter	P0	P1	P2	P3	P4
Age 1-21 days					
FC (g/head/day)	41.65±0.83^{b}	42.66±1.64^{a}	42.69±0.42^{a}	42.55±1.58^{a}	42.66±0.50^{a}
BWG (g/head/day)	24.59±0.46^{b}	25.36±0.34^{a}	25.06±0.77^{a}	24.71±0.85^{b}	24.30±0.88^{b}
FCR	1.69±0.05^{b}	1.68±0.05^{b}	1.70±0.06^{b}	1.72±0.02^{ab}	1.76±0.05^{a}
Age 22-35 days					
FC (g/head/day)	100.58±1.60^{b}	103.83±5.61^{a}	106.85±1.72^{a}	107.69±4.33^{a}	110.85±6.49^{a}
BWG (g/head/day)	50.19±0.95^{b}	54.20±2.13^{a}	53.67±1.14^{a}	53.25±1.27^{a}	53.00±2.24^{a}
FCR	2.00±0.06^{b}	1.92±0.06^{c}	1.99±0.02^{b}	2.02±0.05^{b}	2.09±0.06^{a}
Age 1-35 days					
FC (g/head/day)	71.12±0.61^{b}	73.26±3.12^{a}	74.43±1.16^{a}	75.18±1.65^{a}	77.47±3.75^{a}
BWG (g/head/day)	37.39±0.57^{b}	39.78±1.14^{a}	39.36±0.95^{a}	38.98±0.79^{a}	38.77±1.01^{a}
FCR	1.85±0.04^{b}	1.80±0.07^{b}	1.85±0.04^{b}	1.87±0.02^{ab}	1.93±0.06^{a}

FC=Feed Consumption, BWG = Bodyweight Gain, FCR =Feed Conversion Ratio, P0 = 100% commercial feed (control), P1 = P0 + 3.0% black garlic + 0% curcuma, P2 = P0 + 2.0% black garlic + 1.0% curcuma, P3 = P0 + 1.0% black garlic + 2.0 % curcuma, and P4 = P0 + 0% black garlic + 3.0% curcuma.

and curcuma had significantly (P<0.05) higher than that of a control group. It might be due to black garlic and curcuma contained essential oil and curcuminoid those can improve animal appetite. Besides, Raeesi *et al*. (2010) stated that allicin could improve intestinal performance so that it could increase feed consumption. Issa and Omar (2012) stated that garlic could improve the digestibility of dry matter and crude protein, and thereafter it could increase feed consumption in broilers.

Bodyweight gain

Analysis of variance showed that the treatment diets had significant effect (P<0.05) on bodyweight gain for starter phase (age 1-21 days), finisher phase (age 22-35 days) and whole periods (age 1-35 days). These results were similar to feed consumption of chicken groups fed diet containing either black garlic, curcuma or their combination.

Result of Duncan Multiple Range test on bodyweight gain for starter phase showed that chicken groups fed ration which is added 3% of black garlic and combination of 2% black garlic and 1% curcuma had highly significant higher (P<0.05) on increasing bodyweight gain than that of other chicken groups P0, P3 and P4. The different effects were found on body weght gain for finisher phase and whole phase where bodyweight gain of chicken group fed control diet had lower bodyweight gain than other treatment groups. Other treatment groups (P1, P2, P3 and P4) were not significantly different (P>0.05). This is in line with feed consumption and also might be due to the active compounds in the black garlic and curcuma could increase absorption area of small intestine, thus, the ability to absorb nutrients might also increase. According to Andara (2019), the addition of 3% black garlic in the ration can increase protein retention of quail. Garlic flour supplementation in ration could improve broiler performance (Issa and Omar, 2012). Therefore, broiler growth of chicken group fed black garlic and curcuma had better bodyweight gain than that of control group.

Feed conversion ratio

Analysis of variance showed that the treatment diets had significant effect (P<0.05) on feed conversion ratio for starter phase (age 1-21 days), finisher phase (22-35 days) and whole period (1-35 days). These results were similar to the analysis of variance results of feed consumption and bodyweight gain. Nurhayati (2013) stated that feed conversion ratio represented the feed utilization efficiency and it was influenced by feed consumption and bodyweight gain. The higher feed conversion ratio means lower feed utilization efficiency and diets could be used properly to produce meat.

Results of Duncan Multiple Range test at starter phase indicated that addition curcuma into the ration significantly increased (P<0.05) feed conversion ratio. This is due to addition of curcuma into the ration (treatment group P2, P3 and P4) increased feed consumption but decreased bodyweight of chicken. As we know that feed conversion ratio is depend on the feed consumption and bodyweight gain where increasing feed consumption which is not followed by increasing bodyweight resulted increasing of feed conversion ratio (Nurhayati, *et al*., 2016). This results was in line to Issa and Omar (2012) statement who stated that garlic could reduce feed conversion ratio of broiler chicken. The Duncan test for the finisher phase and whole phase showed that the treatment of curcuma addition 3% significantly (P <0.05) resulted in the highest feed conversion ratio. It was due to that increasing addition of curcuma will be faster intestine peristalsis, so that the diet will be releasing faster from the intestine and the nutrients could not be absorbed optimally. The lowest feed conversion ratio was obtained by chicken group fed ration contained 3% of black garlic. This might be related to active compounds and antibacterial properties of black garlic (Kimura *et al*., 2017) which could increase intestine absorption area, thus, increase nutrients absorption in the intestine, increase chicken growth and finally lead to an improvement in feed conversion ratio. According to Izadi *et al*. (2013), surface absorption area of intestine is related to intestine absorption capacity, where if the area increase, the absorption will increase. Royani (2012) reported that the function of small intestine is related to the ability of poultry to convert feed into meat. This current study found that combination black garlic and curcuma in the ration in 2:1 (Treatment group P2) could be better

in feed conversion ratio than other combination (Treatment group P3) even though was not significantly different. This study indicated that curcuma is not suggested to offered single, it will be better if mixed with other herbs to improve feed conversion ratio.

Blood cholesterol

Effect of black garlic and curcuma addition into the ration on blood cholesterol properties (total cholesterol, triglyceride, HDL and LDL) is shown on Table 5. Analysis of variance resulted that blood properties (total cholesterol, trigliseride, low density lipoprotein and high density of lipoprotein) of among chicken groups were significantly affected (P<0.05) by the treatment diets. Results of Duncan's test showed that total cholesterol of chicken groups fed diet containing either black garlic, curcuma or their combination (P1, P2, P3 or P4) was significantly (P<0.05) lower than the control (P0). This might be due to the active compounds in black garlic (allicin) and curcumin as well as essential oil in curcuma could suppress cholesterol synthesis so that reduced blood cholesterol. Ha *et al*. (2015) stated that the addition of black garlic in the ration significantly reduced total lipids, cholesterol and fat in the liver but increased fat and triglycerides in feces. Harumi *et al*. (2015) reported that curcumin has pharmacological effects including antitumor and anti-inflammation effects and can prevent lipid peroxidation. The reduction in blood cholesterol by curcuma might be due to its penetration of active compounds in curcuma which can reduce cholesterol synthesis and decrease blood cholesterol content (Dono, 2010). Hasimun *et al*. (2011) reported that the combination of curcuminoid and S-metylcysteine had several mechanisms in reducing cholesterol levels, worked synergistically in regulating cholesterol homeostasis in serum and liver and increasing metabolism and conversion of cholesterol to feces. Curcuminoids significantly increased fecal cholesterol levels while S-methylcysteine inhibited intestinal cholesterol absorption and increased cholesterol metabolism in serum and liver.

Result of this study found that total cholesterol of chickens either in control group or treatment diets were higher than previous reports by other authors. The previous study found that in normal condition, total cholesterol in broiler blood ranges from 94.19-135.61 mg/dL (Murwani, 2010) and 52-148 mg/dL (Mustikaningsih, 2010).

Triglyceride

Analysis of variance showed that there was a significant effect (P<0.05) of treatment diets on triglyceride content in broiler blood at 35 days old. Duncan Multiple Range test's showed that triglyceride content chicken groups fed either black garlic, curcuma or their combination in their ration were lower than control group. It was in line with Berliana *et al*. (2018) report. The authors found that the addition of black garlic in quail feed could decrease significantly triglyceride content in quail blood. Decreasing triglyceride in the recent study might be due to increasing pancreatic enzyme activities, the more lipase secretion the more fat is synthesized into glycerol. Kim *et al.* (2011) stated that black garlic has an ability to decrease fat levels in blood.

The triglyceride levels in the treatment group P1, P2, P3 and P4 were significant lower than control group might be due to curcumin and flavonoid compound in the black garlic and curcuma could accelerate bile secretion so that fat digestion is more optimal. According to Arief *et al*. (2012), decreased triglycerides in the blood due to low triglyceride formation in the liver and inhibition of triglyceride absorption in the intestine. Arshami *et al*. (2012) reported that curcumin was able to reduce broiler blood triglyceride levels.

Low density lipoprotein (LDL)

Analysis of variance showed that the treatment had a significant effect (P<0.05) on LDL levels in broiler blood at 35 days of age. Duncan's Multiple Range test showed that the LDL levels in all treatments (P1, P2, P3 and P4) were significantly (P<0.05) lower than the control. This is in line with total blood cholesterol that was also decreased. It could be understood because LDL is part of cholesterol and has positive correlation each other in blood serum. Budiarto *et al*. (2017) found that high cholesterol content in feed would cause an increase in cholesterol absorption in the intestine and LDL synthesis in the liver, thus, an increase serum LDL levels. Likewise, if cholesterol levels in the liver decreased, uptake of LDL in the plasma by the LDL receptors would increase, so that the plasma LDL level would decrease.

High density lipoprotein (HDL)

Results of the analysis of variance showed that the treatment had a significant effect (P<0.05) on HDL blood levels of broilers at 35 days of age.

Table 5. Effect of black garlic and curcuma into the ration on broiler blood properties

Parameter	P0	P1	P2	P3	P4
Total Cholesterol (mg/dL)	130.50±4.20^{a}	118.25±5.74^{b}	119.25±4.50^{b}	118.75±2.75^{b}	118.50±4.43^{b}
Triglyceride (mg/dL)	51.25±4.57^{a}	32.25±3.10^{b}	32.50±5.07^{b}	33.25±3.86^{b}	34.25±5.91^{b}
LDL (mg/dL)	49.25±3.40^{a}	33.50±5.07^{b}	35.25±5.25^{b}	35.75±3.86^{b}	35.75±3.77^{b}
HDL (mg/dL)	71.00±3.16^{b}	78.25±1.71^{a}	77.50±3.87^{a}	76.25±3.50^{b}	76.00±3.27^{b}

LDL = low density Lipoprotein, HDL = High Density Lipoprotein, P0 = 100% commercial ration (control), P1 = P0 + 3.0% black garlic + 0% curcuma, P2 = P0 + 2.0% black garlic + 1.0% curcuma, P3 = P0 + 1.0% black garlic + 2.0 % curcuma, and P4 = P0 + 0% black garlic + 3.0% curcuma.

Duncan Multiple Range test resulted that HDL levels in all treatments (P1, P2, P3 and P4) were significantly (P<0.05) higher than the control (P0). However, HDL level in blood of chicken group fed either 3% black garlic or combination of 2% black garlic and 1% curcuma was significantly higher (P<0.05) than the other treatments where chicken groups fed 1% black garlic and 2% curcuma and chicken fed 3% curcuma. This situation indicated that black garlic has better ability to increase blood HDL levels than curcuma. This statement was supported by Ha *et al*. (2015) who stated that the addition of black garlic in rations significantly increases HDL. Another possibility was due to black garlic also contained high levels of Vitamins C and B.

According to Mustikaningsih (2010), HDL levels should be more than 60 mg/dL. In this study found the HDL levels in blood was ranged from 71.40-76.80 mg/dL. The higher levels of HDL in this study indicated that there was a positive response to the treatment diet. this might be due to the active compounds in the black garlic and curcuma could accelerate the process of transporting cholesterol to the liver so that cholesterol and LDL in the blood are low (Murray *et al*., 2012). Besides, Increase HDL levels with the provision of curcuma was possible due to curcuma contained the active compounds, essential oils and curcumin, which can increase intestinal peristalsis (Budiarto *et al*., 2017). If the cholesterol reserves in the liver do not meet the HDL, liver would take from the tissues, so HDL levels would increase (Rositawati *et al*., 2010).

Conclusions

The conclusion of this study is the combination of 2% black garlic and 1% curcuma can improve growth performance up to 5% and blood profile of broilers (total cholesterol, Triglyceride and LDL decreased 8.62%, 36.59% and 28.43% respectively, HDL increased 9.15% approximately).

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