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Effect of Lactic Acid Bacteria Isolated from Ensiled Kumpai Tembaga on Growth Performance and Meat Quality of Pegagan Ducks

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ABSTRACT

This study aimed to investigate the effect of increasing the lactic acid bacteria (LAB) concentration isolated from ensiled Kumpai Tembaga on the growth performance, carcass yield, and meat quality in Pegagan ducks. A total of 100 Pegagan ducks aged were allocated at seven days into five groups with four replicates: Group 1 (control) and Group 2 to 5 (orally LAB addition with the concentration of $1x10^6$, 10^7, 10^8, and 10^9 CFU/ml, respectively). The measured parameters included growth performance, carcass yield, and meat quality. The LAB supplementation significantly affected ($P<0.05$) the weekly feed intake, body weight gain, and feed conversion ratio starting from the third week. Irrespective of the LAB concentrations, carcass, and breast cut weights increased ($P<0.05$) by 24 and 35.3%, respectively, after LAB supplementation compared to control. The percentage of breast meat and breast meat-to-bone ratio increased ($P<0.05$) by 4.0 and 48.05%, respectively, but the bone percentage decreased ($P<0.05$) by 9.5% after LAB addition. Again, irrespective of the LAB concentrations, the meat shear force declined by 48.05%. ($P<0.05$) after administering LAB compared to the control group. The free fatty acid level dropped by 31.68% in Groups 3 and 4 and continued decreasing by 44.10% ($P<0.05$) in Group 5. In conclusion, oral LAB supplementation with a concentration of 109 produced optimal growth performance after two weeks of administration. The LAB addition also improved carcass yields, which had a greater impact on the breast. The meat texture became more tender with a lower fatty acid content.

Key words: Lactic acid bacteria, Kumpai Tembaga silage, Growth performance, Carcass, Meat quality.

INTRODUCTION

Lactic acid bacteria (LAB) are one of the most potential bacteria used as feed additives for poultry because of their crucial roles in promoting growth performance or egg production, diminishing the proliferation of the gut pathogenic microbial, improving carcass yield and meat quality, enhancing gut immunity and health, and reducing mortality (Vicente et al. 2007; Gallazzi et al. 2008; Menconi et al. 2011; Salehizadeh et al. 2019; Vieco-Saiz et al. 2019). LAB is a group of gram-positive anaerobic bacteria that mainly produce lactic acid from glucose fermentation (Mokoena 2017). So far, most of the LAB applied for growth promotors are originating from poultry feces, gastrointestinal tract, or fermented products (Surachon et al. 2011; Lee et al. 2016; Salehizadeh et al. 2020), while the utilization of LAB derived from ensiled forage has not been studied. Our previous study has succeeded in isolating and identifying isolates from Kumpai Tembaga silage, which is the local name for the swamp forage of *Hymenachne acutigluma*. The results confirmed that all the identified isolates are belonged to the LAB group, specifically the *Lactobacillus* genus (Sandi et al. 2018). According to the *in vitro* tests, the LAB isolates had high tolerance in various acidic conditions, either at low (3 to 6.5) or high (7.5 to 8) pH (Sandi et al. 2019).

Determining the concentration of LAB as a feed additive is essential to achieve a significant impact on the poultry. Several studies noted that there were differences in offering the LAB concentration, primarily *Lactobacillus*, in the diet accompanied with variation in genera and strains, where the broiler responses on the LAB treatments were also varied (Zhu et al. 2009; Peng et al. 2016; Wang et al. 2019). According to those studies, the LAB concentration and genera might be the determining factors to obtain optimal outcomes. Therefore, the evaluation of administering different LAB concentrations is also needed in this study. The determination of LAB concentrations can be implemented from the LAB content in the gastrointestinal tract, but more information is only available in chickens,

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while in ducks is still limited. It was identified that *Lactobacillus* is a genus of LAB which mostly occupies the gastrointestinal tract of broilers in concentrations of 10^6 to 10^9 CFU/g contents (Rehman et al. 2007).

It has been widely proven that LAB isolated from various sources have positive effects on growth performance, carcass traits, and meat quality in poultry (Forte et al. 2018; Salehizadeh et al. 2019; Wang et al. 2019). However, there has been no study observing the inclusion effect of LAB isolated from ensiled swamp forage on these parameters. Based on our previous investigation, the provision of this LAB was able to increase either the length or weight of the ceca and small intestine segments, as well as reduce serum lipid concentrations in Pegagan duck (Yosi et al. 2020). While its effect on growth performance, carcass characteristics, and meat quality have not been observed. Therefore, further evaluation focusing on the effect of increasing the LAB concentration isolated from ensiled Kumpai Tembaga on the growth performance, carcass yield, and meat quality in Pegagan ducks needs to be performed.

MATERIALS AND METHODS

Experimental Birds and Management

All methods and procedures performed in this experiment follow the ethical standards at the Sriwijaya University and the Indonesian government regulation number 18/2009 concerning about health and welfare of farm animals. A total of 100 mixed 1-week-old Pegagan ducks, with initial body weight of 115.31±5.40g, was used in this experiment. Pegagan duck is known as the local duck that originated from South Sumatra, Indonesia (Yosi et al. 2016). All birds were assigned to 5 experimental groups with 4 replicates with a total of 20 birds per group. Group 1 was the group without the addition of LAB, then Groups 2 to 5 were the group with LAB supplementation with concentrations of 10^6, 10^7, 10^8 and 10^9 CFU/mL, respectively. Birds were kept for 7 weeks, where diets and drinking water were offered ad libitum. Diets, based on the corn-soybean meal, were formulated to meet or exceed nutrient recommendations by the NRC, and divided into starter (0-2 week) and finisher (2-8 week) period diets (Table 1). LAB was administered orally, with the following levels: 3ml/bird until 3 weeks of age, then gradually increased to 5, 7.5, and 10mL at 3 to 5, 5 to 7, and 7 to 8 weeks of age, respectively.

Preparation of Ensiled Kumpai Tembaga

The detailed steps for making Kumpai Tembaga silage refer to Yosi et al. (2020). The fresh Kumpai Tembaga grass was first cut into smaller pieces of around 2-5cm and withered in a room for at least 24h. After withering, 500g of grass was mixed with molasses and water with an amount of 3% of the weight of the grass. Next, the mixed grass was placed in 3-layer plastic bags and then compacted to anaerobic environments. After 3 weeks of storage, the silage was opened and samples were taken for further laboratory analysis.

LAB Culture and Determination of Concentration

The procedure for culture and determination of LAB concentration is the same as described by Yosi et al. (2020). After being cultured on media de man rogosa sharpe (MRS) broth, LAB isolates were incubated at 37ºC for 48h. The cultured LAB was then diluted using 0.85% NaCl solution. LAB concentration was determined according to the level of turbidity, by comparing the McFarland standard solution with the diluted LAB solution.

Sample Collection and Analysis

The growth parameters covering weekly body weight gain (BWG), feed intake (FI), and feed conversion ratio (FCR) were determined. FCR was calculated by dividing the FI with BWG per week. After 7 weeks of rearing, all birds were weighed and 2 birds per replicate were then randomly chosen to determine carcass yield and meat quality parameters. The carcass parameters included carcass weight, carcass slice weight (breast, thigh, wing, and back), as well as the percentage of meat, bones, and meat-to-bone ratio on each carcass cut were recorded. For meat quality, the free fatty acid (FFA) level was measured according to the titration technique as described in the AOAC (2000). Analysis of moisture content (MC) was performed according to the AOAC (2000) method. Shear force (SF) of meat samples was determined using a Warner-Bratzler shear with a load cell of 50 kg and a cross-head speed of 200mm/min as described by Choo et al. (2014), while the pH, water holding capacity (WHC), and cooking loss (CL) was measured refers to Yosi and Sandi (2014). The determination of SF was based on the average of the highest forces needed to shear respectively set of samples. For pH determination, 2g of each meat sample were mixed with 18 ml of the distilled water, stirred until homogenous, and filtered. pH meter was first calibrated using 4 and 8 standard solutions and then the pH of the samples was measured. For WHC measurement, 0.3g of breast meat was located on Whatman 41 filter paper and then positioned between 2 metal plates with a pressure capacity of 35kg for 5min to create the wet area on the filter paper. To determine the wet area, it was computed by subtracting the total area with the area-covered meat samples. For measuring CL, a total of 20g of breast meat was put in polyethylene plastic, sealed using a vacuum pack, and heated in a water bath for 30min at 80ºC until cooked. The samples were cooled at room temperature, dried with filter paper on their surface, and then reweighed with analytical balance. The CL was determined from the difference in sample weight between before and after cooking.

Statistical Analysis

All collected data in this study were analysed using SPSS statistical software (SPSS version 17). The obtained data were subjected to one-way analysis of variance for completely randomized design. Differences among main effect means ($P \leq 0.05$) were assessed via Duncan's multiple range tests. Statistical significance was verified based on $P \leq 0.05$.

RESULTS

Effects on Growth Performance

The LAB supplementation of ensiled Kumpai Tembaga had a significant effect ($P<0.05$) on FI, BWG, and FCR of Pegagan ducks from the third week to the last week of rearing (Table 2). At week 3, the FI appeared to be lower ($P<0.05$), whereas BWG increased up to 23,3% after

Table 1: Nutrient composition and ingredients on the experimental diet (g/kg diet as fed basis)

Ingredients	Composition (%)	
	Starter phase (0-2 week)	finisher phase (2-8 week)
Soybean meal	28	16
Corn meal	56	68
Meat bone meal (MBM)	6	5
Bran	9	10
Grit	0.5	0.5
Vitamin-mineral premix[a]	0.5	0.5
Calculated chemichal composition[b]		
ME (Kcal/kg)	2910	3109
Crude fiber (%)	6.24	7.96
Crude protein (%)	22.06	18.16
Ca (%)	0.99	0.85
P (%)	0.67	0.52

[a]provided per kilogram of diet: lysine HCL=5,000mg; methionine=3,400mg; vitamin A=5,000,0000IU; vitamin B12=3,800mg; vitamin E=450IU; vitamin D3=1,500,000IU; vitamin B2=1,500mg; vitamin B6=780mg; vitamin K=1,500mg; vitamin C=330mg; niacin=5,580mg; zinc sulphate=4,000mg; pantotenate acid=1,800mg; magnesium=4,000mg; cooper=4,000mg; sodium sulphate=70,0000mg; sodium chloride=16,500mg; manganese=4,000mg; potasium chloride=29,000mg: [b]Calculated referring to National Research Council (1994).

Table 2: Weekly feed intake, body weight gain, and feed conversion ratio of Pegagan ducks supplemented with different concentrations of LAB isolated from ensiled Kumpai Tembaga

Item	Concentration of LAB solutions (CFU/ml)				
	Group 1 (Control)	Group 2 (10^6)	Group 3 (10^7)	Group 4 (10^8)	Group 5 (10^9)
Week 1					
FI (kg/bird)	0.28±0.05	0.29±0.05	0.25±0.02	0.27±0.02	0.29±0.06
BWG (kg/bird)	0.100±0.013	0.099±0.014	0.100±0.014	0.107±0.004	0.102±0.034
FCR	2.90±0.70	2.93±0.45	2.55±0.28	2.49±0.21	2.78±0.26
Week 2					
FI (kg/bird)	0.41±0.09	0.42±0.09	0.35±0.02	0.36±0.07	0.32±0.06
BWG (kg/bird)	0.109±0.011	0.118±0.029	0.109±0.010	0.117±0.015	0.116±0.013
FCR	3.75±0.88	3.82±1.50	3.22±0.24	3.11±0.52	2.83±0.67
Week 3					
FI (kg/bird)	0.62±0.01^{ab}	0.66±0.05^{a}	0.59±0.06^{abc}	0.52±0.01^{c}	0.54±0.11^{bc}
BWG (kg/bird)	0.130±0.008^{b}	0.161±0.006^{a}	0.159±0.013^{a}	0.157±0.004^{a}	0.164±0.053^{a}
FCR	4.80±0.22^{a}	4.10±0.25^{b}	3.69±0.31^{bc}	3.32±0.28^{c}	3.27±0.45^{c}
Week 4					
FI (kg/bird)	0.75±0.03^{b}	0.78±0.05^{b}	0.76±0.02^{b}	0.77±0.03^{b}	0.84±0.04^{a}
BWG (kg/bird)	0.176±0.006^{b}	0.212±0.032^{b}	0.211±0.015^{b}	0.206±0.013^{b}	0.258±0.019^{a}
FCR	4.29±0.19^{a}	3.71±0.37^{b}	3.62±0.15^{b}	3.74±0.08^{b}	3.34±0.59^{b}
Week 5					
FI (kg/bird)	1.20±0.01^{b}	1.21±0.02^{b}	1.18±0.04^{b}	1.17±0.04^{b}	1.35±0.14^{a}
BWG (kg/bird)	0.187±0.010^{b}	0.192±0.007^{b}	0.190±0.030^{b}	0.192±0.013^{b}	0.234±0.013^{a}
FCR	6.44±0.44^{a}	6.34±0.34^{a}	6.27±0.20^{a}	6.13±0.04^{ab}	5.77±0.21^{b}
Week 6					
FI (kg/bird)	1.04±0.04^{b}	1.12±0.05^{ab}	1.10±0.02^{b}	1.12±0.06^{ab}	1.20±0.09^{a}
BWG (kg/bird)	0.158±0.006^{b}	0.169±0.003^{b}	0.168±0.013^{b}	0.169±0.025^{b}	0.189±0.020^{a}
FCR	6.62±0.14^{a}	6.64±0.08^{a}	6.54±0.10^{ab}	6.65±0.15^{a}	6.37±0.17^{b}
Week 7					
FI (kg/bird)	1.14±0.06^{b}	1.16±0.13^{b}	1.19±0.07^{b}	1.15±0.10^{b}	1.55±0.40^{a}
BWG (kg/bird)	0.153±0.013^{b}	0.157±0.017^{b}	0.163±0.011^{b}	0.164±0.073^{b}	0.221±0.048^{a}
FCR	7.45±0.32^{a}	7.46±0.11^{a}	7.33±0.21^{ab}	7.06±0.06^{b}	7.07±0.07^{b}

[a,b,c]Least squares means within a row with different lowercase superscripts differ (P<0.05): FI=feed intake, BWG=body weight gain, FCR=feed conversion ratio.

the LAB supplementation. Afterward, from week 4 to 7, the FI after supplementing LAB with the concentration of 10^9 increased (P<0.05) by 9.6 to 33.6%, while BWG improved (P<0.05) by 13.9 to 38.8% compared to both control and other LAB concentrations. For the FCR, it declined by 18.9% and 31.4% in the third week after adding LAB up to 10^7 and 10^9 CFU/ml, respectively. At week 4, there was a decrease in FCR by 10.5% (P<0.05) after the addition of LAB compared to the control, but the differences in LAB concentrations presented the similar response to this parameter. From week 5 to 6, FCR reduced (P<0.05) by 8.3 and 3.7% respectively after introducing LAB supplementation of 10^9 CFU/mL, while FCR between control and LAB treatments up to a concentration of 10^8 was not different. In the seventh week, a decrease in FCR occurred by 4.7% (P<0.05) after the addition of LAB starting from the concentration of 10^8 CFU/mL.

Effects on Carcass Yields

The LAB supplementation, irrespective of the LAB concentrations, affected (P<0.05) the whole carcass and breast weights, while the wings, thighs, and back weights did not change after the addition of LAB (Table 3). The weights of whole carcass and breast increased (P<0.05)

Table 3: Carcass yield and meat to bone ratio in each carcass slice of Pegagan ducks after supplementing with LAB solutions isolated from ensiled Kumpai Tembaga

Item	Concentration of LAB solutions (CFU/ml)				
	Group 1 (Control)	Group 2 (10^6)	Group 3 (10^7)	Group 4 (10^8)	Group 5 (10^9)
Carcass (kg)	0.570±0.003[b]	0.671±0.028[a]	0.683±0.027[a]	0.715±0.017[a]	0.749±0.035[a]
Breast (kg)	0.162±0.002[b]	0.207±0.009[a]	0.213±0.009[a]	0.223±0.003[a]	0.234±0.012[a]
Meat (%)	70.54±0.13[b]	72.14±1.98[ab]	73.61±2.26[a]	73.86±0.88[a]	73.75±2.36[a]
Bone (%)	29.46±0.12[a]	27.86±1.98[ab]	26.40±2.26[b]	26.13±0.89[b]	26.24±2.37[b]
Meat:bone ratio	2.39±0.02[b]	2.61±0.27[ab]	2.81±0.36[a]	2.83±0.13[a]	2.84±0.34[a]
Thighs (kg)	0.152±0.003	0.178±0.010	0.175±0.005	0.184±0.011	0.192±0.014
Meat (%)	77.64±1.67	78.31±2.56	78.42±2.53	77.95±3.73	77.98±4.48
Bone (%)	22.36±1.67	21.68±2.55	21.58±2.53	22.05±3.73	22.02±4.47
Meat:bone ratio	3.49±0.36	3.66±0.57	3.68±0.54	3.63±0.77	3.69±0.96
Wings (kg)	0.096±0.003	0.109±0.003	0.112±0.006	0.117±0.003	0.124±0.009
Meat (%)	46.53±1.85	45.92±4.74	46.89±9.07	47.54±3.73	47.25±7.34
Bone (%)	53.47±1.84	54.08±4.74	53.11±9.07	52.47±3.73	52.75±7.33
Meat:bone ratio	0.87±0.07	0.86±0.15	0.92±0.31	0.91±0.13	0.92±0.26
Back (kg)	0.158±0.003	0.176±0.009	0.183±0.010	0.190±0.005	0.198±0.005
Meat (%)	23.84±3.04	23.28±5.58	24.80±2.96	24.39±2.88	22.99±3.79
Bone (%)	76.16±3.04	76.72±5.57	75.20±2.95	75.61±2.88	77.00±3.79
Meat:bone ratio	0.32±0.11	0.33±0.19	0.33±0.10	0.33±0.10	0.31±0.14

[a,b]Least squares means within a row with different lowercase superscripts differ (P<0.05).

Table 4: Meat quality of Pegagan ducks after supplementing with LAB solutions isolated from ensiled Kumpai Tembaga

Item	Concentration of LAB solutions (CFU/ml)				
	Group 1 (Control)	Group 2 (10^6)	Group 3 (10^7)	Group 4 (10^8)	Group 5 (10^9)
pH	6.29±0.38	6.34±0.33	6.04±0.07	6.35±0.47	6.01±0.11
SF (N)	59.75±4.93[a]	31.30±2.83[b]	31.00±4.82[b]	30.60±4.74[b]	31.25±5.70[b]
WHC (%)	55.16±1.45	54.55±1.44	57.61±1.93	59.35±1.42	58.67±2.60
CL (%)	41.12±1.21	41.14±1.72	42.88±1.38	42.56±1.24	42.89±1.17
MC (%)	77.58±0.70	77.13±1.29	77.49±2.03	78.01±0.92	77.20±0.51
FFA (%)	0.81±0.02[a]	0.80±0.02[a]	0.56±0.01[b]	0.54±0.02[b]	0.45±0.05[c]

[a,b,c]Least squares means within a row with different lowercase superscripts differ (P<0.05): SF=shear force, WHC=water holding capacity, CL=cooking loss, MC=moisture content, FFA=free fatty acids.

by 24 and 35.3%, respectively, after LAB supplementation compared to control. Furthermore, there was a significant effect (P<0.05) on the percentage of meat, bones, and the ratio of meat and bones in breast slices, while the same response was shown on the wings, thighs, and back slices after adding LAB compared to control. The percentage of breast meat increased (P<0.05) by 4.0%, but the bone percentage decreased (P<0.05) by 9.5% after LAB addition. The meat-to-bone ratio, irrespective of the LAB concentrations, also increased by 16.0% with LAB supplementation compared to control.

Effects on Meat Quality

The provision of LAB solutions significantly (P<0.05) affected the SF and FFA content in duck meat, while no significant influence was detected on pH, WHC, CL, and MC (Table 4). Irrespective of the LAB concentrations, the meat shear force with LAB supplementation was lower (P<0.05) than control, with a decrease of 48.05%. Furthermore, there was a 31.68% decrease in FFA content after LAB supplementation with a concentration of 10^7 and 10^8 CFU/ml, and it continued decreasing by 44.10% (P<0.05) when LAB was added with a concentration of 10^9 CFU/ml compared to the control and a LAB concentration of 10^6 CFU/ml.

DISCUSSION

The LAB administration during the first 2 weeks did not significantly affect the growth performance. This is also supported by another study that the effect of administering LAB strains on broilers performance during the finisher and growth period was greater than that of during the starter period (Kalavathy et al. 2003; Peng et al. 2016). It is assumed that the LAB, especially *Lactobacillus* genera, have not developed properly in the duck's alimentary tract during the early weeks of life. Some studies reported that the development of *Lactobacillus* in the small intestine of chickens, including duodenum, jejunum, and ileum, started to increase and became dominant after 2 weeks of age (Rehman et al. 2007). The provision of LAB with concentrations ranging from 10^8 to 10^9 CFU/ml seemed to be the optimal dosage to promote growth performance after the third week, both for increasing BWG and improving FCR. This is in line with a study conducted by Forte et al. (2018) that the use of *Lactobacillus* with a concentration of 1×10^9 CFU/kg of feed is highly recommended to improve the growth performance of chickens. The lower feed conversion also occurred in broiler chickens supplemented with two LAB strains with concentration of 6-7 x 10^{10} CFU/kg diet, indicating that the efficiency of using feed was higher than treatment without LAB (Fajardo et al. 2012). The increase in BWG in this study indicated that the absorption of nutrients in the gastrointestinal tract after LAB supplementation is greater, therefore the process of forming tissue protein for body growth is becoming optimal. The ability to absorb feed nutrients is largely determined by the histomorphological indicators of the small intestine, especially the size of the villus, where the increase the villus height will enlarge the surface area of the small intestine, so that the ability to absorb the available nutrients in the intestinal lumen is greater (Chichlowski et

al. 2007). Some investigations demonstrated that the height of jejunal and ileal villi in chicken was increasing after supplementation with *Lactobacillus* group (Forte et al. 2018; Wang et al. 2019). Our previous observation also revealed that there was an increase in the weight and length of the small intestine after LAB supplementation (Yosi et al. 2020). This might be related to the increase in the surface area of the small intestine due to the higher villus height.

The higher carcass weight and breast yield observed in the LAB supplemented groups is attributed to higher BWG in the ducks of these groups. These carcass improvements could be due to their ability to enhance the bioavailability of nutrients and increase digestive enzymes thereby promoting the growth of muscle tissues (Aguihe et al. 2017). Improvements in carcass and breast yield were also noted in broiler chicken after supplementing probiotic LAB (Salehizadeh et al. 2019). However, a study performed by Wang and Zhou (2007) showed that no effect was found on the whole carcass and breast weight of 7-week-old meat ducks after supplementation with LAB strains in the diet. The variations of bacterial strain used in some studies could be a determining factor that causes differences in the results obtained (Otutumi et al. 2012; Cruz et al. 2019). Not only increasing the proportion of meat, but bone weight also increased after LAB supplementation. This might be attributed to higher calcium absorption in the gut lumen and assimilation in the bone, which created a greater proportion of bone. However, there is no well-established link between LAB and bone mineralization so far. Therefore, further investigations are needed to identify the specific mechanism of LAB on bone development in ducks and the LAB action mode on bone mineralization. A study investigated by Panda et al. (2006) reported that dietary supplementation of *Lactobacillus* strain resulted in higher serum concentration of Ca and improved bone breaking strength and bone ash content. Another experiment by Ziarat et al. (2020) using dietary LAB supplementation also confirmed that the use of *Lactobacillus* strains increased the length of the tibia bone and improved bone calcium and phosphorus contents. Nevertheless, the ratio of meat to the bone in the supplemented group was higher than that in the control group, indicating that meat formation still dominates over bone, and this is certainly to be expected in meat duck production.

Shear force is one indicator that can be used to determine the tenderness of the meat, where the lower value of shear force, the higher the tenderness of meat (Barbanti and Pasquini 2005). The decreasing of shear force in this study indicated an improvement in intramuscular quality after LAB supplementation. Another study also showed a decrease in the shear-force of 42-day-old broiler meat after administration of *Lactobacillus* strain in the diet, with a lower value than the results of this study, which was 29.6-42.9N (Wang et al. 2019). Moreover, FFA is one of the most common chemical parameters used to determine the quality of a product (Ozkececi et al. 2008). The increase in the FFA value in meat muscles is primary caused by lipolysis, which is then suspected to promote the spoilage in foodstuff (Soyer et al. 2010; Yousefi et al. 2018). The decrease in FFA after LAB supplementation indicated the administration of LAB could inhibit the lipolysis of meat. The lower fat content in breast meat after LAB supplementation in this study probably was the main reason for the low FFAs production in meat samples compared to the control treatment.

Conclusion

It was concluded that the oral LAB supplementation with a concentration of $1x10^9$ CFU/ml produces optimal growth performance after 2 weeks of LAB administration. The administration of LAB is able to improve carcass yields, which has a greater impact on the breast slices. The meat texture becomes more tender with a lower free fatty acid content.

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Author's Contribution

FY, NG, and SS conceptualized and designed the experiment. FY and MLS conducted an *in vivo* experiment and collected all samples. FY, ES and SS analyzed the data statistically. FY prepared the first manuscript. All authors corrected and approved the final revision of manuscript.

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