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Penulis : Rizki Palupi, Fitri Nova Liya Lubis, A. Suryani, T.C. Bella, D. Nurrachma

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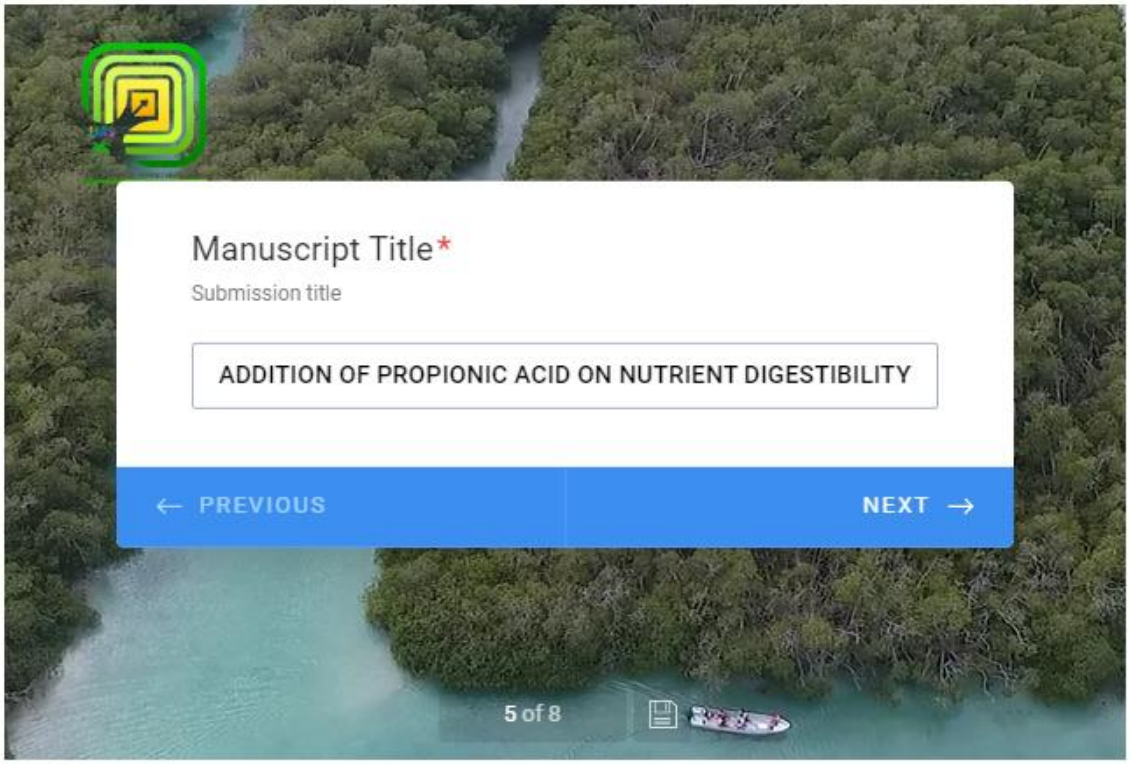

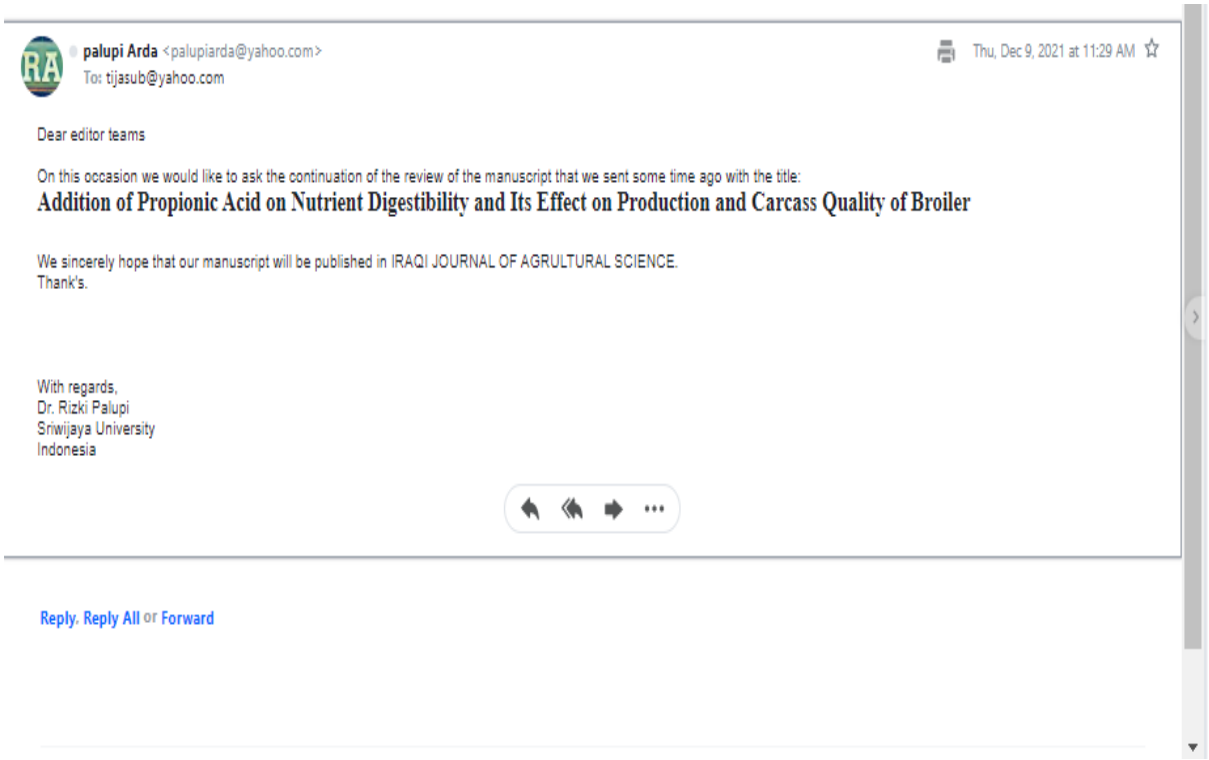

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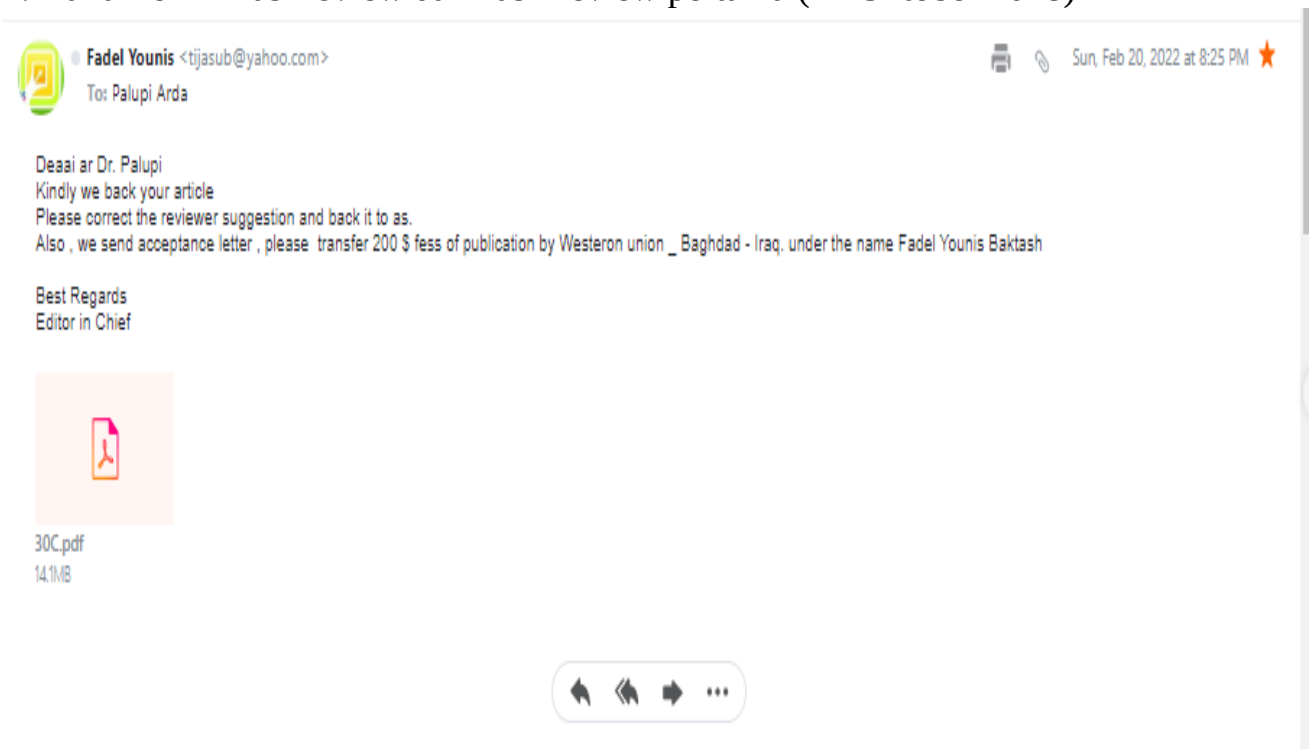

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Addition of Propionic Acid on Nutrient Digestibility and Its Effect on Production and Carcass Quality of Broiler

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الكلمات المفتاحية: دجاج التسمين ، قابلية الهضم ، حمض البروبيونيك ، الأداء ، جودة الذبيحة.

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INTRODUCTION

The growth of broiler chickens can take place well if given feed that suits their needs, both in terms of quality and quantity, to support maximum production. The digestive tract's pH conditions that are not optimal can lead to the development of pathogenic bacteria (1). The results of a review conducted by (2) reported that the ph value of broiler chickens is strongly influenced by nutritional content, physical content, and the amount of feed consumed. However, One of many factors that causes a decrease in the digestive tract's pH value is feed fermentation. For example, The results of research that has been carried out on fermented feed using the lactobacillus type of bacteria reveal that this type of bacteria can act as a feed probiotic by reducing the pH value, which in turn results in a decrease in pathogenic bacteria in the digestive tract (3–6). Pathogenic bacteria often found in the digestive tract of poultry include Escherichia coli and Salmonella. These bacteria enter through feed and drinking water consumed by livestock, which can cause health problems in livestock and disrupt the absorption of food substances, resulting in a decrease in performance that affects the carcass quality produced at the end of broiler maintenance chickens.

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Generally, farmers add Antibiotic Growth Promoter (AGP) to overcome pathogenic bacteria's growth to increase the absorption of food substances. However, AGP's addition can leave antibiotic residues in the chicken meat produced, which will endanger the health of consumers who consume the meat. Food consumers must pay attention to food safety from the presence of contaminants and residues that are harmful to consumers, specific bacterial resistance, and environmental issues (7,8). Efforts can be made to avoid AGP's use with the addition of a specific feed additive that can replace the AGP function. One of the additives feeds that can be used in organic acids play an essential role in optimizing the digestive tract's pH. (9–11) in their report stated that organic acid supplementation in feed could inhibit the work of pathogenic bacteria and have a beneficial effect on the performance of poultry.

Ref.

One of the organic acids that can be used is propionic acid. When given to livestock, propionic acid does not cause residues in meat or carcasses produced, so it is safe to use as additive feeds in livestock. (12) report that organic acids can be used as suitable alternative additive feeds to replace antibiotics. The addition of organic acids can reduce the pH digestive tract of poultry and inhibit the bacteria like Escherichia coli and Salmonella, which cause the absorption of food substances in the intestine can run well and make livestock growth becomes stable. The resulting performance is good and produces good carcass quality and abdominal fat content low. The difference in protein content and acetic acid in the ration makes the pH of the duodenum is 4.17 - 5.68, the pH of the jejunum is 5-6, and the pH of the ileum is 5.83 - 6 (13). One of the organic acids is propionic acid. This study aims to find feed additives that can increase the production and carcass quality of broiler chicken. The study hypothesizes that propionic acid in the diets can increase the production and carcass quality of broiler chicken.

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MATERIAIS AND METHODS

~~Study Site~~ Experimental birds and design

An animal feeding experiment was conducted at the experimental station, Department of Animal Science, Faculty of Agriculture, Universitas Sriwijaya. The ducks were cared for according to the Animal Welfare Guidelines of the Indonesian Institute of Sciences. The approval of the experiment was granted from Universitas Sriwijaya.

birds

Birds, Diets, Housing, and Experimental Design

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effect (P<0.05) on the pH of the duodenum and the pH of the jejunum, but had no significant effect (P>0.05) on the pH of the ileum. This is because propionic acid has acidic properties; so that when it enters the digestive tract of broilers; it was caused the release of hydrogen atoms on digestive tract and cloud impact on the decrease of pH value. The supplementation of organic acids had showed could reduce the pH of the digestive tract and the microbial activity on the stomach and small intestine (17–19). The decrease in pH in each part of the small intestine will affect the condition of the small intestine, where pathogenic bacteria found in the small intestine cannot stand the lower pH conditions. Dittoe et al. (20) reported that the pH of the digestive tract is a microbial condition in the digestive tract of poultry that will have an impact on poultry health.

Table 2. The effect treatment on pH, ration consumption, weight gain and conversion of broiler chickens.

pH on small Intestine	Treatment T0	Treatment T1	Treatment T2
Duodenum	5.86[a]	5.04[b]	5.02[b]
Jejunum	6.00[a]	5.78[b]	5.66[b]
Ileum	6.98[a]	6.22[b]	6.38[b]
Growing Performance	**T0**	**T1**	**T2**
Consumption (g/head/day)	73,94[a]±0,97	75,64[b]±0,87	75,87[b]±0.64
Wight gain (g/head/day)	51,37[a]±2,49	55,22[b]±1,80	56,18[b]±2,64
Conversion	1,44[a]±0,05	1,37[b]±0,04	1,35[b]±0,05

Note: Different superscripts in the same column show significantly different influences (P<0.05). P0 (without the addition of propionic acid), P1 (addition of 0.5% propionic acid), P2 (addition of propionic acid 0.75%).

The addition of 0.5% propionic acid did not differ (P>0.05) with the addition of 0.75% propionic acid in the diet on the pH of the duodenum and the jejunum of broiler chickens. This is due to the optimum concentration of 0.5% addition of propionic acid, so that the increase in concentration level to 0.75% is not significantly different from the 0.5% level. In line with the research results of Ndelekwute et al. (21) that the use of several organic acids, namely citric acid, butyric acid, acetic acid and formic acid at a level of 0.25% acid in drinking water can lower the pH of the small intestine of broiler chickens.

The Observation Data for each of these broiler chicken performance parameters based on average rations consumption, weight gain, and conversion of broiler chicken rations could be seen in Table 2. Consumption of broiler chicken rations during the study ranged from 73.94 to 75.87 g/head/day. The variance analysis results showed that the addition of propionic acid in the ration had a significant effect (P<0.05) on the consumption of broiler chicken rations. It was caused by the addition of propionic acid in the ration to improve the broiler chicken digestive tract's performance by optimizing the pH of the digestive tract. The pH of the broiler small intestine after propionic acid addition was 5.5-5.8. Changes in pH result in pathogenic bacteria's death because pathogenic bacteria cannot resist the acidic conditions. (22) and (23), reported that citric acid could reduce the digestive tract's pH (crop, ventriculus, and intestine), suppress the growth of pathogenic bacteria, and increases lactic acid bacteria, contributing to the digestive process the use of protein becomes good. Lysis of pathogenic bacteria will increase the absorption of nutrients that will be used to form muscle tissue. The increase in the feed flow rate in the digestive tract so that the stomach quickly empty and causes increased ration consumption. Following (2), organic acids can increase the feed flow rate so that gastric emptying is faster and consumption increases.

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The addition of 0.5% propionic acid was not significantly different ($P>0.05$) with 0.75% propionic acid to ration consumption. Due to the addition of propionic acid at a dose of 0.5% and 0.75% in the ration giving effect the same to the digestive tract, the digestive enzyme activity is the same in the treatment. Enzyme activity will affect the feed rate in feed consumed by livestock. It can be absorbed entirely along with the rapid digestion rate, which caused the digestive tract to empty quickly. Broilers chicken continues to consume rations to meet energy needs so that the consumption of rations increases. (24) and (25) reported an increase in the digestive tract's productivity, which functions favorably for bacterial growth by decreasing acidity in the digestive tract and can activate and stimulate the production of endogenous enzymes and can increase ration consumption. Moreover, (11) reported that adding of the mixture of organic acids could increase broiler chicken rations' consumption.

Average Chicken body weight gain during the study ranged from 51.37 to 56.18 g/head/day. The variance analysis results showed that the addition of propionic acid in the ration had a significant effect ($P<0.05$) on the body weight gain of broiler chickens. Because the addition of propionic acid in the ration can reduce the pH of the digestive tract, consequently can inhibit the work of pathogenic bacteria that cannot stand the acidic conditions, so there is no competition in the absorption of nutrients in the digestive tract. The optimal absorption of food substances can increase the bodyweight of broiler chickens. According to (26), organic acid acts as a growth promoter or growth booster capable of suppressing the growth of acid intolerant bacteria such as Escherichia Coli, Salmonella spp, and Clostridium perfringens.

Further tests showed that the addition of 0.5% propionic acid and 0.75% addition of propionic acid were significantly different ($P<0.05$) from the control. The smallest average body weight gain at T0 is 51.37 g/head/day because the ration consumed without the addition of propionic acid is as low as 73.94 g /head /day. In contrast, propionic acid can optimize the pH of the digestive tract so that feed consumed by livestock is converted into muscle tissue. There is an increase in body weight in broiler chickens. (23) states that the administration of organic acids can maintain the balance of microbes in the digestive tract by maintaining the digestive tract's pH and being able to increase protein absorption. According to these results, organic acids such as propionic acid can optimize pH in the digestive tract, increase the pepsin enzyme activity, and increase the digestibility of nitrogen, phosphorus, and minerals that good weight gain occurs (9).

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The ~~treatment of the addition~~ of 0.5% propionic acid was not significantly different (P>0.05) by adding 0.75% ~~propionic acid to the~~ body weight gain of broiler chickens. ~~Because~~ the addition of propionic acid at 0.5% and 0.75% has the same ability to optimize the digestive tract's pH, the digestion process of nutrients goes well. It increases the body weight gain of broiler chickens. The addition of propionic acid at 0.5% and 0.75% can increase body weight gain by build muscle tissue in broiler chickens. The digestive tract's optimal pH can secrete pancreatic enzyme activity amino acids derived from feed can be digested and absorbed by the intestine. (27) stated The addition of organic acids can increase pancreatic enzyme activity to optimize digestion and absorption of amino acids derived from feed for muscle tissue formation. Furthermore, (28) stated that the addition of organic acids could reduce the digestive tract's pH, increasing pepsin enzyme activity resulting in increased body weight. Pepsin enzymes function to break down protein into amino acids and be absorbed by the body so that forming muscle tissue becomes profitable, increasing the body weight gain of broiler chickens. In line with the research results, (18) stated that the administration of 0.5% citric acid showed the best results of body weight and final body weight. (29) the addition of 0.75% acetic acid in the ration resulted in better body weight gain than controls.

Based on the ~~amount of ration~~ consumption and body weight gain produced during the study, broiler chicken ration's average conversion ranged from 1.35 - 1.44. The variance analysis results showed that the addition of propionic acid ~~in the ration~~ had a significant effect (P<0.05) on the conversion ~~of broiler chicken rations~~. The average conversion in T2 treatment with the addition of 0.75% propionic acid is the lowest conversion rate. The low conversion rate of rations is caused by feed consumed by livestock digested and absorbed entirely to form muscle tissue, increasing body weight gain. The addition of propionic acid causes acidic conditions in the digestive tract of broiler chickens that will support digestive enzymes' activity. Changes in the digestive tract's acidity can cause growth disorders in pathogenic bacteria to reduce pathogenic bacteria in the digestive tract of broiler chickens. (22) reported that citric acid can reduce the digestive tract's pH (crop, ventriculus and intestine), suppress pathogenic bacteria's growth, and increase lactic acid bacteria that contribute to the digestive process so that the use of protein becomes optimal.

Based on further testing, the treatment of T0 was significantly different (P <0.05) to T1 (addition of 0.5% propionic acid) and T2 (addition of 0.75% propionic acid). The addition of propionic acid in the ration could reduce the conversion value of feed because the feed consumed by broiler chickens results in higher weight gain than broiler chickens given rations without the addition of propionic acid. The addition of propionic acid can increase the efficient use of feed. ~~They were following~~ (30), ~~which is~~ reported that giving 0.25% citric acid and 0.25% butyric acid positively affects feed efficiency. Treatment without ~~the addition of~~ propionic acid ~~in the ration~~ produces a higher conversion rate, thereby reducing feed use efficiency.

T1 ~~treatment~~ was not significantly different (P>0.05) with T2 ~~on broiler chicken rations'~~ conversion. The addition of 0.5% and 0.75% propionic acid has relatively small propionic acid addition intervals, so the treatment effect of 0.5% and 0.75% is not significantly different from the ration conversion. In line with ~~the results of Vale et al.'s (2004)~~ research, the addition of 70% formic acid and 30% propionic acid at a rate of 0.2 to 25% in the ration can improve the value of broiler chicken conversion. According to (18) addition of 0.5% citric acid can improve ration conversion. (31) state that the appropriate level of propionic acid ~~use~~ is 0.2 to 0.4% in the ration to improve broiler chicken's feed conversion value.

Effect of ~~Treatment~~ on Crude Protein Digestibility

The average digestibility value of crude protein and ~~crude~~ fiber in broiler chickens can be seen in Table 3. The variance results showed that propionic acid's ~~use~~ had a significant effect (P<0.05) on the digestibility of crude protein in broiler chickens. The addition of propionic acid causes this can cause a decrease in pH in the

Effect of Treatment on Crude Fiber Digestibility

The variance results showed that the treatment had a significant effect on crude fiber digestibility ($P<0.05$). Due to a decrease in the digestive tract's pH value, which caused increases in some polysaccharides' chemical hydrolysis and reduced the level of crude fiber. The research stated that organic acids could reduce the digestive tract's pH in the duodenum, jejunum, ileum, and caecum (23). The lower pH will cause the digesta rate to slow down so that the time spent digesting crude fiber will also be longer (2).

Based on the results of further tests showing that each treatment was significantly different. T1 and T2 treatments were significantly different ($P<0.05$) higher with T0. It was caused by a decrease in the digestive tract's pH, which is thought to increase the lactic acid bacteria population. The average population of Lactobacillus sp. in the small intestine of broiler chickens without the administration of propionic acid is 1.2x104 CFU/g, whereas in the treatment of addition of propionic acid an increase in the population of Lactobacillus sp. namely at P1 3.7x106 CFU/g and P2 4.4x106 CFU/g. (35) stated that an increase in lactic acid bacteria produced lactic acid and Short Chain Fatty Acid production. The increase in SCFA and lactic acid accompanied by decreased pH of the digesta will further reduce pH in the cecum. The research by (36) reported the addition of lime acid extract at the level of 3 ml had a very significant effect on pH and the total increase in lactic acid bacteria in the digestive tract. The pH that is suitable for the growth of lactic acid bacteria (LAB) in broiler chicken cecum is 6.09 (23) and 6.20 (37).

The addition of propionic acid in the ration on treatments T1 and T2 was significantly different ($P<0.05$) on the digestibility of crude fiber in broiler chickens. It was thought to be caused by an increase in the higher lactic acid bacteria population in T2. Lactic acid bacteria and other non-pathogenic bacteria that produce organic acids, especially lactic acid, can reduce pH in the cecum (23). On other hands, (35) added that the increasing population of lactic acid bacteria in the caecum would help break down carbohydrates, which can then be fermented by cellulolytic bacteria. Related to this results, (38) reported that the population of cellulolytic bacteria in the digestive tract of poultry was 63x107 cfu/g, where the bacteria could degrade crude fiber. The decrease in crude fiber levels is due to higher cellulose and hemicellulose enzyme activity during the fermentation process (39,40). Decreasing pH will increase the speed of chemical hydrolysis of some polysaccharides, which will reduce crude fiber levels. (41) stated the entering of organic acids on the proventriculus would weaken the crude fiber component to be more easily digested by microorganisms enzymatic.

Effect of Treatment on the Quality of Broiler Chicken Carcasses

The carcass quality was determined based on the resulting live weight, carcass percentage, and abdominal fat percentage, as shown in Table 4. The average live weight of broiler chickens obtained in this study ranged from 1315 - 1619 grams. The variance analysis results showed that the addition of propionic acid in broiler chicken ration had a significant effect ($P<0.05$) on the live weight of broiler chickens. Because propionic acid's addition has a significant effect on ration consumption, the higher the increase of propionic acid concentration in the ration, the higher the increase of the ration consumption. The increase in ration consumption reflects an increase in the consumption of food substances. (42) reports that consumption of rations reflects the entry of several nutrients into the body of broiler chickens.

Further tests showed that broiler chickens' live weight added 0.5% propionic acid and 0.75% propionic acid were significantly different ($P<0.05$) from controls. Because propionic acid optimizes the digestive tract's pH by the digestive tract's acidity, which is 5.5-5.8, especially in the small intestine. According to (23) organic acids such as acetate, propionate, and butyrate can reduce toxin production by bacteria, improve the intestinal wall's morphology, and reduce the colonization of pathogenic bacteria. Optimal digestion of food substances will increase weight gain, which can be seen in the increase in broiler chickens' live weight. The addition of organic acids can increase broiler chicken weight (27,43).

The addition of 0.5% propionic acid was not significantly different ~~(P>0.05)~~ with the addition of 0.75% propionic acid to broiler chickens' live weight. Because at the level of 0.5%, the addition of propionic acid in the ration can provide optimal acid conditions in the digestive tract of broiler chickens to increase body weight. Following the opinion of (18) that the administration of organic acid in the form of 0.5% citric acid in the ration produced the best final body weight compared to acetic acid.

The addition of propionic acid increases the body weight of broiler chicken produced. The higher the increase of body weight produced, the higher the percentage of broiler chicken carcasses. The average percentage of broiler chicken carcass obtained in this research ranged from 69.84 to 73.40%. The variance analysis results showed that the addition of propionic acid ~~in the ration~~ during the research had a significant effect (P<0.05) on the percentage of broiler chicken carcasses due to the percentage of carcass influenced by the resulting live weight. This ~~research's~~ live weight is getting higher by increasing the addition of propionic acid ~~in the ration~~. (9); (5); and (24) states that the achievement of bodyweight components is closely related to carcass weight. The higher the live weight produced, the higher the percentage at the end of the research (~~44~~).

The results of further tests showed that the percentage of the carcass of broiler chicken, which was added by ~~propionic acid~~ 0.5% and 0.75% was significantly different (P<0.05) with T0 (~~control~~). Presumably, propionic acid acts as an acidifier that can optimize the digestive tract's pH to improve the work of digestive enzymes and increase absorption of food substances, especially proteins that function as substances forming body tissues. In line with the study results by (45), the addition of organic acids can maintain the balance of microbes in the digestive tract by maintaining the digestive tract's pH so that protein absorption increases.

The addition of 0.5% propionic acid was not significantly different ~~(P> 0.05)~~ with the addition of 0.75% propionic acid to the percentage of broiler chicken carcasses. It optimized the digestive tract's pH to increase the absorption of nutrients, which affects the percentage of a carcass. In line with the opinion of (32) reported that administering organic acids such as citric acid to the level of 1.2% in single step down feeds could increase carcass weight.

The increase in the carcass percentage was inversely proportional to the percentage of abdominal fat in broiler chickens. The average percentage of abdominal fat produced in each treatment ranged from 1.22-1.92%. The variance analysis results showed that the addition of propionic acid ~~in the ration~~ had a significant effect (P<0.05) on the percentage of abdominal fat in broiler chickens. The addition of propionic acid can cause a decrease in the digestive tract's pH so that it activates the work of the pepsinogen enzyme. This ~~study's~~ percentage of abdominal fat is lower than that stated by (46), who reported the average percentage of abdominal fat in broiler chicken ranges from 2.24 to 3.90%.

In contrast, the lipase enzyme can work actively at pH 6.8 to reduce the activity of lipase enzymes in digesting fat. (24,25)stated the digestion of fat in the intestine includes the breakdown of dietary fat into fatty acids, monoglycerides, and others through, which is cooperation between bile salts and intestinal lipases occurring in environments with high pH due to the presence of bicarbonate secretion. In line with the opinion of (44) the lipase enzyme can work optimally at pH 7.

Further tests showed that the percentage of abdominal fat added with 0.5% ~~propionic acid~~ and 0.75% propionic acid was significantly different (P<0.05) from controls. The percentage of broiler chicken abdominal fat with the addition of propionic acid in feed has a lower percentage of abdominal fat than broiler chickens without propionic acid in the ration (control). Because propionic acid can increase digestive enzymes' work and increase absorption of nutrients such as carbohydrates, proteins, and fats run optimally for the formation of body tissues. Fulfill their basic life so that abdominal fat formation decreases nutrients mainly used for body tissue formation. The addition of organic acids in broiler chicken feed can increase absorption by increasing the function of digestive enzymes to

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influence the increase in digestion and absorption, especially fiber and protein (47).

The addition of 0.5% propionic acid was not significantly different (P>0.05) with the addition of 0.75% propionic acid to the percentage of abdominal fat. It is assumed that the small intervals between treatments cause propionic acid at a dose of 0.5% and 0.75% to have the same activity in optimizing pH. The enzyme activity of the digestive tract is also the same as the pH conditions are not real. Hence, the percentage of abdominal fat produced not significantly different. (45). The addition of organic acids can maintain the balance of microbes in the digestive tract by maintaining the digestive tract's pH to improve the work of digestive enzymes properly. (48) Giving double step down feeding with the addition of 1.6% citric acid as an acidifier in the ration can increase carcass weight and reduce levels of abdominal fat.

CONCLUSION

Based on this study's results, it can be concluded that the addition of propionic acid in the ration at a dose of 0.5% can increase the digestibility of crude protein by 2.42% and crude fiber digestibility by 69.25%. Improve the production performance that increases weight gain by 7.49%, decrease feed conversion by 4.86%, and increase carcass percentage by 4.12% of broiler chicken.

CONFLICT OF INTERESTS

The authors report no conflict of interest.

AUTHORS' CONTRIBUTION

All authors contributed to the work, discussed the results and contributed to the final manuscript.

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Addition of Propionic Acid on Nutrient Digestibility and Its Effect on Production and Carcass Quality of Broiler

R. Palupi
Lecturer

F. N. L. Lubis
Lecturer

A. Suryani
Student

T. C. Bella
Student

D. Nurrachma
Student

Department of Technology and Livestock Industry, Faculty of Agricultural, Sriwijaya University, Indonesia
E-mail: palupiarda@yahoo.com

ABSTRACT

This study aimed to determine protein and crude fiber digestibility by adding propionic acid in rations and its effect on production and carcass quality broiler chicken. This research was carried out using 180-day old chicks (DOC) broiler chicken with Cobb strain. The research method used a completely randomized design (CRD) consisting of three treatments and six replications for every treatment. The treatment in this study consisted of: T0 = ration without propionic acid; T1 = addition of 0.5% propionic acid in the ration; T2 = 0.75% addition of propionic acid in the ration. Parameters observed included crude protein, crude fiber digestibility, feed consumption, body weight gain, feed conversion, live weight, carcass percentage, and percentage of abdominal fat in broiler chickens. The results showed that the addition of 0.5% propionic acid had a significant effect ($P<0.05$) on crude protein and crude fiber's digestibility in broiler chickens. Significantly increased feed consumption up to 2.29%; body weight gain up to 7.49 %, decreased feed conversion by 4.86%; increased body weight by 12.69%; carcass percentage by 4.12% and decreased 33% of abdominal fat broiler chicken. This research concludes that the addition of propionic acid in the ration at a dose of 0.5% can increase the digestibility of crude protein and crude fiber rations, can improve the production performance and carcass quality of broiler chickens.

Key words: Broiler Chicken, Digestibility, Propionic Acid, Performance, Carcass Quality.

سورياني العاني
طالب

F. N. L. Lubis
محاضر

Palupi خطر
محاضر

نوراكما إلهة
طالب

بيلا سيترا تيا
طالب

قسم التكنولوجيا وصناعة الثروة الحيوانية ، كلية الزراعة ، جامعة سريويجايا ، إندونيسيا

المستخلص

هدفت هذه الدراسة إلى تحديد قابلية هضم البروتين والألياف الخام بإضافة حمض البروبيونيك في العلائق وتأثيره على إنتاج وجودة دجاج التسمين .تم إجراء هذا البحث باستخدام كتاكيت التسمين (DOC) التي يبلغ عمرها 180 يومًا من سلالة كوب .استخدمت طريقة البحث تصميمًا عشوائيًا بالكامل (CRD) يتكون من ثلاث معالجات وستة مكررات لكل علاج.. يتكون العلاج في هذه الدراسة من T0 :حصص بدون حمض البروبيونيك T1 = 0.5 ٪ حمض بروبيونيك مضاف لكل حصة ؛ و T2 = 0.75 ٪ حمض بروبيونيك مضاف لكل وجبة .تضمنت المعايير التي تم رصدها البروتين الخام ، وهضم الألياف الخام ، واستهلاك العلف ، وزيادة وزن الجسم ، وتحويل العلف ، والوزن الحي ، ونسبة الذبيحة ، ونسبة دهون البطن في دجاج التسمين .أظهرت النتائج أن إضافة0.5 ٪ حمض البروبيونيك كان له تأثير معنوي ($P <0.05$) على هضم البروتين الخام والألياف الخام في دجاج التسمين .زيادة كبيرة في استهلاك الأعلاف تصل إلى2.29 ٪ ؛ زيادة وزن الجسم بنسبة تصل إلى7.49 ٪ ، وانخفاض تحويل الأعلاف بنسبة4.86 ٪ ؛ زيادة وزن الجسم بنسبة12.69 ٪ .نسبة الذبيحة4.12 ٪ وانخفضت33 ٪ من دهن الفروج البطني .يخلص هذا البحث إلى أن إضافة حمض البروبيونيك في الحصة الغذائية بجرعة

0.5 يمكن أن يزيد من قابلية هضم البروتين الخام وحصص الألياف الخام ، ويمكن أن يحسن أداء الإنتاج وجودة الذبيحة لدجاج التسمين.

الكلمات المفتاحية: دجاج التسمين ، قابلية الهضم ، حمض البروبيونيك ، الأداء ، جودة الذبيحة.

INTRODUCTION

The growth of broiler chickens can take place well if given feed that suits their needs, both in terms of quality and quantity, to support maximum production. The digestive tract's pH conditions that are not optimal can lead to the development of pathogenic bacteria (1). The results of a review conducted by (2) reported that the ph value of broiler chickens is strongly influenced by nutritional content, physical content, and the amount of feed consumed. However, One of many factors that causes a decrease in the digestive tract's pH value is feed fermentation. For example, The results of research that has been carried out on fermented feed using the lactobacillus type of bacteria reveal that this type of bacteria can act as a feed probiotic by reducing the pH value, which in turn results in a decrease in pathogenic bacteria in the digestive tract (3–6). Pathogenic bacteria often found in the digestive tract of poultry include Escherichia coli and Salmonella. These bacteria enter through feed and drinking water consumed by livestock, which can cause health problems in livestock and disrupt the absorption of food substances, resulting in a decrease in performance that affects the carcass quality produced at the end of broiler maintenance chickens.

Generally, farmers add Antibiotic Growth Promoter (AGP) to overcome pathogenic bacteria's growth to increase the absorption of food substances. However, AGP's addition can leave antibiotic residues in the chicken meat produced, which will endanger the health of consumers who consume the meat. Food consumers must pay attention to food safety from the presence of contaminants and residues that are harmful to consumers, specific bacterial resistance, and environmental issues (7,8). Efforts can be made to avoid AGP's use with the addition of a specific feed additive that can replace the AGP function. One of the additives feeds that can be used in organic acids play an essential role in optimizing the digestive tract's pH. (9–11) in their report stated that organic acid supplementation in feed could inhibit the work of pathogenic bacteria and have a beneficial effect on the performance of poultry.

One of the organic acids that can be used is propionic acid. When given to livestock, propionic acid does not cause residues in meat or carcasses produced, so it is safe to use as additive feeds in livestock. (12) report that organic acids can be used as suitable alternative additive feeds to replace antibiotics. The addition of organic acids can reduce the pH digestive tract of poultry and inhibit the bacteria like Escherichia coli and Salmonella, which cause the absorption of food substances in the intestine can run well and make livestock growth becomes stable. The resulting performance is good and produces good carcass quality and abdominal fat content low. The difference in protein content and acetic acid in the ration makes the pH of the duodenum is 4.17 - 5.68, the pH of the jejunum is 5-6, and the pH of the ileum is 5.83 - 6 (13). One of the organic acids is propionic acid. This study aims to find feed additives that can increase the production and carcass quality of broiler chicken. The study hypothesizes that propionic acid in the diets can increase the production and carcass quality of broiler chicken.

MATERIAIS AND METHODS

Study Site

An animal feeding experiment was conducted at the experimental station, Department of Animal Science, Faculty of Agriculture, Universitas Sriwijaya. The ducks were cared for according to the Animal Welfare Guidelines of the Indonesian Institute of Sciences. The approval of the experiment was granted from Universitas Sriwijaya.

Birds, Diets, Housing, and Experimental Design

This research used 180-day old chick (DOC) broiler chicken of Cobb strain with unsexing. The DOC weight used ranged from 53 to 56 g. The DOC was placed in the postal cage. The cage used is a postal cage with a 60cm x 50cm x 60cm size. Broiler chickens are carried out for 28 days. The Broiler chickens were divided into three treatments with various percentages of propionic acid usage in the diets.

The ratio given is HI-Pro type commercial feed given at the age of one to 21 days (starter phase - grower phase) and produced by PT. Charoen Pokphan Indonesia Tbk, MRI-P ration given at the age of 22 to 28 days (finisher phase) produced by PT. Cj Cheiljedang Feed Lampung and Propionic Acid (Zetox) produced by PT. Healthy Bright Indonesia.

Table1. The composition of nutrient rations during the study

Food substances	HI-PRO*	MR1-P**
Water content (Max) (%)	13.0	13.0
Protein (%)	22.0 – 23.0	21.5 – 23.0
Crude Fiber (Max) (%)	5.0	4.0
Fat (Min) (%)	5.0	8.0
Ash (Max) (%)	7.0	6.5
Calcium	0.9	0.9 – 1.2
Phosfor	0.6	0.7 - 1.0
Metabolism Energy (kcal/kg)	3020 - 3120	3000 – 3100

Note : HI-Pro (PT. Charoen Pokphan Indonesia Tbk), **MR1-P (PT. Cj. Cheiljedang Feed Lampung).

The research design used was a Completely Randomized Design (CRD) consisting of 3 treatments and six replications. The DOC was placed into the experimental cages, each unit of the cage was occupied by ten heads each. The treatments used are as follows: T0 (without the addition of propionic acid in the diet), T1 (addition of 0.5% propionic acid), and T2 (addition of propionic acid 0.75%). The propionic acid given comes from commercial propionic acid in the form of flour. Propionic acid is mixed in the ration according to each treatment and stirred evenly until homogeneous. The adaptation of the treatment ration was carried out gradually within four days. According to treatment, chickens were fed treatment rations with a concentration of 25% on the first day, 50% on the second day, then 75% on the third day and 100% on the fourth day.

Growing Performance and pH Measurement of Gizzard

Broiler chicken performance, which includes measurement of parameters: Feed consumption (g/head/day), weight gain (g/head/day), and feed conversion ratio were calculated from the difference between the final body weight and the initial bodyweight of the study (14). Value of pH measurements was carried out on the duodenum, jejunum, and ileum. Simultaneously using a digital pH meter (Extech EC500 Waterproof ExStik II PH Meter), lactic acid bacteria was measured based on the population of Lactobacillus sp. in the small intestine of chicken aged four weeks (CFU/g).

Digestibility and Carcass quality

Measurements Digestibility/Digestion of crude protein (%) and crude fiber (%).were calculated using the formula (15). Furthermore, Carcass quality measurement, which includes measurement of parameters: Live weight (g), calculated based on the difference between the results of weighing the chicken before being cut and after fasting for 6 hours. The percentage of the carcass (%) is calculated as the percentage of the ratio between the carcass weight (g) and the life weight (g), and percentage of abdominal fat, calculated based on the percentage of the comparison between the weight of abdominal fat (g) and the weight of life (g).

Data Analysis

The SAS statistical package (PROC GLM) was used to determine the significance of differences between treatments (SAS, 2013). Data obtained during this study were analyzed according to a Completely Randomized Design (CRD). If there are significant differences, further tests will be carried out using the Duncan Multiple Range Test (16).

RESUITS AND DISCUSSION

Effect of Treatment on pH of small intestine and growth Performance

Based on the analysis of variance, the addition of propionic acid in the diet had a significant

effect (P<0.05) on the pH of the duodenum and the pH of the jejunum, but had no significant effect (P>0.05) on the pH of the ileum. This is because propionic acid has acidic properties; so that when it enters the digestive tract of broilers; it was caused the release of hydrogen atoms on digestive tract and cloud impact on the decrease of pH value. The supplementation of organic acids had showed could reduce the pH of the digestive tract and the microbial activity on the stomach and small intestine (17–19). The decrease in pH in each part of the small intestine will affect the condition of the small intestine, where pathogenic bacteria found in the small intestine cannot stand the lower pH conditions. Dittoe et al. (20) reported that the pH of the digestive tract is a microbial condition in the digestive tract of poultry that will have an impact on poultry health.

Table 2. The effect treatment on pH, ration consumption, weight gain and conversion of broiler chickens.

pH on small Intestine	Treatment		
	T0	T1	T2
Duodenum	5.86[a]	5.04[b]	5.02[b]
Jejunum	6.00[a]	5.78[b]	5.66[b]
Ileum	6.98[a]	6.22[b]	6.38[b]
Growing Performance	**Treatment**		
	T0	T1	T2
Consumption (g/head/day)	73,94[a]±0,97	75,64[b]±0,87	75,87[b]±0.64
Wight gain (g/head/day)	51,37[a]±2,49	55,22[b]±1,80	56,18[b]±2,64
Conversion	1,44[a]±0,05	1,37[b]±0,04	1,35[b]±0,05

Note: Different superscripts in the same column show significantly different influences (P<0.05). P0 (without the addition of propionic acid), P1 (addition of 0.5% propionic acid), P2 (addition of propionic acid 0.75%).

The addition of 0.5% propionic acid did not differ (P>0.05) with the addition of 0.75% propionic acid in the diet on the pH of the duodenum and the jejunum of broiler chickens. This is due to the optimum concentration of 0.5% addition of propionic acid, so that the increase in concentration level to 0.75% is not significantly different from the 0.5% level. In line with the research results of Ndelekwute et al. (21) that the use of several organic acids, namely citric acid, butyric acid, acetic acid and formic acid at a level of 0.25% acid in drinking water can lower the pH of the small intestine of broiler chickens.

The Observation Data for each of these broiler chicken performance parameters based on average rations consumption, weight gain, and conversion of broiler chicken rations could be seen in Table 2. Consumption of broiler chicken rations during the study ranged from 73.94 to 75.87 g/head/day. The variance analysis results showed that the addition of propionic acid in the ration had a significant effect (P<0.05) on the consumption of broiler chicken rations. It was caused by the addition of propionic acid in the ration to improve the broiler chicken digestive tract's performance by optimizing the pH of the digestive tract. The pH of the broiler small intestine after propionic acid addition was 5.5-5.8. Changes in pH result in pathogenic bacteria's death because pathogenic bacteria cannot resist the acidic conditions. (22) and (23), reported that citric acid could reduce the digestive tract's pH (crop, ventriculus, and intestine), suppress the growth of pathogenic bacteria, and increases lactic acid bacteria, contributing to the digestive process the use of protein becomes good. Lysis of pathogenic bacteria will increase the absorption of nutrients that will be used to form muscle tissue. The increase in the feed flow rate in the digestive tract so that the stomach quickly empty and causes increased ration consumption. Following (2), organic acids can increase the feed flow rate so that gastric emptying is faster and consumption increases.

The addition of 0.5% propionic acid did not differ (P>0.05) with the addition of 0.75% propionic acid in the diet on the pH of the duodenum and the jejunum of broiler chickens. This is due to the optimum concentration of 0.5% addition of propionic acid, so that the increase in concentration level

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The addition of 0.5% propionic acid was not significantly different ($P>0.05$) with 0.75% propionic acid to ration consumption. Due to the addition of propionic acid at a dose of 0.5% and 0.75% in the ration giving effect the same to the digestive tract, the digestive enzyme activity is the same in the treatment. Enzyme activity will affect the feed rate in feed consumed by livestock. It can be absorbed entirely along with the rapid digestion rate, which caused the digestive tract to empty quickly. Broilers chicken continues to consume rations to meet energy needs so that the consumption of rations increases. (24) and (25) reported an increase in the digestive tract's productivity, which functions favorably for bacterial growth by decreasing acidity in the digestive tract and can activate and stimulate the production of endogenous enzymes and can increase ration consumption. Moreover, (11) reported that adding of the mixture of organic acids could increase broiler chicken rations' consumption.

Average Chicken body weight gain during the study ranged from 51.37 to 56.18 g/head/day. The variance analysis results showed that the addition of propionic acid in the ration had a significant effect ($P<0.05$) on the body weight gain of broiler chickens. Because the addition of propionic acid in the ration can reduce the pH of the digestive tract, consequently can inhibit the work of pathogenic bacteria that cannot stand the acidic conditions, so there is no competition in the absorption of nutrients in the digestive tract. The optimal absorption of food substances can increase the bodyweight of broiler chickens. According to (26), organic acid acts as a growth promoter or growth booster capable of suppressing the growth of acid intolerant bacteria such as Escherichia Coli, Salmonella spp, and Clostridium perfringens.

Further tests showed that the addition of 0.5% propionic acid and 0.75% addition of propionic acid were significantly different ($P<0.05$) from the control. The smallest average body weight gain at T0 is 51.37 g/head/day because the ration consumed without the addition of propionic acid is as low as 73.94 g /head /day. In contrast, propionic acid can optimize the pH of the digestive tract so that feed consumed by livestock is converted into muscle tissue. There is an increase in body weight in broiler chickens. (23) states that the administration of organic acids can maintain the balance of microbes in the digestive tract by maintaining the digestive tract's pH and being able to increase protein absorption. According to these results, organic acids such as propionic acid can optimize pH in the digestive tract, increase the pepsin enzyme activity, and increase the digestibility of nitrogen, phosphorus, and minerals that good weight gain occurs (9).

The treatment of the addition of 0.5% propionic acid was not significantly different (P>0.05) by adding 0.75% propionic acid to the body weight gain of broiler chickens. Because the addition of propionic acid at 0.5% and 0.75% has the same ability to optimize the digestive tract's pH, the digestion process of nutrients goes well. It increases the body weight gain of broiler chickens. The addition of propionic acid at 0.5% and 0.75% can increase body weight gain by build muscle tissue in broiler chickens. The digestive tract's optimal pH can secrete pancreatic enzyme activity amino acids derived from feed can be digested and absorbed by the intestine. (27) stated The addition of organic acids can increase pancreatic enzyme activity to optimize digestion and absorption of amino acids derived from feed for muscle tissue formation. Furthermore, (28) stated that the addition of organic acids could reduce the digestive tract's pH, increasing pepsin enzyme activity resulting in increased body weight. Pepsin enzymes function to break down protein into amino acids and be absorbed by the body so that forming muscle tissue becomes profitable, increasing the body weight gain of broiler chickens. In line with the research results (18) stated that the administration of 0.5% citric acid showed the best results of body weight and final body weight. (29) the addition of 0.75% acetic acid in the ration resulted in better body weight gain than controls.

Based on the amount of ration consumption and body weight gain produced during the study, broiler chicken ration's average conversion ranged from 1.35 - 1.44. The variance analysis results showed that the addition of propionic acid in the ration had a significant effect (P<0.05) on the conversion of broiler chicken rations. The average conversion in T2 treatment with the addition of 0.75% propionic acid is the lowest conversion rate. The low conversion rate of rations is caused by feed consumed by livestock digested and absorbed entirely to form muscle tissue, increasing body weight gain. The addition of propionic acid causes acidic conditions in the digestive tract of broiler chickens that will support digestive enzymes' activity. Changes in the digestive tract's acidity can cause growth disorders in pathogenic bacteria to reduce pathogenic bacteria in the digestive tract of broiler chickens. (22) reported that citric acid can reduce the digestive tract's pH (crop, ventriculus and intestine), suppress pathogenic bacteria's growth, and increase lactic acid bacteria that contribute to the digestive process so that the use of protein becomes optimal.

Based on further testing, the treatment of T0 was significantly different (P <0.05) to T1 (addition of 0.5% propionic acid) and T2 (addition of 0.75% propionic acid). The addition of propionic acid in the ration could reduce the conversion value of feed because the feed consumed by broiler chickens results in higher weight gain than broiler chickens given rations without the addition of propionic acid. The addition of propionic acid can increase the efficient use of feed. They were following (30), which is reported that giving 0.25% citric acid and 0.25% butyric acid positively affects feed efficiency. Treatment without the addition of propionic acid in the ration produces a higher conversion rate, thereby reducing feed use efficiency.

T1 treatment was not significantly different (P>0.05) with T2 on broiler chicken rations' conversion. The addition of 0.5% and 0.75% propionic acid has relatively small propionic acid addition intervals, so the treatment effect of 0.5% and 0.75% is not significantly different from the ration conversion. In line with the results of Vale et al.'s (2004) research, the addition of 70% formic acid and 30% propionic acid at a rate of 0.2 to 25% in the ration can improve the value of broiler chicken conversion. According to (18) addition of 0.5% citric acid can improve ration conversion. (31) state that the appropriate level of propionic acid use is 0.2 to 0.4% in the ration to improve broiler chicken's feed conversion value.

Effect of Treatment on Crude Protein Digestibility

The average digestibility value of crude protein and crude fiber in broiler chickens can be seen in Table 3. The variance results showed that propionic acid's use had a significant effect (P<0.05) on the digestibility of crude protein in broiler chickens. The addition of propionic acid causes this can cause a decrease in pH in the

digestive tract of broiler chickens, resulting in increased activity of protein degrading enzymes (pepsin and protease). The pH of the digestive tract of broiler chickens in the treatment T1 and T2 is lower than T0. The pH of duodenum T1 and T2 ranged from 4.2 to 5.3, while that of duodenum T0 was 5.8. The pH of the jejunum T1 and T2 ranges from 5.2 - 6, while T0 is 6.6 and the pH of the ileum T1 and T2 ranges from 5.4 to 6.1, and the pH of the ileum at T0 was 7. (32) stated that an acidic atmosphere in the digestive tract would activate pepsinogen into pepsin which plays a role in digesting protein. (24) stated Organic acids can increase the secretion of protein-digesting enzymes and release the gastrin hormones and cholecystokinin, which play a role in stimulating crude protein digestive enzymes. Gastrin is a hormone produced by gastrin cells in the stomach's pylorus, which stimulates stomach acid release.

Further tests showed that the addition of 0.5 and 0.75% propionic acid was significantly different ($P<0.05$) from the control ration on crude protein digestibility. The addition of propionic acid with a level of 0.5 to 0.75% in broiler rations can reduce the digestive tract's pH, thereby increasing the activity of digestive enzymes.

Table 3. The Digestiblity of crude protein and crude fiber in broiler chickens.

Treatment	Crude protein digestibility (%)	Crude fiber digestibility (%)
T0	$72,78^{a}\pm1,22$	$28,33^{a}\pm3,25$
T1	$74,54^{b}\pm1,19$	$47,95^{b}\pm1,09$
T2	$79,79^{b}\pm1,63$	$46,31^{c}\pm1,61$

Note: Different letter superscripts showed significantly different treatments ($P<0.05$) P0 (without addition of propionic acid), P1 (addition of 0.5% propionic acid), P2 (addition of 0.75% propionic acid).

Table 4. the effect treatment on live weight, carcass percentage and abdominal fat percentage during the study.

Treatment	Live Weight (g) (4 weeks old)	Carcass Percentage (%)	Abdominal Fat Percentage (%)
T0	$1315^{a}\pm38,49$	$69,84^{a}\pm1,40$	$1,92^{a}\pm0,44$
T1	$1574^{b}\pm37,21$	$72,72^{b}\pm1,17$	$1,27^{b}\pm0,51$
T2	$1619^{b}\pm65,59$	$73,40^{b}\pm2,28$	$1,22^{b}\pm0,28$

Note: P0 (without the addition of propionic acid), P1 (addition of 0.5% propionic acid), P2 (addition of propionic acid 0.75%). Different superscripts in the same column showed significantly different effects ($P<0.05$).

(25) on review concluded that the addition of organic acids can affect the condition of the small intestine pH's atmosphere becomes more acidic to support the activity of lactic acid bacteria. The optimal pH will make lactic acid bacteria live optimally in the intestinal villi to increase the absorption of nutrients of rations by expanding the intestinal villi surface area. (33) explained that increasing the height and width of villi in the ileum was caused by lactic acid bacteria that we can increase short-chain fatty acids and reduce ammonium production. however, in an experiment reported by (10), it was revealed that organic acid supplementation could increase the production of propionate and iso butyrate; increase the activity of a-glucosidase and b-glucouronidase enzymes; but, it does not decrease ammonium production.

Short-chain fatty acids play a role in stimulating the multiplication of intestinal epithelial cells. The increase of the villi's height and width indicates the villi's broader surface for absorption of food that enters the bloodstream (34).

The addition of propionic acid 0.5 and 0.75% in the ration did not differ significantly ($P>0.05$) on crude protein's digestibility. The addition of propionic acid with a level of 0.5% and 0.75% has the same ability to optimize the digestive tract's pH, thus giving the same effect on the digestibility of crude protein. This result was similar to (32), who reported the addition of citric acidifiers with a level of 0.4 to 0.8% in natural and synthetic form in feed could increase crude protein digestibility by activating pepsin enzyme; such as proteases in the proventriculus and small intestine. (25) report that the use of lactic acid in rations can increase protein digestibility in broiler chickens.

Effect of Treatment on Crude Fiber Digestibility

The variance results showed that the treatment had a significant effect on crude fiber digestibility ($P<0.05$). Due to a decrease in the digestive tract's pH value, which caused increases in some polysaccharides' chemical hydrolysis and reduced the level of crude fiber. The research stated that organic acids could reduce the digestive tract's pH in the duodenum, jejunum, ileum, and caecum (23). The lower pH will cause the digesta rate to slow down so that the time spent digesting crude fiber will also be longer (2).

Based on the results of further tests showing that each treatment was significantly different. T1 and T2 treatments were significantly different ($P<0.05$) higher with T0. It was caused by a decrease in the digestive tract's pH, which is thought to increase the lactic acid bacteria population. The average population of Lactobacillus sp. in the small intestine of broiler chickens without the administration of propionic acid is 1.2x104 CFU/g, whereas in the treatment of addition of propionic acid an increase in the population of Lactobacillus sp. namely at P1 3.7x106 CFU/g and P2 4.4x106 CFU/g. (35) stated that an increase in lactic acid bacteria produced lactic acid and Short Chain Fatty Acid production. The increase in SCFA and lactic acid accompanied by decreased pH of the digesta will further reduce pH in the cecum. The research by (36) reported the addition of lime acid extract at the level of 3 ml had a very significant effect on pH and the total increase in lactic acid bacteria in the digestive tract. The pH that is suitable for the growth of lactic acid bacteria (LAB) in broiler chicken cecum is 6.09 (23) and 6.20 (37).

The addition of propionic acid in the ration on treatments T1 and T2 was significantly different ($P<0.05$) on the digestibility of crude fiber in broiler chickens. It was thought to be caused by an increase in the higher lactic acid bacteria population in T2. Lactic acid bacteria and other non-pathogenic bacteria that produce organic acids, especially lactic acid, can reduce pH in the cecum (23). On other hands, (35) added that the increasing population of lactic acid bacteria in the caecum would help break down carbohydrates, which can then be fermented by cellulolytic bacteria. Related to this results, (38) reported that the population of cellulolytic bacteria in the digestive tract of poultry was 63x107 cfu/g, where the bacteria could degrade crude fiber. The decrease in crude fiber levels is due to higher cellulose and hemicellulose enzyme activity during the fermentation process (39,40). Decreasing pH will increase the speed of chemical hydrolysis of some polysaccharides, which will reduce crude fiber levels. (41) stated the entering of organic acids on the proventriculus would weaken the crude fiber component to be more easily digested by microorganisms enzymatic.

Effect of Treatment on the Quality of Broiler Chicken Carcasses

The carcass quality was determined based on the resulting live weight, carcass percentage, and abdominal fat percentage, as shown in Table 4. The average live weight of broiler chickens obtained in this study ranged from 1315 - 1619 grams. The variance analysis results showed that the addition of propionic acid in broiler chicken ration had a significant effect ($P<0.05$) on the live weight of broiler chickens. Because propionic acid's addition has a significant effect on ration consumption, the higher the increase of propionic acid concentration in the ration, the higher the increase of the ration consumption. The increase in ration consumption reflects an increase in the consumption of food substances, (42) reports that consumption of rations reflects the entry of several nutrients into the body of broiler chickens.

Further tests showed that broiler chickens' live weight added 0.5% propionic acid and 0.75% propionic acid were significantly different ($P<0.05$) from controls. Because propionic acid optimizes the digestive tract's pH by the digestive tract's acidity, which is 5.5-5.8, especially in the small intestine. According to (23) organic acids such as acetate, propionate, and butyrate can reduce toxin production by bacteria, improve the intestinal wall's morphology, and reduce the colonization of pathogenic bacteria. Optimal digestion of food substances will increase weight gain, which can be seen in the increase in broiler chickens' live weight. The addition of organic acids can increase broiler chicken weight (27,43).

The addition of 0.5% propionic acid was not significantly different (P>0.05) with the addition of 0.75% propionic acid to broiler chickens' live weight. Because at the level of 0.5%, the addition of propionic acid in the ration can provide optimal acid conditions in the digestive tract of broiler chickens to increase body weight. Following the opinion of (18) that the administration of organic acid in the form of 0.5% citric acid in the ration produced the best final body weight compared to acetic acid.

The addition of propionic acid increases the body weight of broiler chicken produced. The higher the increase of body weight produced, the higher the percentage of broiler chicken carcasses. The average percentage of broiler chicken carcass obtained in this research ranged from 69.84 to 73.40%. The variance analysis results showed that the addition of propionic acid in the ration during the research had a significant effect (P<0.05) on the percentage of broiler chicken carcasses due to the percentage of carcass influenced by the resulting live weight. This research's live weight is getting higher by increasing the addition of propionic acid in the ration. (9); (5); and (24) states that the achievement of bodyweight components is closely related to carcass weight. The higher the live weight produced, the higher the percentage at the end of the research (44).

The results of further tests showed that the percentage of the carcass of broiler chicken, which was added by propionic acid 0.5% and 0.75% was significantly different (P<0.05) with T0 (control). Presumably, propionic acid acts as an acidifier that can optimize the digestive tract's pH to improve the work of digestive enzymes and increase absorption of food substances, especially proteins that function as substances forming body tissues. In line with the study results by (45), the addition of organic acids can maintain the balance of microbes in the digestive tract by maintaining the digestive tract's pH so that protein absorption increases.

The addition of 0.5% propionic acid was not significantly different (P> 0.05) with the addition of 0.75% propionic acid to the percentage of broiler chicken carcasses. It optimized the digestive tract's pH to increase the absorption of nutrients, which affects the percentage of a carcass. In line with the opinion of (32) reported that administering organic acids such as citric acid to the level of 1.2% in single step down feeds could increase carcass weight.

The increase in the carcass percentage was inversely proportional to the percentage of abdominal fat in broiler chickens. The average percentage of abdominal fat produced in each treatment ranged from 1.22-1.92%. The variance analysis results showed that the addition of propionic acid in the ration had a significant effect (P<0.05) on the percentage of abdominal fat in broiler chickens. The addition of propionic acid can cause a decrease in the digestive tract's pH so that it activates the work of the pepsinogen enzyme. This study's percentage of abdominal fat is lower than that stated by (46), who reported the average percentage of abdominal fat in broiler chicken ranges from 2.24 to 3.90%.

In contrast, the lipase enzyme can work actively at pH 6.8 to reduce the activity of lipase enzymes in digesting fat. (24,25)stated the digestion of fat in the intestine includes the breakdown of dietary fat into fatty acids, monoglycerides, and others through, which is cooperation between bile salts and intestinal lipases occurring in environments with high pH due to the presence of bicarbonate secretion. In line with the opinion of (44) the lipase enzyme can work optimally at pH 7.

Further tests showed that the percentage of abdominal fat added with 0.5% propionic acid and 0.75% propionic acid was significantly different (P<0.05) from controls. The percentage of broiler chicken abdominal fat with the addition of propionic acid in feed has a lower percentage of abdominal fat than broiler chickens without propionic acid in the ration (control). Because propionic acid can increase digestive enzymes' work and increase absorption of nutrients such as carbohydrates, proteins, and fats run optimally for the formation of body tissues. Fulfill their basic life so that abdominal fat formation decreases nutrients mainly used for body tissue formation. The addition of organic acids in broiler chicken feed can increase absorption by increasing the function of digestive enzymes to

influence the increase in digestion and absorption, especially fiber and protein (47).

The addition of 0.5% propionic acid was not significantly different (P>0.05) with the addition of 0.75% propionic acid to the percentage of abdominal fat. It is assumed that the small intervals between treatments cause propionic acid at a dose of 0.5% and 0.75% to have the same activity in optimizing pH. The enzyme activity of the digestive tract is also the same as the pH conditions are not real. Hence, the percentage of abdominal fat produced not significantly different. (45) The addition of organic acids can maintain the balance of microbes in the digestive tract by maintaining the digestive tract's pH to improve the work of digestive enzymes properly. (48) Giving double step down feeding with the addition of 1.6% citric acid as an acidifier in the ration can increase carcass weight and reduce levels of abdominal fat.

CONCLUSION

Based on this study's results, it can be concluded that the addition of propionic acid in the ration at a dose of 0.5% can increase the digestibility of crude protein by 2.42% and crude fiber digestibility by 69.25%. Improve the production performance that increases weight gain by 7.49%, decrease feed conversion by 4.86%, and increase carcass percentage by 4.12% of broiler chicken.

CONFLICT OF INTERESTS

The authors report no conflict of interest.

AUTHORS' CONTRIBUTION

All authors contributed to the work, discussed the results and contributed to the final manuscript.

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Addition Of Propionic Acid On Nutrient Digestibility And Its Effect On Production And Carcass Quality Of Broiler

R. Palupi	F. N. L. Lubis	A. Suryani
Lecturer	Lecturer	Researcher
T. C. Bella	D. Nurrachma	A. N. T. Pratama
Researcher	Researcher	Lecturer

Department of Technology and Livestock Industry, Faculty of Agricultural, Sriwijaya University, Indonesia
E-mail: palupiarda@yahoo.com

ABSTRACT

This study aimed to determine protein and crude fiber digestibility by adding propionic acid in rations and its effect on production and carcass quality broiler chicken. This research was carried out using 180-day old chicks (DOC) broiler chicken with Cobb strain. The research method used a completely randomized design (CRD) consisting of three treatments and six replications for every treatment. The treatment in this study consisted of: T0 = ration without propionic acid; T1 = addition of 0.5% propionic acid in the ration; T2 = 0.75% addition of propionic acid in the ration. Parameters observed included crude protein, crude fiber digestibility, feed consumption, body weight gain, feed conversion, live weight, carcass percentage, and percentage of abdominal fat in broiler chickens. The results showed that the addition of 0.5% propionic acid had a significant effect (P<0.05) on crude protein and crude fiber's digestibility in broiler chickens. Significantly increased feed consumption up to 2.29%; body weight gain up to 7.49 %, decreased feed conversion by 4.86%; increased body weight by 12.69%; carcass percentage by 4.12% and decreased 33% of abdominal fat broiler chicken. This research concludes that the addition of propionic acid in the ration at a dose of 0.5% can increase the digestibility of crude protein and crude fiber rations, can improve the production performance and carcass quality of broiler chickens.

Key words: Digestibility, Propionic Acid, Performance

إضافة حا مض البروبيونيك على قابلية هضم العناصر الغذائية وتأثيره على إنتاج وجودة الذبيحة من الدجاج اللدجاجةاحم

خطر Palupi	F. N. L. Lubis	سورياني العاني
مدرس	رمدرس	باحث
بيلا سيترا تيا	نورراكما إلهة	أنغرياوان نايديليا تترا براتاما
باحث	باحث	مدرس

مسق ايجولونكتلا ةعانصو ةورثلا ةيناويحلا ، ةيلك ةعارزلا ، ةعماج ايجيويرس ، ايسينودنإ

المستخلص

تفده هذه ةساردلا ىلإ ديدحت ةيلباق مضه نيتوربلا فايللأاو ماخلا ةفاضإب ضمح كينويبوربلا يف قئلاعلا هريثأتو ىلع جاتنإ ةدوجو جاجد نيمسلا. مت ءارجإ اذه ثحبلا مادختساب تيكاتك نيمسلا (DOC) يتلا غلبي اهرمع 180 اموي نم ةللاس بوك. مدختست ةقيرط ثحبلا اميمصت ايئاوشع لماكلاب (CRD) نوكتي نم ثلاث تاجلاعم ةتسو تارركم لكل جلاع. نوكتي جلاعلا يف هذه ةساردلا نم: T0 = صصح نودب ضمح كينويبوربلا. T1 = 0.5٪ ضمح كينويبوربب فاضم لكل ةصح ؛ و T2 = 0.75٪ ضمح كينويبوربب فاضم لكل ةبجو. تنمضت ريياعملا يتلا مت اهدصر نيتوربلا ماخلا ، مضهو فايللأا ماخلا ، كلاهتساو فلعلا ، ةدايزو نزو مسجلا ، ليوحتو فلعلا ، نزوللاو يحلا ، ةبسنو ةحيبذلا ، ةبسنو نوهد نطبلا يف جاجد نيمسلا. ترهظأ جئاتنلا نأ ةفاضإ 0.5٪ ضمح كينويبوربلا ناك هل ريثأت يونعم (P <0.05) ىلع مضه نيتوربلا ماخلا فايللأاو ماخلا يف جاجد نيمسلا. ةدايز ةريبك يف كلاهتسا فلاعلأا تلصو ىلإ 2.29٪ ؛ ةدايز نزو مسجلا ةبسنب تلصو ىلإ 7.49٪ ، ضافخناو ليوحت فلاعلأا ةبسنب 4.86٪ ؛ ةدايز نزو مسجلا ةبسنب 12.69٪. ةبسن ةحيبذلا 4.12٪ تضفخناو 33٪ نم نهد جورفلا ينطبلا.

الكلمات المفتاحية: جاجد نيمسلا ، ةيلباق مضهلا ، ضمح كينويبوربلا ، ءادلأا ، ةدوج ةحيبذلا.

INTRODUCTION

The growth of broiler chickens can take place well if given feed that suits their needs, both in terms of quality and quantity, to support maximum production. The digestive tract's pH conditions that are not optimal can lead to the development of pathogenic bacteria (1). The others results of a review conducted by (2) reported that the pH value of broiler chickens is strongly influenced by nutritional content, physical content, and the amount of feed consumed. However, One of many factors that causes a decrease in the digestive tract's pH value is feed fermentation. For example, The results of Study that has been carried out on fermented feed using the lactobacillus type of bacteria reveal that this type of bacteria can act as a feed probiotic by reducing the pH value, which in turn results in a decrease in pathogenic bacteria in the digestive tract (3);(4);(5);(6). Pathogenic bacteria often found in the digestive tract of poultry include *Escherichia coli* and Salmonella. These bacteria enter through feed and drinking water consumed by livestock, which can cause health problems in livestock and disrupt the absorption of food substances, resulting in a decrease in performance that affects the carcass quality produced at the end of broiler maintenance chickens.

Generally, farmers add antibiotic growth promoter (AGP) to overcome pathogenic bacteria's growth to increase the absorption of food substances. However, AGP's addition can leave antibiotic residues in the chicken meat produced, which will endanger the health of consumers who consume the meat (muaz 2018). Food consumers must pay attention to food safety from the presence of contaminants and residues that are harmful to consumers, specific bacterial resistance, and environmental issues (7, 8). Efforts can be made to avoid AGP's use with the addition of a specific feed additive that can replace the AGP function. One of the additives feeds that can be used in organic acids play an essential role in optimizing the digestive tract's pH. (9); (10); and (11) in their report stated that organic acid supplementation in feed could inhibit the work of pathogenic bacteria and have a beneficial effect on the performance of poultry.

One of the organic acids that can be used is propionic acid. When given to livestock, propionic acid does not cause residues in meat or carcasses produced, so it is safe to use as additive feeds in livestock. (12) report that organic acids can be used as suitable alternative additive feeds to replace antibiotics. The addition of organic acids can reduce the pH digestive tract of poultry and inhibit the bacteria like *Escherichia coli* and Salmonella, which cause the absorption of food substances in the intestine can run well and make livestock growth becomes stable. The resulting performance is good and produces good carcass quality and abdominal fat content low. The difference in protein content and acetic acid in the ration makes the pH of the duodenum is 4.17 – 5.68, the pH of the jejunum is 5-6, and the pH of the ileum is 5.83 – 6 (13). This study was aimed at finding a dose of propionic acid that could increase the production and carcass quality of broiler chickens with an approach to measuring the digestibility of dietary fiber and protein. The study hypothesizes that propionic acid in the diets can increase the production and carcass quality of broiler chicken.

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MATERIAIS AND METHODS

Experimental birds and Design

An animal feeding experiment was conducted at the experimental station, Department of Animal Science, Faculty of Agriculture, Universitas Sriwijaya. The birds were cared for according to the Animal Welfare Guidelines of the Indonesian Institute of Sciences. The approval of the experiment was granted from Universitas Sriwijaya.

This research used 180-day old chick (DOC) broiler chicken of Cobb strain with unsexing. The DOC weight used ranged from 53 to 56 g. The DOC was placed in the postal cage. The cage used is a postal cage with a 60cm x 50cm x 60cm size. Broiler chickens are carried out for 28 days. The Broiler chickens were divided into three treatments with various percentages of propionic acid usage in the diets.

The ratio given is HI-Pro type commercial feed given at the age of one to 21 days (starter phase

– grower phase) and produced by PT. Charoen Pokphan Indonesia Tbk, MRI-P ration given at the age of 22 to 28 days (finisher phase) produced by PT. Cj Cheiljedang Feed Lampung and Propionic Acid (Zetox) produced by PT. Healthy Bright Indonesia.

Table1. The composition of nutrient rations during the study

Food substances	HI-PRO*	MR1-P**
Water content (Max) (%)	13.0	13.0
Protein (%)	22.0 – 23.0	21.5 – 23.0
Crude Fiber (Max) (%)	5.0	4.0
Fat (Min) (%)	5.0	8.0
Ash (Max) (%)	7.0	6.5
Calcium	0.9	0.9 – 1.2
Phosfor	0.6	0.7 – 1.0
Metabolism Energy (kcal/kg)	3020 – 3120	3000 – 3100

Note : HI-Pro (PT. Charoen Pokphan Indonesia Tbk), **MR1-P (PT. Cj. Cheiljedang Feed Lampung).

The research design used was a Completely Randomized Design (CRD) consisting of 3 treatments and six replications. The DOC was placed into the experimental cages, each unit of the cage was occupied by ten heads each. The treatments used are as follows: T0 (without the addition of propionic acid in the diet), T1 (addition of 0.5% propionic acid), and T2 (addition of propionic acid 0.75%). The propionic acid given comes from commercial propionic acid in the form of flour. Propionic acid is mixed in the ration according to each treatment and stirred evenly until homogeneous. The adaptation of the treatment ration was carried out gradually within four days. According to treatment, chickens were fed treatment rations with a concentration of 25% on the first day, 50% on the second day, then 75% on the third day and 100% on the fourth day.

Growing Performance and pH Measurement of Gizzard

Broiler chicken performance, which includes measurement of parameters: Feed consumption (g/head/day), weight gain (g/head/day), and feed conversion ratio were calculated from the difference between the final body weight and the initial bodyweight of the study (14). Value of pH measurements was carried out on the duodenum, jejunum, and ileum. Simultaneously using a digital pH meter (Extech EC500 Waterproof ExStik II PH Meter), lactic acid bacteria was measured based on the population of Lactobacillus sp. In the small intestine of chicken aged four weeks (CFU/g).

Digestibility and Carcass quality

Measurements Digestibility/Digestion of crude protein (%) and crude fiber (%).were calculated using the formula (15). Furthermore, Carcass quality measurement, which includes measurement of parameters: Live weight (g), calculated based on the difference between the results of weighing the chicken before being cut and after fasting for 6 hours. The percentage of the carcass (%) is calculated as the percentage of the ratio between the carcass weight (g) and the life weight (g), and percentage of abdominal fat, calculated based on the percentage of the comparison between the weight of abdominal fat (g) and the weight of life (g).

Data Analysis

The SAS statistical package (PROC GLM) was used to determine the significance of differences between treatments (SAS, 2013). Data obtained during this study were analyzed according to a Completely Randomized Design (CRD). If there are significant differences, further tests will be carried out using the Duncan Multiple Range Test (16).

RESUITS AND DISCUSSION

Effect of Treatment on pH of small intestine and growth Performance

Based on the analysis of variance, the addition of propionic acid in the diet had a significant effect ($P<0.05$) on the pH of the duodenum and the pH of the jejunum, but had no significant effect ($P>0.05$) on the pH of the ileum. This is because propionic acid has acidic properties; so that when it enters the digestive tract of broilers; it was caused the release of hydrogen atoms on digestive tract and cloud impact on the decrease of pH value. The supplementation of organic acids had showed could reduce the pH of the digestive tract and the microbial activity on the stomach and small intestine (17); (18); (19). The

decrease in pH in each part of the small intestine will affect the condition of the small intestine, where pathogenic bacteria found in the small intestine cannot stand the lower pH conditions. Dittoe et al. (20) reported that the pH of the digestive tract is a microbial condition in the digestive tract of poultry that will have an impact on poultry health.

Table 2. Effect of adding propionic acid on pH, ration consumption, weight gain and conversion of broiler chickens.

pH on small Intestine	Treatment T0	T1	T2
Duodenum	5.86^{a}	5.04^{b}	5.02^{b}
Jejunum	6.00^{a}	5.78^{b}	5.66^{b}
Ileum	6.98^{a}	6.22^{b}	6.38^{b}
Growing Performance	**Treatment T0**	**T1**	**T2**
Consumption (g/head/day)	73,94^{a}±0,97	75,64^{b}±0,87	75,87^{b}±0.64
Wight gain (g/head/day)	51,37^{a}±2,49	55,22^{b}±1,80	56,18^{b}±2,64
Conversion	1,44^{a}±0,05	1,37^{b}±0,04	1,35^{b}±0,05

Note: Different superscripts in the same column show significantly different influences (P<0.05). T0 (without the addition of propionic acid), T1 (addition of 0.5% propionic acid), T2 (addition of propionic acid 0.75%).

The adding of 0.5% propionic acid did not differ with the adding of 0.75% dietary propionic acid on the pH of the duodenum and the jejunum of broiler chickens. This is due to the optimum concentration of 0.5% propionic acid, so that the increase in concentration level to 0.75% was not significantly different from the 0.5% level. Similar with the research results of (21) that the use of several organic acids, namely citric acid, butyric acid, acetic acid and formic acid at a level of 0.25% acid in drinking water can lower the pH of the small intestine of broiler chickens.

The observation data for each of these broiler chicken performance parameters based on average rations consumption, weight gain, and conversion of broiler chicken rations could be seen in Table (2). Consumption of broiler chicken rations during the study ranged from 73.94 to 75.87 g/head/day. The variance analysis results showed that the adding of propionic acid had a significant effect (P<0.05) on dietary consumption of broiler. It was caused by the addition of propionic acid in the ration to improve the broiler chicken performance by optimizing the pH of the digestive tract. The pH of the broiler small intestine after propionic acid addition was 5.5-5.8. Changes in pH was caused pathogenic bacteria to enter the death phase because pathogenic bacteria cannot tolerate acidic conditions. (22) and (23), reported that citric acid could reduce the digestive tract's pH (crop, ventriculus, and intestine), suppress the growth of pathogenic bacteria, and increases lactic acid bacteria, contributing to the digestive process the use of protein becomes good. Lysis of pathogenic bacteria will increase the absorption of nutrients that will be used to form muscle tissue.The increase in the feed flow rate in the digestive tract so that the stomach quickly empty and causes increased ration consumption. Following (2), organic acids can increase the feed flow rate so that gastric emptying is faster and consumption increases.

The addition of 0.5% propionic acid did not differ with the addition of 0.75% propionic acid in the diet on the pH of the duodenum and the jejunum of broiler chickens. This is due to the optimum concentration of 0.5% addition of propionic acid, so that the increase in concentration level to 0.75% is not significantly different from the 0.5% level.

The addition of 0.5% propionic acid was not significantly different from 0.75% propionic acid for the resulting consumption. This could be happen, because the addition of the two propionic acids gives the same effect on the digestive tract, so the activity of digestive enzymes is not much different. The enzyme activity had a role in influencing the rate of feed as long as the feed is consumed by broiler chi. Which in turn can cause absorption of nutrients in the digestive tract to be maximized due to the high rate of digestion with the end result that the digestive tract will empty quickly. Broilers

chicken continues to consume rations to meet energy needs so that the consumption of rations increases. (24) and (25) reported an increase in the digestive tract's productivity, which functions favorably for bacterial growth by decreasing acidity in the digestive tract and can activate and stimulate the production of endogenous enzymes and can increase ration consumption. Moreover, (11) reported that adding of the mixture of organic acids could increase broiler chicken rations' consumption.

Average Chicken body weight gain during the study ranged from 51.37 to 56.18 g/head/day. The variance analysis results showed that the addition of propionic acid in the ration had a significant effect ($P<0.05$) on the body weight gain of broiler chickens. Because the addition of propionic acid in the ration can reduce the pH of the digestive tract, consequently can inhibit the work of pathogenic bacteria that cannot stand the acidic conditions, so there is no competition in the absorption of nutrients in the digestive tract. The optimal absorption of food substances can increase the bodyweight of broiler chickens. According to (26), organic acid acts as a growth promoter or growth booster capable of suppressing the growth of acid intolerant bacteria such as *Escherichia coli*, Salmonella spp, and Clostridium perfringens.

Further tests showed that the addition of 0.5% propionic acid and 0.75% addition of propionic acid were significantly different ($P<0.05$) from the control. The smallest average body weight gain at T0 is 51.37 g/head/day because the ration consumed without the addition of propionic acid is as low as 73.94 g /head /day. In contrast, propionic acid can optimize the pH of the digestive tract so that feed consumed by livestock is converted into muscle tissue. There is an increase in body weight in broiler chickens. (23) stated that the administration of organic acids can maintain the balance of microbes in the digestive tract by maintaining the digestive tract's pH and being able to increase protein absorption. According to these results, organic acids such as propionic acid can optimize pH in the digestive tract, increase the pepsin enzyme activity, and increase the digestibility of nitrogen, phosphorus, and minerals that good weight gain occurs (9).

The adding of 0.5% propionic acid was not significantly different with 0.75% level on body weight gain of broiler chickens. the adding of propionic acid at 0.5% and 0.75% has the same ability to optimize the digestive tract's pH, the digestion process of nutrients goes well. It increases the body weight gain of broiler chickens. The addition of propionic acid at 0.5% and 0.75% can increase body weight gain by build muscle tissue in broiler chickens. The digestive tract's optimal pH can secrete pancreatic enzyme activity amino acids derived from feed can be digested and absorbed by the intestine. (27) stated The addition of organic acids can increase pancreatic enzyme activity to optimize digestion and absorption of amino acids derived from feed for muscle tissue formation. Furthermore, (28) stated that the adding of organic acids could reduce the digestive tract's pH, increasing pepsin enzyme activity resulting in increased body weight. Pepsin enzymes function to break down protein into amino acids and be absorbed by the body so that forming muscle tissue becomes profitable, increasing the body weight gain of broiler chickens. In line with the current results, (18) stated that the administration of 0.5% citric acid showed the best results of body weight and final body weight. (29) the adding of 0.75% acetic acid in the ration resulted in better body weight gain than controls.

Based on the feed consumption and body weight gain produced during the study, broiler chicken raton average conversion ranged from 1.5 - 1.44. The variance analysis results showed that the adding of propionic acid feed had a significant effect ($P<0.05$) on the conversion ratio. The average conversion in T2 treatment with the adding of 0.75% propionic acid is the lowest conversion rate. The low conversion rate of rations is caused by feed consumed by livestock digested and absorbed entirely to form muscle tissue, increasing body weight gain (30); and these results are in line with the study conducted by (31) in a trial using conjugated linolenic acid . The adding of propionic acid causes acidic conditions in the digestive tract of broiler chickens that will support digestive enzyme activity. Changes in the digestive tract's acidity can cause growth disorders in pathogenic bacteria to reduce pathogenic bacteria in the digestive tract of broiler

chickens. (22) reported that citric acid can reduce the digestive tract's pH (crop, ventriculus and intestine), suppress pathogenic bacteria growth, and increase lactic acid bacteria that contribute to the digestive process so that the use of protein becomes optimal.

Based on further testing, the treatment of T0 was significantly different (P <0.05) to T1 and T2 groups. The adding of propionic acid in the ration could reduce the conversion value of feed because the feed consumed by broiler chickens results in higher weight gain than broiler chickens given rations without the addition of propionic acid. The addition of propionic acid can increase the efficient use of feed. The (32), reported that giving 0.25% citric acid and 0.25% butyric acid positively affects feed efficiency. Treatment without propionic acid produces a higher dietary conversion rate, thereby reducing feed use efficiency.

T1 group was not significantly different with T2 in feed conversion. In line with the results of (33) research, the addition of 70% formic acid and 30% propionic acid at a rate of 0.2 to 25% in the ration can improve the value of broiler chicken conversion. According to (18) addition of 0.5% citric acid can improve ration conversion. (34) state that the appropriate level of propionic acid is 0.2 to 0.4% in the ration to improve broiler chicken's feed conversion value.

Effect of treatment on crude protein digestibility

The average digestibility value of crude protein and fiber in broiler chickens can be seen in Table (3). The variance results showed that propionic acid had a significant effect (P<0.05) on the digestibility of crude protein in broiler chickens. The adding of propionic acid causes this can cause a decrease in pH in the digestive tract of broiler chickens, resulting in increased activity of protein degrading enzymes (pepsin and protease). The pH of the digestive tract of broiler chickens in the treatment T1 and T2 is lower than T0. The pH of duodenum T1 and T2 ranged from 4.2 to 5.3, while that of duodenum T0 was 5.8. The pH of the jejunum T1 and T2 ranges from 5–2 - 6, while T0 is 6.6 and the pH of the ileum T– and T2 ranges from 5.4 to 6.1, and the pH of the ileum at T0 was 7. (35) stated that an acidi– atmosphere in the digestive tract would activate pepsinogen into pepsin which plays a role in digesting protein. (24) stated organic acids can increase the secretion of protein-digesting enzymes and release the gastrin hormones and cholecystokinin, which play a role in stimulating crude protein digestive enzymes. Gastrin is a hormone produced by gastrin cells in the stomach pylorus, which stimulates stomach acid release.

Further tests showed that the adding of 0.5 and 0.75% propionic acid was significantly different (P<0.05) from the control ration on crude protein digestibility. The adding of propionic acid with a level of 0.5 to 0.75% in broiler rations can reduce the digestive tract's pH, thereby increasing the activity of digestive enzymes.

Table 3. The Digestiblity of crude protein and fiber in broiler chickens.

Treatment	Crude protein digestibility (%)	Crude fiber digestibility (%)
T0	72,78^{a}±1,22	28,33^{a}±3,25
T1	74,54^{b}±1,19	47,95^{b}±1,09
T2	79,79^{b}±1,63	46,31^{c}±1,61

Note: Different letter superscripts showed significantly different treatments (P <0.05) T0 (without addition of propionic acid), T1 (addition of 0.5% propionic acid), T2 (addition of 0.75% propionic acid).

Table 4. the effect treatment on live weight, carcass percentage and abdominal fat percentage during the study.

Treatment	Live Weight (g) (4 weeks old)	Carcass Percentage (%)	Abdominal Fat Percentage (%)
T0	1315^{a}±38,49	69,84^{a}±1,40	1,92^{a}±0,44
T1	1574^{b}±37,21	72,72^{b}±1,17	1,27^{b}±0,51
T2	1619^{b}±65,59	73,40^{b}±2,28	1,22^{b}±0,28

Note: T0 (without the addition of propionic acid), T1 (addition of 0.5% propionic acid), T2 (addition of propionic acid 0.75%). Different superscripts in the same column showed significantly different effects (P <0.05).

(25) on review concluded that the addition of organic acids can affect the condition of the small intestine pH atmosphere becomes more acidic to support the activity of lactic acid

bacteria. The optimal pH will make lactic acid bacteria live optimally in the intestinal villi to increase the absorption of nutrients of rations by expanding the intestinal villi surface area. (36) explained that increasing the height and width of villi in the ileum was caused by lactic acid bacteria that we can increase short-chain fatty acids and reduce ammonium production. however, in an experiment reported by (10), it was revealed that organic acid supplementation could increase the production of propionate and iso-butyrate; increase the activity of a-glucosidase and b-glucouronidase enzymes; but, it does not decrease ammonium production. Short-chain fatty acids play a role in stimulating the multiplication of intestinal epithelial cells. The increase of the villi's height and width indicates the villi's broader surface for absorption of food that enters the bloodstream (37).

The adding of propionic acid (0.5 and 0.75%) in the ration did not differ significantly (P> 0.05) on crude protein's digestibility. The adding of propionic acid with a level of 0.5% and 0.75% has the same ability to optimize the digestive tract's pH, thus giving the same effect on the digestibility of crude protein. This result was similar to (35), who reported the addition of citric acidifiers with a level of 0.4 to 0.8% in natural and synthetic form in feed could increase crude protein digestibility by activating pepsin enzyme; such as proteases in the proventriculus and small intestine. (25) reported that the use of lactic acid in rations can increase protein digestibility in broiler chickens.

Effect of treatment on crude fiber digestibility

The variance results showed that the treatment had a significant effect on crude fiber digestibility (P<0.05). Due to a decrease in the digestive tract's pH value, which caused increases in some polysaccharides' chemical hydrolysis and reduced the level of crude fiber (38). The study stated that organic acids could reduce the digestive tract's pH in the duodenum, jejunum, ileum, and caecum (23). The lower pH will cause the digesta rate to slow down so that the time spent digesting crude fiber will also be longer (2).

Based on the results of further testing showed that each treatment was significantly different. T2 treatment had the highest fiber digestibility value compared to other treatments (P<0.05) and T1 treatment had a higher value when compared to T0 treatment. It was caused by a decrease in the digestive tract's pH, which is thought to increase the lactic acid bacteria population. The average population of Lactobacillus sp. In the small intestine of broiler chickens without the administration of propionic acid is 1.2x104 CFU/g, whereas in the treatment of adding of propionic acid an increase in the population of Lactobacillus sp. Namely at T1 3.7x106 CFU/g and T2 4.4x106 CFU/g. (39) stated that an increase in lactic acid bacteria produced lactic acid and short chain fatty acid production. The increase in SCFA and lactic acid accompanied by decreased pH of the digesta will further reduce pH in the cecum. The study by (40) reported the adding of lime acid extract at the level of 3 ml had a very significant effect on pH and the total increase in lactic acid bacteria in the digestive tract. The pH that is suitable for the growth of lactic acid bacteria (LAB) in broiler chicken cecum is 6.09 (23) and 6.20 (41).

The adding of propionic acid in the ration on treatments T1 and T2 group was significantly different (P <0.05) on the digestibility of crude fiber in broiler chickens. It was thought to be caused by an increase in the higher lactic acid bacteria population in T2. Lactic acid bacteria and other non-pathogenic bacteria that produce organic acids, especially lactic acid, can reduce pH in the cecum (23). On other hands, (39) revealed that the increasing population of lactic acid bacteria in the caecum would help break down carbohydrates, which can then be fermented by cellulolytic bacteria. Related to this results, (42) reported that the population of cellulolytic bacteria in the digestive tract of poultry was 63x107 cfu/g, where the bacteria could degrade crude fiber. The decrease in crude fiber levels is due to higher cellulose and hemicellulose enzyme activity during the fermentation process (43, 44). Decreasing pH will increase the speed of chemical hydrolysis of some polysaccharides, which will reduce crude fiber levels. (45) stated the entering of organic acids on the proventriculus would weaken the crude fiber component to be more easily digested by microorganisms enzymatic.

Effect of treatment on the quality of broiler chicken carcasses

The carcass quality was determined based on the resulting live weight, carcass percentage, and abdominal fat percentage, as shown in Table (4). The average live weight of broiler chickens obtained in this study ranged from 1315 – 1619 grams. The variance analysis results showed that the adding of propionic acid had a significant effect (P<0.05) on the live weight of broiler chickens. Because propionic acid's addition has a significant effect on ration consumption, the higher the increase of propionic acid concentration in the ration, the higher the increase of the ration consumption. The increase in ration consumption reflects an increase in the consumption of food substances. (46) reports that consumption of rations reflects the entry of several nutrients into the body of broiler chickens.

Further tests showed that broiler chickens' live weight added 0.5% propionic acid and 0.75% propionic acid were significantly different (P<0.05) from controls. Because propionic acid optimizes the digestive tract's pH by the digestive tract's acidity, which is 5.5-5.8, especially in the small intestine. According to (23) organic acids such as acetate, propionate, and butyrate can reduce toxin production by bacteria, improve the intestinal wall's morphology, and reduce the colonization of pathogenic bacteria. Optimal digestion of food substances will increase weight gain, which can be seen in the increase in broiler chickens' live weight. The addition of organic acids can increase broiler chicken weight (27, 47).

The adding of 0.5% propionic acid was not significantly different (P>0.05) with the adding of 0.75% propionic acid to broiler chickens' live weight. Because at the level of 0.5%, the addition of propionic acid in the ration can provide optimal acid conditions in the digestive tract of broiler chickens to increase body weight. Following the opinion of (18) that the administration of organic acid in the form of 0.5% citric acid in the ration produced the best final body weight compared to acetic acid.

The adding of propionic acid increases the body weight of broiler chicken produced. The higher the increase of body weight produced, the higher the percentage of broiler chicken carcasses. The average percentage of broiler chicken carcass obtained in this study ranged from 69.84 to 73.40%. The variance analysis results showed that the adding of propionic acid in the ration during the research had a significant effect (P<0.05) on the percentage of broiler chicken carcasses due to the percentage of carcass influenced by the resulting live weight. This research's live weight is getting higher by increasing the addition of dietary propionic acid. (9); (5); and (24) stated that the achievement of bodyweight components is closely related to carcass weight. The higher the live weight produced, the higher the percentage at the end of the research (48).

The results of further tests showed that the percentage of the carcass of broiler chicken, which was added by propionic acid 0.5% and 0.75% propionic acid was significantly different (P<0.05) with T0 (control). Presumably, propionic acid acts as an acidifier that can optimize the digestive tract's pH to improve the work of digestive enzymes and increase absorption of food substances, especially proteins that function as substances forming body tissues. In line with the study results by (49), the adding of organic acids can maintain the balance of microbes in the digestive tract by maintaining the digestive tract's pH so that protein absorption increases.

The adding of 0.5% propionic acid was not significantly different (P> 0.05) with the adding of 0.75% propionic acid to the percentage of broiler chicken carcasses. It optimized the digestive tract's pH to increase the absorption of nutrients, which affects the percentage of a carcass. In line with the opinion of (35) reported that administering organic acids such as citric acid to the level of 1.2% in single step down feeds could increase carcass weight.

The increase in the carcass percentage was inversely proportional to the percentage of abdominal fat in broiler chickens. The average percentage of abdominal fat produced in each treatment ranged from 1.22-1.92%. The variance analysis results showed that the adding of propionic acid had a significant effect (P<0.05) on the percentage of abdominal fat in broiler chickens. The addition of propionic acid can cause a decrease in the digestive tract's pH so that it activates the work of the pepsinogen enzyme. This percentage of abdominal fat is

lower than that stated by (50), who reported the average percentage of abdominal fat in broiler chicken ranges from 2.24 to 3.90%.

In contrast, the lipase enzyme can work actively at pH 6.8 to reduce the activity of lipase enzymes in digesting fat. (24, 25) stated the digestion of fat in the intestine includes the breakdown of dietary fat into fatty acids, monoglycerides, and others through, which is cooperation between bile salts and intestinal lipases occurring in environments with high pH due to the presence of bicarbonate secretion. In line with the opinion of (48) the lipase enzyme can work optimally at pH 7.

Further tests showed that the percentage of abdominal fat added with 0.5% and 0.75% propionic acid was significantly different ($P<0.05$) from controls. The percentage of broiler chicken abdominal fat with the adding of propionic acid in feed has a lower percentage of abdominal fat than broiler chickens without propionic acid in the ration (control). Because propionic acid can increase digestive enzymes' work and increase absorption of nutrients such as carbohydrates, proteins, and fats run optimally for the formation of body tissues (38). Fulfill their basic life so that abdominal fat formation decreases nutrients mainly used for body tissue formation. The addition of organic acids in broiler chicken feed can increase absorption by increasing the function of digestive enzymes to influence the increase in digestion and absorption, especially fiber and protein (51).

The addition of 0.5% propionic acid was not significantly different with the adding of 0.75% propionic acid to the percentage of abdominal fat. It is assumed that the small intervals between treatments cause propionic acid at a dose of 0.5% and 0.75% to have the same activity in optimizing pH. The enzyme activity of the digestive tract is also the same as the pH conditions are not real. Hence, the percentage of abdominal fat produced not significantly different. (49) The adding of organic acids can maintain the balance of microbes in the digestive tract by maintaining the digestive tract's pH to improve the work of digestive enzymes properly. (52) Giving double step down feeding with the addition of 1.6% citric acid as an acidifier in the ration can increase carcass weight and reduce levels of abdominal fat.

CONCLUSION

Based on these results, it can be concluded that the addition of propionic acid in the ration at a dose of 0.5% can increase the digestibility of crude protein by 2.42% and crude fiber digestibility by 69.25%. Improve the production performance that increases weight gain by 7.49%, decrease feed conversion by 4.86%, and increase carcass percentage by 4.12% of broiler chicken.

CONFLICT OF INTERESTS

The authors report no conflict of interest.

AUTHORS' CONTRIBUTION

All authors contributed to the work, discussed the results and contributed to the final manuscript.

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ADDITION OF PROPIONIC ACID ON NUTRIENT DIGESTIBILITY AND ITS EFFECT ON PRODUCTION AND CARCASS QUALITY OF BROILER

R. Palupi
Lecturer
F. N. L. Lubis
Lecturer
A. Suryani
Researcher
T. C. Bella
Researcher
D. Nurrachma
Researcher
Dept.Techn.and Livestock Industry, Faculty of Agric., Sriwijaya University Indonesia
E-mail: palupiarda@yahoo.com

ABSTRACT

This study was aimed to determine protein and crude fiber digestibility by adding propionic acid in rations and its effect on production and carcass quality broiler chicken. This research was carried out using 180-day old chicks (DOC) broiler chicken with Cobb strain. This research method used a completely randomized design (CRD) consisting of three treatments and six replications for every treatment. The treatment in this study consisted of: T0 = ration without propionic acid; T1 = addition of 0.5% propionic acid in the ration; T2 = 0.75% addition of propionic acid in the ration. Parameters observed included crude protein, crude fiber digestibility, feed consumption, body weight gain, feed conversion, live weight, carcass percentage, and percentage of abdominal fat in broiler chickens. The results showed that the addition of 0.5% propionic acid had a significant effect (P<0.05) on crude protein and crude fiber's digestibility in broiler chickens. Significantly increased feed consumption up to 2.29%; body weight gain up to 7.49 %, decreased feed conversion by 4.86%; increased body weight by 12.69%; carcass percentage by 4.12% and decreased 33% of abdominal fat broiler chicken. This research concludes that the addition of propionic acid in the ration at a dose of 0.5% could be increase the digestibility of crude protein and crude fiber rations, can improve the production performance and carcass quality of broiler chickens.

Key words: broiler chicken, digestibility, fiber, performance,protein.

إضافة حمض البروبيونيك على قابلية هضم العناصر الغذائية وتأثيره على إنتاج وجودة الذبيحة من الدجاج اللاحم

سورياني العاني
باحث
F. N. L. Lubis
مدرس
Palupi خطر
مدرس
نوروراكما إلهة
باحث
بيلا سيترا تيا
باحث

سم التكنولوجيا وصناعة الثروة الحيوانية ، كلية الزراعة ، جامعة سريويجايا ، إندونيسيا

المستخلص

هدفت هذه الدراسة إلى تحديد قابلية هضم البروتين والألياف الخام بإضافة حمض البروبيونيك في العلائق وتأثيره على إنتاج وجودة دجاج التسمين .تم إجراء هذا البحث باسعمال ت كتاكيت التسمين (DOC) التي يبلغ عمرها 180 يومًا من سلالة كوب .استعملت طريقة البحث تصميمًا عشوائيًا بالكامل (CRD) يتكون من ثلاث معملاتا وستة مكررات لكل معاملة.. تتكون المعاملة في هذه الدراسة من = T0 : حصص بدون حمض البروبيونيك0.5 = T1 .٪ حمض بروبيونيك مضاف لكل حصة ؛ و0.75 = T2 ٪ حمض بروبيونيك مضاف لكل وجبة .تضمنت المعايير التي تم رصدها البروتين الخام ، وهضم الألياف الخام ، واستهلاك العلف ، وزيادة وزن الجسم ، وتحويل العلف ، والوزن الحي ، ونسبة الذبيحة ، ونسبة دهون البطن في دجاج التسمين .أظهرت النتائج أن إضافة0.5 ٪ حمض البروبيونيك كان له تأثير معنوي (P <0.05) على هضم البروتين الخام والألياف الخام في دجاج التسمين .زيادة كبيرة في استهلاك الأعلاف تصل إلى 2.29٪ ؛ زيادة وزن الجسم بنسبة تصل إلى7.49 ٪ ، وانخفاض تحويل الأعلاف بنسبة4.86 ٪ ؛ زيادة وزن الجسم بنسبة12.69 ٪ . نسبة الذبيحة4.12 ٪ وانخفضت33 ٪ من دهن الفروج البطني . خلاصة هذا البحث إلى أن إضافة حمض البروبيونيك في الحصة الغذائية بجرعة0.5 ٪ يمكن أن يزيد من قابلية هضم البروتين والألياف الخام ، ويمكن أن يحسن أداء الإنتاج وجودة الذبيحة.

الكلمات المفتاحية: دجاج التسمين، قابلية الهضم، حمض البروبيونيك، الأداء، جودة الذبيحة.

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INTRODUCTION

The growth of broiler chickens can take place well if given feed that suits their needs, both in terms of quality and quantity, to support maximum production. The digestive tract's pH conditions that are not optimal can lead to the development of pathogenic bacteria (48). The results of a review conducted by (34) reported that the ph value of broiler chickens is strongly influenced by nutritional content, physical content, and the amount of feed consumed. However, One of many factors that causes a decrease in the digestive tract's pH value is feed fermentation. For example, The results of research that has been carried out on fermented feed using the lactobacillus type of bacteria reveal that this type of bacteria can act as a feed probiotic by reducing the pH value, which in turn results in a decrease in pathogenic bacteria in the digestive tract (1,2). Pathogenic bacteria often found in the digestive tract of poultry include Escherichia coli and Salmonella. These bacteria enter through feed and drinking water consumed by livestock, which can cause health problems in livestock and disrupt the absorption of food substances, resulting in a decrease in performance that affects the carcass quality produced at the end of broiler maintenance chickens. Generally, farmers add Antibiotic Growth Promoter (AGP) to overcome pathogenic bacteria's growth to increase the absorption of food substances. However, AGP's addition can leave antibiotic residues in the chicken meat produced, which will endanger the health of consumers who consume the meat. Food consumers must pay attention to food safety from the presence of contaminants and residues that are harmful to consumers, specific bacterial resistance, and environmental issues (,28, 46). Efforts can be made to avoid AGP's use with the addition of a specific feed additive that can replace the AGP function. One of the additives feeds that can be used in organic acids play an essential role in optimizing the digestive tract's pH. (4 , 42) in their report stated that organic acid supplementation in feed could inhibit the work of pathogenic bacteria and have a beneficial effect on the performance of poultry. One of the organic acids that can be used is propionic acid. When given to livestock, propionic acid does not cause residues in meat or carcasses produced, so it is safe to use as additive feeds in livestock. (5) report that organic acids can be used as suitable alternative additive feeds to replace antibiotics. The addition of organic acids can reduce the pH digestive tract of poultry and inhibit the bacteria like Escherichia coli and Salmonella, which cause the absorption of food substances in the intestine can run well and make livestock growth becomes stable. The resulting performance is good and produces good carcass quality and abdominal fat content low. The difference in protein content and acetic acid in the ration makes the pH of the duodenum is 4.17 - 5.68, the pH of the jejunum is 5-6, and the pH of the ileum is 5.83 - 6 (33). One of the organic acids is propionic acid. This study aims to find feed additives that can increase the production and carcass quality of broiler chicken. The study hypothesizes that propionic acid in the diets can increase the production and carcass quality of broiler chicken.

MATERIAIS AND METHODS

Study Site: An animal feeding experiment was conducted at the experimental station, Department of Animal Science, Faculty of Agriculture, Universitas Sriwijaya. The ducks were cared for according to the Animal Welfare Guidelines of the Indonesian Institute of Sciences. The approval of the experiment was granted from Universitas Sriwijaya.

Birds, Diets, Housing, and Experimental Design: This research used 180-day old chick (DOC) broiler chicken of Cobb strain with unsexing. The DOC weight used ranged from 53 to 56 g. The DOC was placed in the postal cage. The cage used is a postal cage with a 60cm x 50cm x 60cm size. Broiler chickens are carried out for 28 days. The Broiler chickens were divided into three treatments with various percentages of propionic acid usage in the diets. The ratio given is HI-Pro type commercial feed given at the age of one to 21 days (starter phase - grower phase) and produced by PT. Charoen Pokphan Indonesia Tbk, MRI-P ration given at the age of 22 to 28 days (finisher phase) produced by PT. Cj Cheiljedang Feed Lampung and Propionic Acid (Zetox) produced by PT. Healthy Bright Indonesia.

Table1. Composition of nutrient rations during the study

Food substances	HI-PRO*	MR1-P**
Water content (Max) (%)	13.0	13.0
Protein (%)	22.0 – 23.0	21.5 – 23.0
Crude Fiber (Max) (%)	5.0	4.0
Fat (Min) (%)	5.0	8.0
Ash (Max) (%)	7.0	6.5
Calcium	0.9	0.9 – 1.2
Phosfor	0.6	0.7 - 1.0
Metabolism Energy (kcal/kg)	3020 – 3120	3000 – 3100

Note : HI-Pro (PT. Charoen Pokphan Indonesia Tbk), **MR1-P (PT. Cj. Cheiljedang Feed Lampung).

The research design used was a Completely Randomized Design (CRD) consisting of 3 treatments and six replications. The DOC was placed into the experimental cages, each unit of the cage was occupied by ten heads each. The treatments used are as follows: T0 (without the addition of propionic acid in the diet), T1 (addition of 0.5% propionic acid), and T2 (addition of propionic acid 0.75%). The propionic acid given comes from commercial propionic acid in the form of flour. Propionic acid is mixed in the ration according to each treatment and stirred evenly until homogeneous. The adaptation of the treatment ration was carried out gradually within four days. According to treatment, chickens were fed treatment rations with a concentration of 25% on the first day, 50% on the second day, then 75% on the third day and 100% on the fourth day.

Growing Performance and pH Measurement of Gizzard: Broiler chicken performance, which includes measurement of parameters: Feed consumption (g/head/day), weight gain (g/head/day), and feed conversion ratio were calculated from the difference between the final body weight and the initial bodyweight of the study (47). Value of pH measurements was carried out on the duodenum, jejunum, and ileum. Simultaneously using a digital pH meter (Extech EC500 Waterproof ExStik II PH Meter), lactic acid bacteria was measured based on the population of Lactobacillus sp. in the small intestine of chicken aged four weeks (CFU/g).

Digestibility and Carcass quality

Measurements Digestibility/Digestion of crude protein (%) and crude fiber (%).were calculated using the formula (45). Furthermore, Carcass quality measurement, which includes measurement of parameters: Live weight (g), calculated based on the difference between the results of weighing the chicken before being cut and after fasting for 6 hours. The percentage of the carcass (%) is calculated as the percentage of the ratio between the carcass weight (g) and the life weight (g), and percentage of abdominal fat, calculated based on the percentage of the comparison between the weight of abdominal fat (g) and the weight of life (g).

Data Analysis

The SAS statistical package (PROC GLM) was used to determine the significance of differences between treatments (SAS, 2013). Data obtained during this study were analyzed according to a Completely Randomized Design (CRD). If there are significant differences, further tests will be carried out using the Duncan Multiple Range Test (42).

RESUITS AND DISCUSSION

Effect of Treatment on pH of small intestine and growth Performance: Based on the analysis of variance, the addition of propionic acid in the diet had a significant effect ($P<0.05$) on the pH of the duodenum and the pH of the jejunum, but had no significant effect ($P>0.05$) on the pH of the ileum. This is because propionic acid has acidic properties; so that when it enters the digestive tract of broilers; it was caused the release of hydrogen atoms on digestive tract and cloud impact on the decrease of pH value. The supplementation of organic acids had showed could reduce the pH of the digestive tract and the microbial activity on the stomach and small intestine (11 , 31). The decrease in pH in each part of the small intestine will affect the condition of the small intestine, where pathogenic bacteria found in the small intestine cannot stand the lower pH conditions. Dittoe et al. (12) reported that the pH of the digestive tract is a microbial condition in the digestive tract of poultry that will have an impact on poultry health.

Table 2. Effect treatment on pH, ration consumption, weight gain and conversion of broiler chickens

pH on small Intestine	Treatment T0	T1	T2
Duodenum	5.86[a]	5.04[b]	5.02[b]
Jejunum	6.00[a]	5.78[b]	5.66[b]
Ileum	6.98[a]	6.22[b]	6.38[b]
Growing Performance	**T0**	**Treatment T1**	**T2**
Consumption (g/head/day)	73,94[a]±0,97	75,64[b]±0,87	75,87[b]±0.64
Wight gain (g/head/day)	51,37[a]±2,49	55,22[b]±1,80	56,18[b]±2,64
Conversion	1,44[a]±0,05	1,37[b]±0,04	1,35[b]±0,05

Note: Different superscripts in the same column show significantly different influences (P<0.05). P0 (without the addition of propionic acid), P1 (addition of 0.5% propionic acid), P2 (addition of propionic acid 0.75%).

The addition of 0.5% propionic acid did not differ (P>0.05) with the addition of 0.75% propionic acid in the diet on the pH of the duodenum and the jejunum of broiler chickens. This is due to the optimum concentration of 0.5% addition of propionic acid, so that the increase in concentration level to 0.75% is not significantly different from the 0.5% level. In line with the research results of Ndelekwute et al. (32) that the use of several organic acids, namely citric acid, butyric acid, acetic acid and formic acid at a level of 0.25% acid in drinking water can lower the pH of the small intestine of broiler chickens.The Observation Data for each of these broiler chicken performance parameters based on average rations consumption, weight gain, and conversion of broiler chicken rations could be seen in Table 2. Consumption of broiler chicken rations during the study ranged from 73.94 to 75.87 g/head/day. The variance analysis results showed that the addition of propionic acid in the ration had a significant effect (P<0.05) on the consumption of broiler chicken rations. It was caused by the addition of propionic acid in the ration to improve the broiler chicken digestive tract's performance by optimizing the pH of the digestive tract. The pH of the broiler small intestine after propionic acid addition was 5.5-5.8. Changes in pH result in pathogenic bacteria's death because pathogenic bacteria cannot resist the acidic conditions. Others (5) and (19), reported that citric acid could reduce the digestive tract's pH (crop, ventriculus, and intestine), suppress the growth of pathogenic bacteria, and increases lactic acid bacteria, contributing to the digestive process the use of protein becomes good. Lysis of pathogenic bacteria will increase the absorption of nutrients that will be used to form muscle tissue. The increase in the feed flow rate in the digestive tract so that the stomach quickly empty and causes increased ration consumption. Following (34), organic acids can increase the feed flow rate so that gastric emptying is faster and consumption increases. The addition of 0.5% propionic acid did not differ (P>0.05) with the addition of 0.75% propionic acid in the diet on the pH of the duodenum and the jejunum of broiler chickens. This is due to the optimum concentration of 0.5% addition of propionic acid, so that the increase in concentration level to 0.75% is not significantly different from the 0.5% level. In line with the research results of Ndelekwute et al. (32) that the use of several organic acids, namely citric acid, butyric acid, acetic acid and formic acid at a level of 0.25% acid in drinking water can lower the pH of the small intestine of broiler chickens.The Observation Data for each of these broiler chicken performance parameters based on average rations consumption, weight gain, and conversion of broiler chicken rations could be seen in Table 2. Consumption of broiler chicken rations during the study ranged from 73.94 to 75.87 g/head/day. The variance analysis results showed that the addition of propionic acid in the ration had a significant effect (P<0.05) on the consumption of broiler chicken rations. It was caused by the addition of propionic acid in the ration to improve the broiler chicken digestive tract's performance by optimizing the pH of the digestive tract. The pH of the broiler small intestine after propionic acid addition was 5.5-5.8. Changes in pH result in pathogenic bacteria's death because pathogenic bacteria cannot resist the acidic conditions. (22) and (23), reported that

citric acid could reduce the digestive tract's pH (crop, ventriculus, and intestine), suppress the growth of pathogenic bacteria, and increases lactic acid bacteria, contributing to the digestive process the use of protein becomes good. Lysis of pathogenic bacteria will increase the absorption of nutrients that will be used to form muscle tissue. The increase in the feed flow rate in the digestive tract so that the stomach quickly empty and causes increased ration consumption. Following (2), organic acids can increase the feed flow rate so that gastric emptying is faster and consumption increases. The addition of 0.5% propionic acid was not significantly different (P>0.05) with 0.75% propionic acid to ration consumption. Due to the addition of propionic acid at a dose of 0.5% and 0.75% in the ration giving effect the same to the digestive tract, the digestive enzyme activity is the same in the treatment. Enzyme activity will affect the feed rate in feed consumed by livestock. It can be absorbed entirely along with the rapid digestion rate, which caused the digestive tract to empty quickly. Broilers chicken continues to consume rations to meet energy needs so that the consumption of rations increases. (24) and (25) reported an increase in the digestive tract's productivity, which functions favorably for bacterial growth by decreasing acidity in the digestive tract and can activate and stimulate the production of endogenous enzymes and can increase ration consumption. Moreover, Others (42) reported that adding of the mixture of organic acids could increase broiler chicken rations' consumption. Average Chicken body weight gain during the study ranged from 51.37 to 56.18 g/head/day. The variance analysis results showed that the addition of propionic acid in the ration had a significant effect (P<0.05) on the body weight gain of broiler chickens. Because the addition of propionic acid in the ration can reduce the pH of the digestive tract, consequently can inhibit the work of pathogenic bacteria that cannot stand the acidic conditions, so there is no competition in the absorption of nutrients in the digestive tract. The optimal absorption of food substances can increase the bodyweight of broiler chickens. According to (18), organic acid acts as a growth promoter or growth booster capable of suppressing the growth of acid intolerant bacteria such as Escherichia Coli, Salmonella spp, and Clostridium perfringens. Further tests showed that the addition of 0.5% propionic acid and 0.75% addition of propionic acid were significantly different (P<0.05) from the control. The smallest average body weight gain at T0 is 51.37 g/head/day because the ration consumed without the addition of propionic acid is as low as 73.94 g /head /day. In contrast, propionic acid can optimize the pH of the digestive tract so that feed consumed by livestock is converted into muscle tissue. There is an increase in body weight in broiler chickens. (19) states that the administration of organic acids can maintain the balance of microbes in the digestive tract by maintaining the digestive tract's pH and being able to increase protein absorption. According to these results, organic acids such as propionic acid can optimize pH in the digestive tract, increase the pepsin enzyme activity, and increase the digestibility of nitrogen, phosphorus, and minerals that good weight gain occurs (4). The treatment of the addition of 0.5% propionic acid was not significantly different (P>0.05) by adding 0.75% propionic acid to the body weight gain of broiler chickens. Because the addition of propionic acid at 0.5% and 0.75% has the same ability to optimize the digestive tract's pH, the digestion process of nutrients goes well. It increases the body weight gain of broiler chickens. The addition of propionic acid at 0.5% and 0.75% can increase body weight gain by build muscle tissue in broiler chickens. The digestive tract's optimal pH can secrete pancreatic enzyme activity amino acids derived from feed can be digested and absorbed by the intestine. (35) stated The addition of organic acids can increase pancreatic enzyme activity to optimize digestion and absorption of amino acids derived from feed for muscle tissue formation. Furthermore, (6) stated that the addition of organic acids could reduce the digestive tract's pH, increasing pepsin enzyme activity resulting in increased body weight. Pepsin enzymes function to break down protein into amino acids and be absorbed by the body so that forming muscle tissue becomes profitable, increasing the body weight gain of broiler chickens. In line with the research results (23)

stated that the administration of 0.5% citric acid showed the best results of body weight and final body weight. (40) the addition of 0.75% acetic acid in the ration resulted in better body weight gain than controls. Based on the amount of ration consumption and body weight gain produced during the study, broiler chicken ration's average conversion ranged from 1.35 - 1.44. The variance analysis results showed that the addition of propionic acid in the ration had a significant effect (P<0.05) on the conversion of broiler chicken rations. The average conversion in T2 treatment with the addition of 0.75% propionic acid is the lowest conversion rate. The low conversion rate of rations is caused by feed consumed by livestock digested and absorbed entirely to form muscle tissue, increasing body weight gain. The addition of propionic acid causes acidic conditions in the digestive tract of broiler chickens that will support digestive enzymes' activity. Changes in the digestive tract's acidity can cause growth disorders in pathogenic bacteria to reduce pathogenic bacteria in the digestive tract of broiler chickens. (23) reported that citric acid can reduce the digestive tract's pH (crop, ventriculus and intestine), suppress pathogenic bacteria's growth, and increase lactic acid bacteria that contribute to the digestive process so that the use of protein becomes optimal. Based on further testing, the treatment of T0 was significantly different (P <0.05) to T1 (addition of 0.5% propionic acid) and T2 (addition of 0.75% propionic acid). The addition of propionic acid in the ration could reduce the conversion value of feed because the feed consumed by broiler chickens results in higher weight gain than broiler chickens given rations without the addition of propionic acid. The addition of propionic acid can increase the efficient use of feed. They were following (13), which is reported that giving 0.25% citric acid and 0.25% butyric acid positively affects feed efficiency. Treatment without the addition of propionic acid in the ration produces a higher conversion rate, thereby reducing feed use efficiency. T1 treatment was not significantly different (P>0.05) with T2 on broiler chicken rations' conversion. The addition of 0.5% and 0.75% propionic acid has relatively small propionic acid addition intervals, so the treatment effect of 0.5% and 0.75% is not significantly different from the ration conversion. In line with the results of Vale et al.'s (2004) research, the addition of 70% formic acid and 30% propionic acid at a rate of 0.2 to 25% in the ration can improve the value of broiler chicken conversion. According to (23) addition of 0.5% citric acid can improve ration conversion. (21) state that the appropriate level of propionic acid use is 0.2 to 0.4% in the ration to improve broiler chicken's feed conversion value.

Effect of Treatment on Crude Protein Digestibility: The average digestibility value of crude protein and crude fiber in broiler chickens can be seen in Table 3. The variance results showed that propionic acid's use had a significant effect (P<0.05) on the digestibility of crude protein in broiler chickens. The addition of propionic acid causes this can cause a decrease in pH in the digestive tract of broiler chickens, resulting in increased activity of protein degrading enzymes (pepsin and protease). The pH of the digestive tract of broiler chickens in the treatment T1 and T2 is lower than T0. The pH of duodenum T1 and T2 ranged from 4.2 to 5.3, while that of duodenum T0 was 5.8. The pH of the jejunum T1 and T2 ranges from 5.2 - 6, while T0 is 6.6 and the pH of the ileum T1 and T2 ranges from 5.4 to 6.1, and the pH of the ileum at T0 was 7. (22) stated that an acidic atmosphere in the digestive tract would activate pepsinogen into pepsin which plays a role in digesting protein. (12) stated Organic acids can increase the secretion of protein-digesting enzymes and release the gastrin hormones and cholecystokinin, which play a role in stimulating crude protein digestive enzymes. Gastrin is a hormone produced by gastrin cells in the stomach's pylorus, which stimulates stomach acid release. Further tests showed that the addition of 0.5 and 0.75% propionic acid was significantly different (P<0.05) from the control ration on crude protein digestibility. The addition of propionic acid with a level of 0.5 to 0.75% in broiler rations can reduce the digestive tract's pH, thereby increasing the activity of digestive enzymes.

Table 3. Digestiblity of crude protein and crude fiber in broiler chickens

Treatment	Crude protein digestibility (%)	Crude fiber digestibility (%)
T0	72,78^{a}±1,22	28,33^{a}±3,25
T1	74,54^{b}±1,19	47,95^{b}±1,09
T2	79,79^{b}±1,63	46,31^{c}±1,61

Note: Different letter superscripts showed significantly different treatments (P <0.05) P0 (without addition of propionic acid), P1 (addition of 0.5% propionic acid), P2 (addition of 0.75% propionic acid).

Table 4. Effect treatment on live weight, carcass percentage and abdominal fat percentage during the study

Treatment	Live Weight (g) (4 weeks old)	Carcass Percentage (%)	Abdominal Fat Percentage (%)
T0	1315^{a}±38,49	69,84^{a}±1,40	1,92^{a}±0,44
T1	1574^{b}±37,21	72,72^{b}±1,17	1,27^{b}±0,51
T2	1619^{b}±65,59	73,40^{b}±2,28	1,22^{b}±0,28

Note: P0 (without the addition of propionic acid), P1 (addition of 0.5% propionic acid), P2 (addition of propionic acid 0.75%). Different superscripts in the same column showed significantly different effects (P <0.05).

(24) on review concluded that the addition of organic acids can affect the condition of the small intestine pH's atmosphere becomes more acidic to support the activity of lactic acid bacteria. The optimal pH will make lactic acid bacteria live optimally in the intestinal villi to increase the absorption of nutrients of rations by expanding the intestinal villi surface area. (38) explained that increasing the height and width of villi in the ileum was caused by lactic acid bacteria that we can increase short-chain fatty acids and reduce ammonium production. however, in an experiment reported by (12), it was revealed that organic acid supplementation could increase the production of propionate and iso butyrate; increase the activity of a-glucosidase and b-glucouronidase enzymes; but, it does not decrease ammonium production. Short-chain fatty acids play a role in stimulating the multiplication of intestinal epithelial cells. The increase of the villi's height and width indicates the villi's broader surface for absorption of food that enters the bloodstream (1). The addition of propionic acid 0.5 and 0.75% in the ration did not differ significantly (P> 0.05) on crude protein's digestibility. The addition of propionic acid with a level of 0.5% and 0.75% has the same ability to optimize the digestive tract's pH, thus giving the same effect on the digestibility of crude protein. This result was similar to (22), who reported the addition of citric acidifiers with a level of 0.4 to 0.8% in natural and synthetic form in feed could increase crude protein digestibility by activating pepsin enzyme; such as proteases in the proventriculus and small intestine. (20) report that the use of lactic acid in rations can increase protein digestibility in broiler chickens.

Effect of Treatment on Crude Fiber Digestibility: The variance results showed that the treatment had a significant effect on crude fiber digestibility (P<0.05). Due to a decrease in the digestive tract's pH value, which caused increases in some polysaccharides' chemical hydrolysis and reduced the level of crude fiber. The research stated that organic acids could reduce the digestive tract's pH in the duodenum, jejunum, ileum, and caecum (19). The lower pH will cause the digesta rate to slow down so that the time spent digesting crude fiber will also be longer (34). Based on the results of further tests showing that each treatment was significantly different. T1 and T2 treatments were significantly different (P<0.05) higher with T0. It was caused by a decrease in the digestive tract's pH, which is thought to increase the lactic acid bacteria population. The average population of Lactobacillus sp. in the small intestine of broiler chickens without the administration of propionic acid is 1.2x104 CFU/g, whereas in the treatment of addition of propionic acid an increase in the population of Lactobacillus sp. namely at P1 3.7x106 CFU/g and P2 4.4x106 CFU/g. (25) stated that an increase in lactic acid bacteria produced lactic acid and Short Chain Fatty Acid production. The increase in SCFA and lactic acid accompanied by decreased pH of the digesta will further reduce pH in the cecum. The research by (26) reported the addition of lime acid extract at the level of 3 ml had a very significant effect on

pH and the total increase in lactic acid bacteria in the digestive tract. The pH that is suitable for the growth of lactic acid bacteria (LAB) in broiler chicken cecum is 6.09 (19) and 6.20 (29). The addition of propionic acid in the ration on treatments T1 and T2 was significantly different (P <0.05) on the digestibility of crude fiber in broiler chickens. It was thought to be caused by an increase in the higher lactic acid bacteria population in T2. Lactic acid bacteria and other non-pathogenic bacteria that produce organic acids, especially lactic acid, can reduce pH in the cecum (19). On other hands, (25) added that the increasing population of lactic acid bacteria in the caecum would help break down carbohydrates, which can then be fermented by cellulolytic bacteria. Related to this results, (15) reported that the population of cellulolytic bacteria in the digestive tract of poultry was 63x107 cfu/g, where the bacteria could degrade crude fiber. The decrease in crude fiber levels is due to higher cellulose and hemicellulose enzyme activity during the fermentation process (10 , 14). Decreasing pH will increase the speed of chemical hydrolysis of some polysaccharides, which will reduce crude fiber levels. (16) stated the entering of organic acids on the proventriculus would weaken the crude fiber component to be more easily digested by microorganisms enzymatic.=

Effect of Treatment on the Quality of Broiler Chicken Carcasses: The carcass quality was determined based on the resulting live weight, carcass percentage, and abdominal fat percentage, as shown in Table 4. The average live weight of broiler chickens obtained in this study ranged from 1315 - 1619 grams. The variance analysis results showed that the addition of propionic acid in broiler chicken ration had a significant effect (P<0.05) on the live weight of broiler chickens. Because propionic acid's addition has a significant effect on ration consumption, the higher the increase of propionic acid concentration in the ration, the higher the increase of the ration consumption. The increase in ration consumption reflects an increase in the consumption of food substances. (34) reports that consumption of rations reflects the entry of several nutrients into the body of broiler chickens. Further tests showed that broiler chickens' live weight added 0.5% propionic acid and 0.75% propionic acid were significantly different (P<0.05) from controls. Because propionic acid optimizes the digestive tract's pH by the digestive tract's acidity, which is 5.5-5.8, especially in the small intestine. According to (19) organic acids such as acetate, propionate, and butyrate can reduce toxin production by bacteria, improve the intestinal wall's morphology, and reduce the colonization of pathogenic bacteria. Optimal digestion of food substances will increase weight gain, which can be seen in the increase in broiler chickens' live weight. The addition of organic acids can increase broiler chicken weight (27 , 35). The addition of 0.5% propionic acid was not significantly different (P>0.05) with the addition of 0.75% propionic acid to broiler chickens' live weight. Because at the level of 0.5%, the addition of propionic acid in the ration can provide optimal acid conditions in the digestive tract of broiler chickens to increase body weight. Following the opinion of (23) that the administration of organic acid in the form of 0.5% citric acid in the ration produced the best final body weight compared to acetic acid. The addition of propionic acid increases the body weight of broiler chicken produced. The higher the increase of body weight produced, the higher the percentage of broiler chicken carcasses. The average percentage of broiler chicken carcass obtained in this research ranged from 69.84 to 73.40%. The variance analysis results showed that the addition of propionic acid in the ration during the research had a significant effect (P<0.05) on the percentage of broiler chicken carcasses due to the percentage of carcass influenced by the resulting live weight. This research's live weight is getting higher by increasing the addition of propionic acid in the ration. Others (4); (20); and (23) states that the achievement of bodyweight components is closely related to carcass weight. The higher the live weight produced, the higher the percentage at the end of the research (30). The results of further tests showed that the percentage of the carcass of broiler chicken, which was added by propionic acid 0.5% and 0.75% was significantly different (P<0.05) with T0 (control). Presumably, propionic acid

acts as an acidifier that can optimize the digestive tract's pH to improve the work of digestive enzymes and increase absorption of food substances, especially proteins that function as substances forming body tissues. In line with the study results by (31), the addition of organic acids can maintain the balance of microbes in the digestive tract by maintaining the digestive tract's pH so that protein absorption increases. The addition of 0.5% propionic acid was not significantly different (P> 0.05) with the addition of 0.75% propionic acid to the percentage of broiler chicken carcasses. It optimized the digestive tract's pH to increase the absorption of nutrients, which affects the percentage of a carcass. In line with the opinion of (22) reported that administering organic acids such as citric acid to the level of 1.2% in single step down feeds could increase carcass weight. The increase in the carcass percentage was inversely proportional to the percentage of abdominal fat in broiler chickens. The average percentage of abdominal fat produced in each treatment ranged from 1.22-1.92%. The variance analysis results showed that the addition of propionic acid in the ration had a significant effect (P<0.05) on the percentage of abdominal fat in broiler chickens. The addition of propionic acid can cause a decrease in the digestive tract's pH so that it activates the work of the pepsinogen enzyme. This study's percentage of abdominal fat is lower than that stated by (46), who reported the average percentage of abdominal fat in broiler chicken ranges from 2.24 to 3.90%. In contrast, the lipase enzyme can work actively at pH 6.8 to reduce the activity of lipase enzymes in digesting fat. (24,25)stated the digestion of fat in the intestine includes the breakdown of dietary fat into fatty acids, monoglycerides, and others through, which is cooperation between bile salts and intestinal lipases occurring in environments with high pH due to the presence of bicarbonate secretion. In line with the opinion of (44) the lipase enzyme can work optimally at pH 7. Further tests showed that the percentage of abdominal fat added with 0.5% propionic acid and 0.75% propionic acid was significantly different (P<0.05) from controls. The percentage of broiler chicken abdominal fat with the addition of propionic acid in feed has a lower percentage of abdominal fat than broiler chickens without propionic acid in the ration (control). Because propionic acid can increase digestive enzymes' work and increase absorption of nutrients such as carbohydrates, proteins, and fats run optimally for the formation of body tissues. Fulfill their basic life so that abdominal fat formation decreases nutrients mainly used for body tissue formation. The addition of organic acids in broiler chicken feed can increase absorption by increasing the function of digestive enzymes to influence the increase in digestion and absorption, especially fiber and protein (9). The addition of 0.5% propionic acid was not significantly different (P>0.05) with the addition of 0.75% propionic acid to the percentage of abdominal fat. It is assumed that the small intervals between treatments cause propionic acid at a dose of 0.5% and 0.75% to have the same activity in optimizing pH. The enzyme activity of the digestive tract is also the same as the pH conditions are not real. Hence, the percentage of abdominal fat produced not significantly different. (31) The addition of organic acids can maintain the balance of microbes in the digestive tract by maintaining the digestive tract's pH to improve the work of digestive enzymes properly. (37) Giving double step down feeding with the addition of 1.6% citric acid as an acidifier in the ration can increase carcass weight and reduce levels of abdominal fat.

CONCLUSION

Based on this study's results, it can be concluded that the addition of propionic acid in the ration at a dose of 0.5% can increase the digestibility of crude protein by 2.42% and crude fiber digestibility by 69.25%. Improve the production performance that increases weight gain by 7.49%, decrease feed conversion by 4.86%, and increase carcass percentage by 4.12% of broiler chicken.

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AUTHORS' CONTRIBUTION: All authors contributed to the work, discussed the results and contributed to the final manuscript.

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