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Evaluation of Curcuma and Black Garlic Flour on Small Intestine Morphometrics, Carcass Weight, and Abdominal Fat of Broiler Chickens

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ABSTRACT

Curcuma flour and black garlic have potential benefits for chicken digestive health. A healthy digestive tract will help the process of absorbing feed more optimally. This research aimed to evaluate the potential of curcuma flour and black garlic in feed on small intestine morphometrics, carcass weight, and abdominal fat in broiler chickens. The study used 200 broiler chicken day-old chicks (DOC) randomly assigned to 5 treatments with 4 replications, including P0 = 100% commercial ratio (control), P1 = P0 + 2% black garlic, P2 = P1 plus 0.25% curcuma flour, P3 = P1 + 0.50% curcuma flour, and P4 = P1 + 0.75% curcuma flour. The study employed a completely randomized design (CRD), and the data were analyzed using analysis of variance (ANOVA). Significant differences between treatments were further tested using Duncan's Multiple Range Test. The results showed that supplementation with Curcuma flour and black garlic in feed did not have a significant effect (P>0.05) on feed consumption, slaughter weight, small intestine morphometrics, carcass weight, carcass percentage, abdominal fat weight, and abdominal fat percentage. The results of this study indicate that the evaluation of Curcuma flour up to 0.75% and black garlic 2% in broiler chicken feed does not affect the activity of the small intestine, broiler carcass, and abdominal fat, as reflected in normal organ weights.

Keywords: Abdominal fat, black garlic, carcass, curcuma, small intestine

ABSTRAK

Tepung temulawak dan *black garlic* memiliki potensi manfaat untuk kesehatan pencernaan ayam. Saluran pencernaan yang sehat akan membantu proses penyerapan pakan menjadi lebih optimal. Penelitian ini bertujuan untuk mengevaluasi potensi tepung curcuma dan bawang hitam dalam pakan terhadap morfometri usus halus, berat karkas, dan lemak abdominal pada ayam broiler. Penelitian ini menggunakan 200 anak ayam broiler (DOC) yang secara acak ditugaskan ke 5 perlakuan dengan 4 ulangan, termasuk P0 = 100% pakan komersial (kontrol), P1 = P0 + 2% *black garlic*, P2 = P1+ 0.25% tepung temulawak P3 = P1+0.50% tepung temulawak dan P4 = P1 + 0.75% tepung temulawak. Penelitian ini menggunakan rancangan acak lengkap (RAL), dan data dianalisis menggunakan analisis variansi (ANOVA). Perbedaan signifikan antara perlakuan selanjutnya diuji menggunakan uji Duncan. Hasil penelitian menunjukkan bahwa suplementasi dengan tepung curcuma dan *black garlic* dalam pakan tidak memiliki efek signifikan (P>0.05) pada konsumsi pakan, bobot potong, morfometrik usus halus, berat karkas, persentase karkas, berat lemak abdominal, dan persentase lemak abdominal. Kesimpulan penelitian ini bahwa evaluasi tepung temulawak hingga 0.75% dan *black garlic* 2% dalam pakan ayam broiler tidak mempengaruhi aktivitas usus halus, karkas ayam broiler, dan lemak abdominal, sebagaimana tercermin dalam berat organ yang normal.

Kata kunci: *Black garlic,* curcuma, karkas, lemak abdominal, usus halus

INTRODUCTION

The broiler chicken farming industry faces serious challenges such as the impact of extreme heat which can cause heat stress in chickens. Heat stress affects the appetite, growth, and digestive tract health of broiler chickens (Subekti *et al.* 2012). Chickens try to balance their body temperature by releasing heat into the environment. Research shows that heat-stressed chickens spend less time eating, more time drinking, panting, raising their wings and resting (Lara and Rostagno 2013). As a result, there is a decrease in appetite, poor nutrient absorption, and an increased risk of health problems, as well as a decrease in broiler chicken carcass quality. To reduce the impact of heat stress and achieve optimal performance, the practice of providing antibiotic supplementation in broiler chicken feed needs to be carried out.

The current challenge is related to providing antibiotic supplementation which has prohibited the use of antibiotics as growth stimulants in animal feed. Regulation of the Minister of Agriculture Law No.14/PERMENTAN/PK.350/5/2017 on January 1 as a step to minimize the emergence of antibiotic resistance. The use of antibiotics as feed additives is prohibited because antibiotics have the potential to be absorbed into livestock products, and indirectly consumers will receive antibiotics in low concentrations, which can increase bacterial resistance and chemical residues, and can cause allergic effects in humans (Xu *et al.* 2020). A potential alternative effort is the use of feed additives originating from plants as a source of phytogenic compounds, which at certain doses can be positively beneficial as a growth promoter, helping prevent stress in chickens and improving the performance of the digestive tract. One way is by giving curcuma flour (*Curcuma xanthorrhiza* Roxb).

Curcuma is a medicinal plant that has many benefits (Anggraini *et al.* 2019). Curcuma is known to have anti-hepatitis, anti-carcinogenic, antimicrobial, antioxidant, antihyperlipidemic, antiviral, anti-inflammatory, and detoxification properties (Candra 2013). According to Masti *et al.* (2020) adding curcuma to the feed can cope with chickens in hot situations. Curcuma has main components that are important for health and efficacy, including the active substance content of curcuminoids, essential oils, protein, fat, cellulose, and minerals (Rahardjo 2010). The curcumin content in curcuma rhizomes ranges from 1.6% – 2.22% (Wibowo *et al.* 2020). Curcumin can increase the activity of the digestive organs of broiler chickens, stimulate the secretion of bile and pancreatic juice, and improve the digestion of carbohydrates, fats, and proteins (Alhadi *et al.* 2021). Bile can effectively dissolve fat, reduce cholesterol levels, and improve digestion and absorption of fat. Curcumin increases appetite by its effect on the pancreas, while curcuma accelerates gastric emptying, causes hunger, and stimulates appetite (Bayoa *et al.* 2014). Providing carbonated curcuma can increase the body weight gain of broiler chickens (Candra 2013). Curcumin and essential oils in curcuma physically and chemically have the potential as feed additives in animal feed to increase productivity, product quality, and health (Rifat *et al.* 2008). However, to optimize the function of curcuma, there needs to be a combination of other herbal ingredients such as fermented garlic (black garlic).

Black garlic is garlic that has undergone a fermentation process for more than one month using an oven with controlled temperature and humidity (Bae *et al.* 2014). This process produces a new formulation that does not have the typical garlic flavor but has higher properties than ordinary garlic. According to the research results of Berliana *et al.* (2018), black garlic has been proven to be able to reduce cholesterol, triglyceride, and LDL levels in laying quail. The biological activity of black garlic is significantly higher than that of fresh garlic. The research results of Nelwida *et al.* (2019) show that fresh garlic heated for 17 days at a temperature of 60º Celsius produces a more balanced nutritional content than heated for more or less than 17 days. According to Bae *et al.* (2014), black garlic contains 5-7 times more active compounds than garlic. Black garlic is rich in Organosulfur compounds, especially Allicin (Wang *et al.* 2010), the S-Allylcysteine content in black garlic reaches 194.3 µg/g, whereas in fresh garlic it is only around 23.7 µg/g (Isna *et al.* 2021). The Allicin content can increase the height of the villi and the depth of the crypts of the small intestine (Lee *et al.* 2016). Black garlic also functions to maintain the balance of intestinal microflora in the digestive system (Zulfikar *et al.* 2022), resulting in the ability of the food consumed to be digested and absorbed better.

Curcuma is known to have anti-inflammatory and antimicrobial potential, while black garlic contains bioactive compounds with high antioxidant properties. These two ingredients have the potential to improve digestive tract health activities and regulate fat metabolism in broiler chickens. However, it is necessary to increase the dose sufficiently to increase the optimal function of these bioactive substances on the performance of broiler chickens. Previous research by Berliana *et al.* (2020) that giving 5% black garlic to broiler chickens can reduce weight gain in broiler chickens and does not show significant results on ration consumption and slaughter weight, while the use of 1% curcuma does not have a significant effect on ration consumption, slaughter weight, and carcass quality broiler chickens. It is thought that the distinctive aroma of black garlic and curcuma and the bitter taste do not affect the performance of broiler chickens. According to Ananda *et al.* (2022), the decrease in broiler palatability is thought to be caused by the very sharp distinctive aroma and bitter taste of curcuma. So it is necessary to evaluate reducing the level of curcuma and black garlic in broiler chicken feed so that it is hoped that the chicken will consume well and the activity of the desired bioactive substances will work optimally on the performance of the small intestine, carcass and abdominal fat of broiler chickens.

Through this research is hoped that optimal doses of curcuma and black garlic will be obtained to increase digestive tract activity and fat metabolism in broiler chickens without reducing performance. This research aimed to evaluate the potential of curcuma flour and black garlic in

feed on small intestine morphometrics, carcass weight, and abdominal fat in broiler chickens.

MATERIAL AND METHODS

Material

The materials used in this research included 200 2-day-old broiler chickens (DOC), curcuma, and garlic obtained from the Angso Duo market, as well as commercial feed without antibiotics from Starter phase (N-511) and Finisher phase (N-512) from PT. Charoen Pokphand. Apart from that, other equipment used includes 20 units of colony cages measuring 1x1 m, husks, newspapers for food and drink, lights, analytical scales, a rice cooker, and knives.

Methods

The cages were prepared in 20-size units (1x1 m) and the equipment were sanitized using lime and formades-type disinfectant at a dose of 100 ml per 25 liters of water. Feed and drinking equipment were washed using detergent and then dried in the sun until dry.

The production of black garlic was modified according to Nelwida *et al.* (2019) starting with selecting garlic that has had its skin removed, was not rotten, and has a uniform size to ensure even heat and simultaneous ripening when heated. Then, the garlic is wrapped one by one in aluminum foil and placed in a rice cooker that has been heated at a temperature of around 60 °C for 17 days. Harvesting was done by separating each clove of onion that has been peeled and arranging it on a tray, then placing it in the oven for 3 days at a temperature of 60 °C. After the black garlic has dried, it was milled until it becomes flour and then given to feed according to the treatment. The production of curcuma flour was modified according to Dono›s instructions (2010), starting with selecting curcuma rhizomes that were neither too young nor too old, then washing the curcuma rhizomes to clean the epidermis, after washing the curcuma, cutting them into thin pieces, then arrange them on a tray and air-dry for 2-3 days without exposure to sunlight. Once the curcuma has been dried, it can be ground and given to feed according to treatment.

Chickens were kept for 5 weeks (35 days) with rations given ad libitum according to treatment. Every week each chicken is weighed to obtain data on body weight gain, and the remaining ration was weighed to obtain data on ration consumption per week. Before weighing, the chickens were fasted for 8 hours. At the end of the rearing period, 2 chickens were slaughtered which have a weight close to the average of 10 chickens per cage unit. Cutting was done by cutting the neck so that the two blood vessels, the food pipe, and the respiratory tract were cut off. After cutting, the digestive tract was removed, which will be observed, such as parts of the small intestine. Next, the carcass weight was weighed which was obtained by weighing the slaughtered chicken parts, without blood, feathers, head, lower legs, and innards except the kidneys and lungs. Then separate the abdominal fat and weigh the abdominal fat. All data obtained were analyzed using analysis according to the design used.

The treatment ration consists of commercial rations without antibiotics, curcuma flour, and black garlic flour, the composition of which is detailed in the Table 1-4.

The variables observed in this study included feed consumption, slaughter weight, feed conversion, carcass weight, abdominal fat weight, and length and relative weight of the duodenum, jejunum, and ileum.

1. Ration consumption is measured weekly based on the amount of ration given at the beginning of the week with the remaining ration at the end of the week expressed in grams/head/week.
2. Slaughter weight is obtained by weighing the chicken at the end of rearing, after fasting before slaughter
3. Carcass weight is calculated by weighing the chicken after it has been slaughtered without the head, legs, feathers, blood, and digestive tract except for the lungs and kidneys, expressed in grams/head.
4. Meanwhile, the carcass percentage is based on the reference of Mangais *et al*. (2015), the comparison between carcass weight and slaughter weight multiplied by 100% expressed in percent (%) or by the formula:

$$Carcass\ Percentage\ (\%) \frac{Weight\ Carcass\ (gr)}{\text{Slaughter Weight}}\ x\ 100\%$$

5. Abdominal fat is body fat located in the lower abdominal cavity. Abdominal fat weight is measured after the fat is removed and weighed in grams. The percentage of abdominal fat follows the reference of Mangais *et al.* (2015) on the comparison between abdominal fat weight and slaughter weight, which is usually expressed as a percentage. The percentage of abdominal fat can be calculated using the formula:

$$Abdominal\ Fat\ Percentage\ \ (\%) \frac{Abdominal\ Fat\ Weight\ (gr)}{Slaughter\ Weight}\ x\ 100\%$$

6. The length of the small intestine was measured by a long ruler based on its parts, namely the duodenum, jejunum, and ileum, expressed in cm.
7. The relative weights of the duodenum, jejunum, and ileum were obtained following the reference of Satimah *et al.* (2019), namely the comparison of absolute weight and cutting weight, which is usually expressed in percent. The formula for calculating the relative weight of the small intestine is as follows:

$$\text{Relative Weight of Small Intestine}\ \ (\%) \frac{Intestine\ Weight\ (gr)}{Slaughter\ Weight}\ x\ 100\%$$

This research used an experimental method with a Completely Randomized Design (CRD) with 5 treatments and 4 replications, where each replication consisted of 10 chickens that were kept for 35 days with the treatments given including P0 = 100% commercial ratio (control), P1 = P0 + 2% black garlic, P2 = P1 + 0.25% curcuma flour, P3 = P1 + 0.50% curcuma flour and P4 = P1 + 0.75% curcuma flour.

Data Analysis

Data obtained from observed variables were analyzed using analysis of variance (ANOVA). The significant effect between treatments was tested further using Duncan's

Table 1. Composition of Treatment Ingredients

Material	Treatment (%)				
	P0	P1	P2	P3	P4
Rations Commercial	100	100	100	100	100
Black Garlic	0	2	2	2	2
Flour Curcuma	0	0	0.25	0.5	0.75
Amount	100	102	102.25	102.5	102.75

Table 2. Composition of food substances that make up commercial rations, black onions, and black garlic

Nutrient Content (%)	Black garlic	Curcuma	N-511b	N-512b
Dry Material	88.13	83.91	86	86
Crude Protein	18.43	3.07	21.5	19
Crude Fiber	0.49	4.01	5	6
Crude Lipid	0.36	4.99	5	5
Ash	5.52	7.25	8	8
NFE	63.32	64.59	46.5	48
EM (Kcal/Kg*	2921.02	2717.26	3000	3100

Description: a. Results of Integrated Laboratory Analysis of the Faculty of Animal Husbandry, Jambi University (2021); b. PT. Charoen Pokphand. *EM=34.92 CP + 62.16 CL + 35.61 NFE (Janssen 1989).

Table 3. Composition of food substances in starter phase treatment rations

Nutrient Content (%)	P0	P1	P2	P3	P4
Dry Ingredients	86	86.04	86.04	86.03	86.03
Crude Protein	21.5	21.44	21.39	21.35	21.3
Crude Fiber	5	4.91	4.91	4.91	4.9
Crude Lipid	5	4.91	4.91	4.91	4.91
Ash	8	7.95	7.95	7.9	7.95
NFE	46.5	46.83	46.87	46.92	46.96
EM (Kcal/Kg)	3000	2998.45	2997.75	2997.05	2996.36

Description: Calculation results based on Tables 1 and 2

Multiple Range tests (Steel and Torrie 1995). Data were checked for assumptions with SPSS 23 (IBM, NY, USA).

RESULTS AND DISCUSSION

Ration Consumption

The results of research on the evaluation of curcuma and black garlic flour in feed on carcass weight and abdominal fat could be seen in the Table 5. The results of the analysis of variance showed that the use of Curcuma flour and black garlic in broiler chicken feed in Table 5 above with a consumption range of 524.97-553.26 (g/head/week) does not have a significant effect (P>0.05). This

Table 4. Food substance composition of rations treated in the finisher phase

Nutrient Content (%)	P0	P1	P2	P3	P4
Dry Ingredients	86	86.04	86.04	86.03	86.03
Crude Protein	19	18.99	18.95	18.91	18.87
Crude Fiber	5	5.89	5.89	5.88	5.88
Crude Lipid	6	4.91	4.91	4.91	4.91
Ash	8	7.95	7.95	7.95	7.95
NFE	48	48.3	48.34	48.38	48.42
EM (Kcal/Kg)	3100	3096.49	3095.54	3094.6	3094.67

Description: Calculation results based on Tables 1 and 2

means chickens can consume feed with this content without negative reactions at the level of 0.75% for curcuma flour and 2% for black garlic. Previously, Tadanu *et al.* (2022) even stated that curcuma does not have acute toxic effects based on rat tests. According to Gholami-Ahangaran *et al.* (2016) showed that curcuma can protect against the toxic effects of aflatoxin on the liver and kidneys of broiler chickens. Factors such as interactions between feed components, response physiology, taste image, and feed texture can influence the results of feed consumption. This is following Dharmawati *et al.* (2013) that broiler chicken feed is influenced by the form of feed given. Although Curcuma and black garlic have the potential to improve the health and performance of broiler chickens, their effect on feed consumption is not significant in the context of this study. Individual variations in tolerance and feeding preferences are also possible influence results of ration consumption. Therefore, despite their health and performance potential, the effects of these two ingredients on feed consumption were not significant in this study.

Slaughtered Weight

The results of this study showed that the evaluation of curcuma and black garlic flour did not have a significant effect (P>0.05) on the slaughter weight of broiler chickens. This may be due to the relatively similar consumption of rations for each treatment indicating that broiler chickens receive similar amounts of nutrition from each treatment. In line with Sjofjan and Djunaidi (2016), the resulting body weight is influenced by the type of feed consumed. The very close relationship between slaughter weight and feed consumption implies that when there is no difference in feed consumption, the same slaughter weight will result. Factors that influence the slaughter weight of broiler chickens include macroclimatic conditions, quality and quantity of feed, and the amount of feed consumed (Nurhidayat *et al.* 2020). The results of this research are in line with Tanti *et al.* (2022) Giving 2% black garlic flour and 1% curcuma flour did not show a significant effect on slaughter weight and feed consumption in broiler chickens.

Table 5. Average feed consumption, slaughter weight, carcass weight, carcass percentage, abdominal fat weight, and abdominal fat percentage of broiler chickens

Treatment	Variable					
	Ration Consumption (g/bird/week)	Slaughter Weight (g/bird)	Carcass Weight (g/bird)	Carcass Percentage (%)	Abdominal Fat Weight (g/bird)	Abdominal Fat Percentage (%)
P0	524.97 ±17.74	1665.75±64.39	1166.18±49.35	70.08±3.75	15,14±2.41	0.91±0.16
P1	529.55 ±18.29	1644.59±38.38	1180.04 ± 50.95	71.79±2.28	15,18±2.56	0.95±0.16
P2	529.55 ± 19.37	1661.56±38.31	1222.54 ± 27.12	73.62±2.31	13.44±2.43	0.81±0.13
P3	538.81 ±15.54	1621.63±13.19	1161.56±54.81	71.65±3.09	12.53±1.46	0.77±0.10
P4	553.26 ±13.24	1648.83 ± 40.85	1211.84±81.23	73.45±3.13	15.28±2.90	0.93±0.18

Information: P0 = commercial ration (control), P1 = ration commercial and 2% black garlic P2 = P1 + 0.25% curcuma flour, P3 = P1 + 0.50% curcuma flour, P4 = P1 + 0.75% curcuma flour.

Carcass Weight

The results of the analysis of variance showed that the use of curcuma flour and black garlic did not have a significant effect (P>0.05) on broiler chicken carcass weight. The results of this study were also in line with the slaughter weight which was also not significant. Broiler chicken carcass weight is greatly influenced by slaughter weight, where the heavier the chicken, the greater the carcass weight (Solikin 2016). This is because carcass weight is part of the total weight of the chicken that has been slaughtered. According to Herlinae *et al.* (2022), if there is no significant difference in slaughter weight, then there will be no significant difference in carcass weight either. Other factors that also influence carcass weight include the percentage of fat, muscle, and bone in the chicken's body.

Carcass Percentage

Table 5 shows that there is no significant effect (P>0.05) from the evaluation of curcuma and black garlic flour on broiler chicken carcass percentage. This is thought to be due to the absence of significant differences in carcass weight, which indicates that carcass percentage does not have a real influence on overall carcass weight. The normal carcass percentage of broiler chickens ranges from 65% - 75%, and the carcass percentage is influenced by slaughter weight and carcass weight (Salam *et al.* 2017). According to Subekti *et al.* (2012) stated that carcass percentage is influenced by final live weight so that a large live weight will be followed by a large carcass percentage, and vice versa. The carcass percentage results in this study ranged from 70.08% to 73.62%. The results of this research are in line with research by Zulfikar *et al.* (2022) which shows that the average carcass percentage using turmeric and black garlic in feed ranges from 69.64% to 73.12%.

Abdominal Fat Weight

The results showed that the treatment had no effect significant (P>0.05) on abdominal fat weight in broiler chickens. This is thought to be an indication that use in this context has equivalent effectiveness as a control in treating abdominal fat in chickens. In addition, the metabolic activity of chickens may not be directly influenced by curcuma and black garlic in the doses used in this study as well as individual variability in response to the evaluation of the herb. Determining the dose of curcuma given to broiler chickens refers to the dose given so that the function of the bioactive substances plays an optimal role in reducing abdominal fat (Kartini *et al.* 2023). However, in this study, it seems that the activity of allicin and curcumin does not play an optimal role in breaking down fat in the body to effectively break down the fat components in the body of broiler chickens.

Abdominal Fat Percentage

The results of the analysis of variance showed that the evaluation of curcuma and black garlic had no effect significant (P>0.05) on the percentage of abdominal fat in broiler chickens. This shows that the variation in treatment given does not significantly affect the percentage of abdominal fat in broiler chickens. Therefore, it is necessary to add curcuma and black garlic at even higher doses so that abdominal fat can decrease significantly. The results of this study are in line with Zulfikar *et al.* (2022) that giving black garlic and turmeric cannot have a significant effect on the percentage of broiler abdominal fat, which is around 0.55%-0.81%.

The Length of Small Intestine

The results of research evaluating curcuma and black garlic flour in feed on small intestine morphometrics are presented in Table 6. Table 6 shows that the evaluation level of 0.75% Curcuma and 2% black garlic does not have a significant effect (P>0.05) on duodenal length, jejunum, and ileum. This is assumed to be because all broiler chickens are given the same form of feed and treatment, so there is no difference in the taste or attractiveness of the feed which could affect the length of the small digestive intestine. Feed consumption is a factor that can influence the length of the small intestine (Kusmayadi *et al.* 2019). The results of this study are consistent with Wahyuni *et al*. (2022), the use of black garlic and turmeric in feed did not show a significant effect (P>0.05) on the length of the small intestine of broilers. Comparable growth will result in similar length and weight of the intestine, because the development of the digestive tract organs, especially the intestine, is closely related to the level of growth (Berliana *et al.* 2022). The average length of the small intestine in this study was still within the normal level. According to research by Satimah *et al.* (2019), the normal length of the duodenum is around 32.75 cm, the jejunum around 79.25 cm, and the ileum around 83.25 cm.

Table 6. Small intestine morphometric means

Treatment	Variable					
	Duodenum Length (cm)	Jejunum Length (cm)	Ileum Length (cm)	Duodenum Relative Weight (%)	Jejunum Relative Weight (%)	Ileum Relative Weight (%)
P0	29.06±0.83	78.89±2.04	79.63±2.31	0.50±0.07	0.95±0.12	0.75±0.04
P1	29.81±1.48	78.19±2.56	79.74±0.53	0.55±0.05	0.98±0.16	0.76±0.11
P2	30.50±1.47	78.31±1.36	80.13±1.59	0.53±0.04	0.98±0.08	0.77±0.05
P3	30.09±1.71	78.63±1.98	80.63±0.60	0.53±0.04	1.01±0.05	0.77±0.08
P4	31.75±0.89	78.69±1.80	80.69±0.69	0.55±0.04	1.02±0.07	0.78±0.04

Information: P0 = commercial ration (control), P1 = ration commercial and 2% black garlic P2 = P1 + 0.25% curcuma flour, P3 = P1 + 0.50% curcuma flour, P4 = P1 + 0.75% curcuma flour.

Relative Weight of Small Intestine (%)

Results of analysis of variance in the table. showed that the use of 0.75% curcuma flour and 2% black garlic did not have a significant effect (P>0.05) on the relative weights of the duodenum, jejunum, and ileum. It is estimated that the factor causing the low effectiveness of curcuma and black garlic in this study was the same form of feed and feed additives, the doses given were still low. Thus, it results in the non-optimal function of these two supplements on the weight of parts of the small intestine. The results of this study are similar to Wahyuni *et al.* (2022) who concluded that giving black garlic at a 3% level did not affect the small intestine of broiler chickens. As a result, the allicin contained in black garlic cannot be absorbed effectively by intestinal epithelial cells, so it does not affect the metabolism of the digestive tract, especially in the small intestine (Praktikno 2010). The results of this study are in line with the findings of Satimah *et al.* (2019), where the average relative weight of the duodenum is around 0.52%, the jejunum is around 1.11% and the ileum is around 0.93% of the slaughter weight.

CONCLUSION

The conclusion of this study indicate that the addition of curcuma flour up to 0.75% and black garlic 2% in broiler chicken feed does not affect the activity of the small intestine, broiler carcass, and abdominal fat, as reflected in normal organ weights. There is a need for further research involving higher levels of variation and given in feed in pellet form, so that the activity of the active substances contained can optimally play a role in improving the quality of the carcass and digestive tract of broiler chickens.

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