Open access
Vol. 21 No. 1: 63-68, April 2023
e-ISSN: 2622-3279, p-ISSN: 2657-0068
DOI: http://dx.doi.org/10.29244/jintp.21.1.63-68

Jurnal Ilmu Nutrisi dan Teknologi Pakan
http://journal.ipb.ac.id/index.php/jurnalintp

Effect Dietary Garlic Processed on Performance and Intestinal of Broilers

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Submitted : February 04, 2023
Accepted : April 05, 2023

ABSTRACT

This study aimed to determine the effect of dietary processed garlic in feed on the performance, intestinal weight, intestinal length, and morphology of the intestinal villi of broilers. A total of 200 Day-Old-Chick (DOC) Cobb strains (unsexed) with an average body weight of 42 ± 3 g were randomly allocated to four experimental groups with five replications, each containing ten chicks per replication. The treatments were T0 (basal diet as control), T1 (basal diet + 3% garlic paste), T2 (basal diet + 3% garlic powder), and T3 (basal feed + 3% black garlic powder). The variables measured were feed intake, body weight gain, feed conversion ratio, final body weight, intestinal weight, intestinal length, and intestinal villi morphology. The data were analyzed for variance based on a Completely Randomized Design. If there was a difference, Duncan's multiple range test was applied. The results showed that the treatment had a significant effect ($p<0.05$) on intestinal weight, but there was no significant effect on intestinal length and performance. The addition of processed garlic increased the height and width of the villi of the intestines of broilers. The present study's findings suggest that the dietary intake of processed garlic significantly improved the intestinal weight and morphology of broiler villi. However, it did not significantly improve performance.

Key words: broilers, garlic processed, intestinal, morphology of villi, supplementation

ABSTRAK

Penelitian ini bertujuan untuk mengevaluasi pengaruh pemberian bawang putih olahan dalam pakan terhadap performa, bobot usus, panjang usus dan morfologi vili usus ayam broiler. Sebanyak 200 ekor DOC (*Day-Old-Chick*) *unsexed* dengan rata-rata bobot badan 42 ± 3 g secara acak dibagi ke dalam empat kelompok percobaan dengan lima ulangan, masing-masing ulangan terdiri dari sepuluh ekor ayam. Perlakuan yang diberikan adalah T0 (pakan dasar sebagai kontrol), T1 (pakan dasar + 3% pasta bawang putih), T2 (pakan dasar + 3% tepung bawang putih), dan T3 (pakan dasar + 3% tepung bawang hitam). Peubah yang diukur adalah konsumsi pakan, pertambahan berat badan, rasio konversi pakan, bobot badan akhir, bobot usus, panjang usus, dan morfologi vili usus. Data dianalisis untuk peubah berdasarkan Rancangan Acak Lengkap. Jika terdapat perbedaan, dilakukan uji beda nyata jarak berganda Duncan. Hasil penelitian menunjukkan bahwa perlakuan memiliki pengaruh signifikan ($p<0,05$) pada bobot usus, tetapi tidak memiliki pengaruh signifikan pada panjang usus dan performa. Penambahan bawang putih olahan meningkatkan tinggi dan lebar vili usus ayam broiler. Simpulan penelitian ini menunjukkan bahwa konsumsi pakan bawang putih olahan secara signifikan meningkatkan bobot usus dan morfologi vili ayam broiler. Namun, tidak signifikan meningkatkan performa.

Kata Kunci: ayam broiler, bawang putih olahan, morfologi vili, suplementasi, usus.

INTRODUCTION

The productivity of broiler chickens is influenced by their health. Under healthy conditions, livestock can optimally absorb the nutrients they consume, resulting in a high body weight. The health of the digestive tract, as an absorption organ, plays a crucial role in nutrient absorption. The segments of the digestive tract, such as the duodenum, jejunum, and ileum, are equipped with villi, which significantly influence the smooth absorption of nutrients. Farmers have traditionally used antibiotics in animal feed to improve the health of their animals' digestive tracts. However, the use of antibiotics can result in residues in livestock, which can lead to bacterial resistance in humans. To address this issue, in January 2018, the Indonesian government officially prohibited the use of antibiotics as additional feed, as stated in Article 16 of the Minister of Agriculture No. 14 of 2017 regarding the classification of veterinary drugs.

The prohibition on the use of AGP in feed raises concerns about the decline in health, which could affect broiler production performance. As a result, we need alternative natural ingredients that perform a similar function to AGP. One such natural ingredient that can be used is garlic, which contains allicin, a natural antibiotic (Lingga 2012). Allicin functions similarly to AGP, the most widely used tetracycline in poultry (Ambrožič 2012). The allicin compound found in garlic acts as an antibacterial, which can increase the activity of the digestive tract by relaxing the small intestine and inhibiting harmful microorganisms in the digestive tract. Allicin in garlic enhances digestion by improving the performance of the intestinal flora, which ultimately leads to an increase in body weight (Pourali *et al*. 2014). However, the use of garlic as a feed additive is limited due to its high water content and strong aroma, which require processing before use. According to Kothari *et al*. (2019), the supplementation of processed garlic in feed increases palatability and influences feed consumption due to taste factors. The processing method used should be evaluated in terms of its impact on broiler performance and intestines to be used as an alternative feed to replace antibiotics in feed. Garlic processing methods have an impact on their ability to improve broiler performance by increasing the height and width of the intestinal villi.

Based on the description above, this research aimed to determine the effect of dietary processed garlic in feed on the performance, intestinal weight, intestinal length, and morphology of the intestinal villi of broilers. The goal was to provide recommendations for appropriate garlic processing techniques that can effectively serve as an alternative feed additive to AGP.

METHODS

Birds and Dietary Treatments

This study utilized two hundred broiler chicks with an initial body weight of 42±3 g obtained from a local breeder. A completely randomized design with four treatments and five replications, containing ten chicks per replication, was arranged for this study. The treatments were T0 = basal diet, T1 = T0 + 3% garlic paste, T2 = T0 + 3% garlic powder, and T3 = T0 + 3% black garlic powder. The addition of garlic processed was based on a percentage of the total diet. The basal feed was categorized into three types based on age: pre-starter feed (1-7 days), starter phase feed (8-21 days), and finisher phase feed (22-35 days). The composition and nutritional content of the basal diet are presented in Table 1, while the composition and nutritional content of garlic processed are presented in Table 2.

Experimental Bird Management

This research began by preparing garlic paste, black garlic powder, diet, cages, and equipment. Garlic paste was prepared by modifying the method of Gautam *et al.* (2017). The outer skin was peeled off, and the cloves were separated from the bulb. After peeling, the outer skin was weighed, and the cloves were ground in a food grinder before being added to the diet. Garlic was processed into garlic powder by modifying the method of Syakir *et al.* (2017), in which the garlic was separated into single cloves and peeled. The garlic was thinly sliced (2-3 mm) and dried in an oven at 60ºC for 5 hours. After drying, it was ground with a blender until it resembled flour. Garlic was processed into black garlic by modifying the method of Berliana *et al.* (2018). The garlic was wrapped in aluminum foil and heated in a rice cooker at a temperature of 60ºC for 17 days. After the garlic turned black, the outer skin was peeled, and it was dried in an oven at 60ºC for 3 days. After drying, it was ground with a blender until it resembled flour.

The chicks were obtained from a local breeder and offered dietary treatments from eight days of age with an average body weight of 210.75 g until they were 35 days old. Feeds and water were provided ad libitum throughout the study period. On day 35, a total of 20 chicks with an average body weight (not the lowest or highest) were slaughtered.

Table 1 The composition and nutritional content of basal diet

Ingredients	Amount (%)		
	Pre-starter	*Starter*	*Finisher*
Metabolic Energy (kcal kg^{-1}	2900	3000	3100
Moisture (max) %	14	14	14
Ash (max) %	8	8	8
Crude protein (min) %	20	20	19
Crude fat %	4	5	5
Crude fiber (min) %	4	5	6
Calcium %	0.8 - 1.1	0.8 - 1.1	0.8 - 1.1
Phosphorus (min) %	0.5	0.5	0.5

Based on the information stated on the commercial ration label

Table 2 The composition and nutritional content of garlic processed

Ingredients	Garlic paste*	Garlic Powder**	Black garlic powder**
Dry matter (%)	27.58	93.41	93.39
Moisture (%)	72.42	6.59	6.61
Ash (%)	3.01	5.05	5.49
Crude fat (%)	0.11	0.91	0.22
Crude protein (%)	10.62	14.67	15.22
Crude fiber (%)	6.32	0.56	4.07

Sources: *Nassur *et al.* (2017) **Laboratorium PAU IPB University (2021)

Each replication of each treatment was represented by one chick, which was then defeathered and eviscerated. The intestines were immediately removed and weighed. The following parameters were evaluated (as a percentage of live body weight): intestinal weight and length. Then, a 3 cm sample was taken from the middle part of the intestine to observe the morphology of the villi (Alagawany *et al.* 2021). The analysis and measurement of intestinal villi in broilers were carried out in the Iratco laboratory.

Statistical Analysis

The data on feed intake, body weight gain, feed conversion ratio, final body weight, intestinal weight, and intestinal length were analyzed using a Completely Randomized Design by ANOVA. Duncan's multiple range test was used to further analyze significant differences among treatment groups. A significance level of $p<0.05$ was implemented. The morphology data of the villi (villi height and villi width) were analyzed descriptively.

RESULTS AND DISCUSSION

Performance

The supplementation of garlic processed in broiler feed did not show any significant effect on feed intake, body weight gain, feed conversion ratio, and final body weight. The results of the impact of dietary garlic processing on broiler performance are presented in Table 3.

The addition of processed garlic to the broiler feed had no significant impact on feed intake. This is likely due to the loss of essential oils, one of garlic's main components, during processing, which renders them ineffective in stimulating gastric emptying and thereby limiting their ability to increase appetite. This is consistent with the assertion of Wińska *et al.* (2019) that essential oils are volatile compounds with a low boiling point, making them prone to evaporation, and consequently, studies may yield divergent outcomes.

Processed garlic supplementation in feed had no significant effect on broiler body weight gain. This could be attributed to the fact that their feed consumption remained relatively constant, resulting in a similar increase in body weight. The rate of growth and final weight of broiler chickens are largely determined by the amount of feed they consume, as weight and body composition are an accumulation of the nutrients ingested. This is supported by Moraes *et al.* (2013), who found that higher levels of dietary protein and amino acids led to greater body weight gain, feed intake, and protein synthesis in birds. Citrawidi *et al.* (2012) also noted that broiler chicken growth is influenced by the quantity and quality of their feed, as they require sufficient nutrients to support their tissue growth. Additionally, Nugraha *et al.* (2017) affirmed that weight gain is closely linked to feed consumption, and any disruption in this process may hinder the growth of broiler chickens.

Processed garlic supplementation had no significant effect on broiler feed conversion ratio. This is consistent with the findings of Atuahene *et al.* (2019), which showed that adding garlic to the Cobb strain broiler feed did not significantly affect feed conversion. The group of broilers that received 3% garlic powder supplementation (P2) had a feed conversion value of 1.55, while the highest feed conversion of 1.63 was obtained by the group of broilers fed with 3% black garlic powder supplementation (P3). This indicates that P2 is more efficient in utilizing feed compared to P3. These results are in line with the research conducted by Fadlalla *et al.* (2010) and Saleh *et al.* (2012), who discovered that supplementing feed with 3% garlic powder led to better feed conversion.

Data on Tabel 3 showed that there was no significant effect on final body weight. Supplementing broiler feed with 3% garlic powder (T2) resulted in an average final body weight of 2178.57 g per bird. Garlic powder contains allicin and scordinin, which have been found to

Table 3 Effect of dietary garlic processed on performance of broilers 35 days old

Variables	Garlic supplementation treatment:				SEM	*P*
	T0	T1	T2	T3		
Feed intake (g bird^{-1})	3339.11	3290.49	3309.17	3295.78	22.84	0.90
Body weight gain (g bird^{-1})	2176.23	2113.38	2143.70	2030.05	25.35	0.21
Feed conversion ratio	1.54	1.56	1.55	1.63	0.02	0.29
Final body weight (g bird^{-1})	2218.51	2173.57	2178.57	2112.29	19.68	0.31

T0 = basal diet, T1 = T0 + 3% garlic paste, T2 = T0 + 3% garlic powder, T3 = T0 + 3% black garlic powder

contribute to the growth of broilers. Allicin is believed to increase the height of villi and depth of intestinal crypts, which expands the area for nutrient absorption and leads to increased digestion. The development of intestinal villi is important for intestinal function and growth in broilers, and feed additives such as garlic can promote their development and improve growth performance (Qaisrani *et al*. 2015; Rahman *et al.* 2021). Scordinin in garlic also plays a role in accelerating and increasing the formation of body cells, leading to optimal final weight (Dahlan & Haqiqi, 2012). Peinado *et al.* (2013) found that garlic compounds can increase nutrient digestibility and intestinal mucosal enzyme activity in Cobb strain broilers. In this study, broilers supplemented with garlic had a higher average final body weight of 2112.29 to 2218.51 g bird^{-1} at 35 days of age compared to broilers without garlic supplementation. The final weight of broilers reflects accumulated growth during maintenance, which is influenced by feed intake and type of feed (Jaelani *et al*. 2014). High slaughter weight indicates good carcass quality and more meat, which is an important economic variable in livestock business (Indra *et al*. 2015; Husna *et al*. 2016).

Intestinal

Garlic supplementation from processing in broiler feed had a significant effect ($p<0.05$) on intestinal weight, but there was no significant effect ($P>0.05$) on intestinal length. The effect of dietary garlic processed on the intestinal of broilers is presented in Table 4.

The results of the analysis of variance showed that the supplementation of processed garlic in the feed had a significant ($p<0.05$) effect on the intestinal weight of broilers. Intestine weight produced in this study ranged from 4.29-5.38%. The treatment T1 was significantly different from T0. The group of broilers supplemented with 3% fresh garlic in feed (T1) had the highest intestinal weight, which is thought to be due to the high crude fiber content of garlic paste, which contains 6.32% crude fiber compared to 0.56% in garlic powder and 4.07% in black garlic powder (based on data in Table 2). According to Sun *et al.* (2019), high-fiber diets can increase intestinal weight. Table 4 showed no significant difference between T1, T2, and T3, which is likely due to relatively the same growth (data in Table 3 are not significantly different) producing intestinal weights that efficiency of feed utilization in broilers. There are also not significantly different, as the development of the digestive tract organs, especially the intestine, correlates with growth rates, and high growth produces organ weights. Liu *et al.* (2014) stated that ration intake influences the proportion of small intestine weight, improves intestinal performance, and increasing the surface area of the intestine can improve nutrient absorption and growth performance in broiler chickens.

Based on the data in Table 4, it can be seen that the average length of the intestine in this study ranged from 7.97% to 8.76% of the slaughter weight. The results show that the treatment had no significant effect on intestinal length. The increase in the length of the small intestine in the broiler group that was fed with 3% garlic paste supplementation (T1) in the feed was also probably due to the increased activity of the small intestine during the digestion and absorption of incoming nutrients. The small intestine can stretch and expand in size (length), so that the intensity of nutrients needed by the body can be optimally absorbed. According to Satimah *et al*. (2019), the length of the intestine is closely related to the length of the villi and the relative weight of the intestine. The longer the intestinal villi, the wider the surface for nutrient absorption and the optimal absorption of nutrients, causing the intestine to become heavier and longer. This follows the opinion of Rostami *et al.* (2014), which states that the growth of small intestinal villi height is closely related to the potential of the small intestine to absorb nutrients. The higher the small intestinal villi, the greater the effectiveness of nutrient absorption through the small intestine epithelium. Wang *et al*. (2016) argue that a longer small intestine indicates a larger area for the digestion and absorption of nutrients.

Supplementation of 3% black garlic powder in the feed (T3) resulted in villi with a height of 2033.282 area of the villi play an important role in nutrient digestion and absorption in broiler chickens, and increasing the surface area of the villi can improve the µm, which was the highest mean villi height observed. According to Zhang *et al.* (2019), the height and surface In line with the research results obtained by Lee *et al.* (2016), supplementation of fermented garlic or black garlic can increase the villi height and crypt depth of the small

Table 4 Effect of dietary garlic processed on the intestinal of broilers

Variables	Garlic supplementation treatment:				SEM	*P*
	T0	T1	T2	T3		
Intestinal weight (%)	4.29^{b}	5.38^{a}	4.94^{ab}	4.47^{ab}	0.16	0.09
Intestinal length (%)	8.10	8.63	7.97	8.76	4.12	0.38
Height of villi (µm)	1876.079	1876.678	1862.151	2033.282	-	-
Width of villi (µm)	104.484	107.072	139.885	147.403	-	-

T0 = basal diet, T1 = T0 + 3% garlic paste, T2 = T0 + 3% garlic powder, T3 = T0 + 3% black garlic powder; Different superscripts on the same line indicate significantly different $p<0,05$

intestine. This is due to the ability of the active compounds in black garlic that can affect the performance of the intestines in the digestive process and absorption of nutrients. An increase in villi height in the small intestine of broilers is closely related to an increase in digestive and absorption functions because the absorption area expands, and it is an expression of a smooth nutrient transport system throughout the body. In the broiler group fed with 3% garlic powder supplementation (T2), there was a decrease in villi height compared to the control, from 1876.079 µm to 1862.151 µm. This decrease probably occurred because the intestines of broilers in group T2 were less active, and "villous atrophy" occurred, meaning that the limited amount of consumption and nutrients led to intestinal hypomotility due to the limited amount of feed consumed.

Supplementation of processed garlic in feed causes an increase in the width of the intestinal villi of broilers compared to the control treatment (T0). The broiler group fed commercial feed without processed garlic supplementation (T0) produced villi with a width of 104.484 µm, while the width of the villi in the broiler groups fed with supplementation of garlic paste, garlic powder, and black garlic powder were 107.072 µm (T1), 139.885 µm (T2), and 147.403 µm (T3), respectively. These findings are consistent with the results obtained by Karangiya *et al.* (2016), which indicate that garlic supplementation in feed can significantly increase the width of the intestinal villi of broilers. According to Landung *et al.* (2013), the performance of the small intestine villi is influenced by several factors, including the type of feed (feed additive) and feed chemicals (nutrients). Feed that requires intensive absorption will cause the small intestine to expand its surface area, which is expressed by the height and width of the intestinal villi. El-Hack *et al.* (2017) reported that garlic significantly increased the villi height and crypt depth while decreasing the epithelial thickness and the number of goblet cells in the duodenum, jejunum, and ileum of poultry. The growth of small intestinal villi height is closely related to the potential of the small intestine to absorb nutrients.

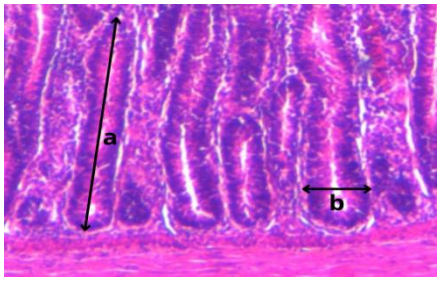

Figure 1 Histological villi of intestinal. Height of villi (a) and width of villi (b)

The higher the small intestine villi, the greater the effectiveness of nutrient absorption through the small intestinal epithelium (Rostami *et al*. 2014). Similarly, as the width of the intestinal villi increases, so does the surface area of the villi for nutrient absorption into the bloodstream (Elnesr *et al.* 2020). Histological description of the small intestine (jejunum) of broilers in this study can be seen in Figure 1.

The supplementation of black garlic powder (T3) in the feed resulted in a longer transit time for nutrients in the intestine compared to the other treatments. However, the higher mean width of the villi (T3) may not be supported by the number of gastrointestinal microflora. It has been shown to increase protein digestibility better than the other treatments. Ultimately, the highest body weight was obtained in the broiler group fed with 3% garlic powder supplementation (T2). Furthermore, the larger width of the villi (T3) is also likely not matched by better protein digestibility. It is thought to be due to the inhibition of pepsin enzyme activity in the proventriculus to digest protein into peptide pieces. The supplementation of 3% garlic paste (T1) and 3% black garlic powder (T3) in the feed increased the fiber content, which caused an increase in digest viscosity, leading to a decrease in nutrient (protein) digestibility. According to Cadogan & Choct's (2015) opinion, the fiber's water-binding capacity reduces the diffusion of digestive products on the intestinal surface mucosa.

Studies have shown that feeding processed garlic in broiler diets can increase the weight of the intestinal tract and villi, which are important for nutrient absorption and digestion. However, the effects of processed garlic on broiler performance (such as growth rate, feed intake, and feed conversion ratio) have been mixed, with some studies reporting no significant effects while others reporting improvements in performance. The lack of significant effects on broiler performance may be due to various factors such as the dose and duration of feeding, the age of the birds, and the composition of the basal diet. Additionally, environmental conditions and management practices can also affect broiler performance.

CONCLUSION

The dietary supplementation of processed garlic significantly improved the intestinal weight and morphology of broiler villi. However, it did not significantly improve performance.

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